Development of standardised sizing systems for the South African children's wear market

By

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DECLARATION

I, the undersigned, hereby declare that the work contained in this dissertation is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

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ABSTRACT

This research focused on the need of the children's wear industry in South Africa for sizing systems based on accurate and current body measurement tables developed from the actual measurements of children. The broad objective of this study was to develop standardised measuring methodologies and techniques which would be relevant to the subsequent development of reliable, accurate and comprehensive body measurement tables. These tables could then be implemented as a basis for the development of new sizing systems, as well as new, improved and authentic fit dummy ranges.

The literature study served as a point of departure for the planning and execution of the empirical study, focusing on sizing and size designation systems. The study population comprised children representative of three categories, namely age (2 to 14 years), gender (boys and girls) and sector (Black and Non-Black) categories. A convenience sample was selected, representing children from two geographical areas (Western Cape and Gauteng).

The empirical study has a three phase structure. The first pilot study aimed at developing standardised measuring equipment, as well as the methodologies and properly recorded guidelines for their implementation. The specific standards according to which subjects were measured and the strict quality control measures implemented to ensure the validity, reliability and accuracy of recorded data, were confirmed during the second pilot study. Based on this, the final study was executed following the guidelines as recorded in the *Field Worker Manual*.

The statistical analysis was done after data capturing during which the data sets were first cleaned up. Secondly, the key measurements for use as a basis for the development of the sizing systems were identified. Based on these, body measurement tables were compiled and age of gender split and growth patterns were analysed for fit dummy prototype development.

The new size designation system developed for children's clothing was successfully implemented as a multi-indicator system, linking height ranges with both age ranges and numerical size indicators. The development of the subsequent new and improved fit

dummy prototypes was based on measurements within minimum and maximum values of the body measurements, in order to facilitate the construction of these three-dimensional bodies. It was also possible to develop complete body measurement tables with accurate, and notably irregular, increments between sizes as well as to determine specific growth patterns and separate growth spurts for both boys and girls.

This study made new and original as well as more detailed and correct information available concerning the size and shape of the typical South African children's wear consumer. Using the information contained in the new height based sizing system, retailers have been able to develop a proper set of grade rules for application in product development. The identification and demarcation of important body landmarks facilitated pattern drafting, garment development and fit assessments, resulting in an improved product offering for the typical South African children's wear consumer.

Recommendations regarding further research were formulated, such as comparing the study population categories, namely gender, age and sector. Implications for retailers, inter alia that each retail company could choose how to implement the new height based sizing system and the specific size designation system most suitably for their own consumers and internal systems. The standards set and methodologies implemented in this survey were an improvement on the sizing and fit of children's wear in the context of South African manufacturers, retailers and consumers.

OPSOMMING

Hierdie navorsing fokus op die behoefte van die Suid-Afrikaanse kinderklere-kleinhandelbedryf aan ‘n sisteem van kleregroottes, gebaseer op akkurate en huidige liggaamsmate-tabelle wat ontwikkel is van die werklike mates van kinders. Die oorkoepelende doelstelling van hierdie studie was om gestandaardiseerde meetmetodologieë en -tegnieke te ontwikkel wat relevant is vir die daarstelling van betroubare, akkurate en omvattende liggaamsmate-tabelle, wat dan gebruik kan word as basis vir die nuwe kleregroottesisteem, sowel as om nuwe, verbeterde en oorspronklike figuurmodelreekse te ontwikkel.

Die literatuurstudie het gedien as vertrekpunt vir die beplanning en uitvoering van die empiriese studie met die fokus op kleregroottesisteme en kleregrootte-aanwysingsisteme. Die kinders in die studiepopulasie het drie kategorieë verteenwoordig: ouderdom (2 tot 14 jaar), geslag (seuns en meisies) en sektor (Swart en Nie-Swart). ‘n Gerieflikheidsteekproef is uit twee geografiese areas (Wes-Kaap en Gauteng) gekies.

Die empiriese studie het ‘n drie-fase-struktuur. Die eerste loodsstudie het ten doel gehad om gestandaardiseerde meettoerusting, meetmetodologieë en behoorlik aangetekende implementeringsriglyne daar te stel. Die spesifieke standaarde waarvolgens die proefpersone gemeet is en die implementering van streng kwaliteitbeheermaatreëls wat geldige, betroubare en akkuraat vasgelegde data verseker, is tydens die tweede loodsstudie bevestig. Die finale studie is gebaseer op en uitgevoer volgens die riglyne soos uiteengesit in die *Field Worker Manual*.

Die statistiese analise is gedoen nadat die data vasgelê en skoongemaak is. Vervolgens is sleutelmates geïdentifiseer wat as basis vir die ontwikkeling van kleregroottesisteme kan dien. Volledige liggaamsmate-tabelle is daarna ontwikkel. Die identifisering van die geslagverdelingsouderdom, sowel as die analisering van groeipatrone vir die ontwikkeling van figuurmodelle, is hierop gebaseer.

Die nuwe klere-aanwysingsisteme wat ontwikkel is vir kinderklere is suksesvol geïmplementeer as ‘n veelvoudige aanwysingsisteem wat liggaamslengtereekse met

ouderdomsreekse en numeriese grootte-aanwysers koppel. Die nuwe en verbeterde figuurmodel-prototipes wat vervolgens ontwikkel is, is gebaseer op minimum en maksimum waardes van die liggaamsmates ten einde die konstruksie van die drie-dimensionele figure te vergemaklik. Daarbenewens was dit moontlik om volledige liggaamsmate-tabelle met akkurate en opmerklik ongelyke inkremente tussen groottes daar te stel, sowel as om die spesifieke groeipatrone en afsonderlike groeitoenames vir beide seuns en meises te bepaal.

Die studie het nuwe en oorspronklike, sowel as meer gedetailleerde en korrekte inligting ten opsigte van die grootte en vorm van die tipiese Suid-Afrikaanse kinderklereverbruiker beskikbaar gestel. Met hierdie nuwe kennis van die liggaamslengte-gebaseerde kleregroottesisteem, is dit nou vir kleinhandelaars moontlik om ‘n volledige stel graderingsreëls daar te stel en in produkontwikkeling toe te pas. Die identifikasie en afbakening van belangrike liggaamsbakens vergemaklik patroon- en klereontwikkeling sowel as die evaluering van die mate waarin dit pas; dit waarborg ‘n verbeterde produk vir die tipiese Suid-Afrikaanse kinderklereverbruiker.

Aanbevelings vir verdere navorsing is gemaak, soos ‘n vergelyking van die studiepopulasiekategorieë, naamlik geslag, ouderdom en sektor. Die implikasies vir kleinhandelaars is onder meer dat elke kleinhandelaar kan kies hoe om hierdie nuwe liggaamslengte-gebaseerde kleregroottesisteem te implementer en watter die mees geskikte kleregrootte-aanwysingsisteem vir hul verbruikers en interne sisteme sal wees. Die standaarde wat vir hierdie studie gestel is, sowel as die metodologieë wat geïmplementeer is, is ‘n aansienlike verbetering op die groottes en pas van kinderklere binne die konteks van die Suid-Afrikaanse vervaardigers, kleinhandelaars en verbruikers.

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CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

The human body has been a subject of study in many fields for years and it was not until recent years that more precise knowledge became available through anthropometry. Anthropometry studies the measurable characteristics of mankind (Sameint, 2002: 1). Over the years and particularly since garments were first mass-produced, by the end of World War One, the problem of what sizes to make and how to label them, has existed (Winks, 1997:1). Traditionally, garment sizing systems had been based on intuitive or trial-and-error methods, but increased competitiveness and trends towards mass-customisation of clothing required more accurate and empirically based sizing systems (Anthrotech, 2002:1). Garment manufacturers are therefore constantly faced with the dilemma of what sizes to make when mass-producing clothes. However, the availability of anthropometric data on the dimensions of a population creates a scientific basis for the clothing industry to specify what size range a design should fit.

It is, however, important to recognise that analysing the size and shape of a population is a very complex exercise. For application in any garment industry, Taylor (1990:48) recommended that the primary aim of such an exercise should be to find the statistically average height, size and shape of the study population. The secondary aim is to establish an acceptable sizing system for general use in that market sector. With regard to sizing, surveying the bodies of children, infants and babies is the most difficult, due to the growth factor of children, which results in the need to offer numerous sizes. During the development of the human body, different changes in width, height and weight are evident with the increase in age. It is important to consider that the human body develops, grows and changes during the lifecycle by increase in size, differentiation of structure and the alteration of shape. These changes need to be understood in order to make clothing that fits comfortably and is suitable for its intended purpose. Such information, however, requires to be updated over time to take into consideration the changing rate of growth from one generation to another (Winks, 1997:8).

Considering this, clothing manufacturers and retailers should be responsible enough to study the body sizes and figure types of their consumers before they design and manufacture garments. This should be done to ensure that garments fit the intended shape, silhouette and size of the consumer identified. Evidence was found by Winks (1997:8) stating that this type of scientific and anthropometric research regarding civilian populations has only been done in a few countries worldwide. In South Africa, however, there is a great need for such studies to benefit clothing manufacturers, retailers and consumers alike. In this regard, the economic viability for the clothing manufacturer and retailer finally depends on consumer satisfaction.

1.2 PROBLEM STATEMENT AND MOTIVATION FOR STUDY

In an effort to continuously improve the fit of garments for the South African children's wear market sector, technical experts over the years have been confronted with questionable and problematic sizing systems used as basis for ranges of fit dummies. On investigating the reliability and accuracy of the sizing systems on which the fit dummy ranges for children's wear were based, it became apparent that there was no evidence supporting the validity of either the sizing systems or the correctness of the range of fit dummies in terms of the body measurements, size and shape.

Furthermore, the different sizing systems applied in the South African children's wear market were all based on age as size indicator. This makes the drafting of patterns and the selection of clothing extremely difficult. As reported by O'Brien, Gitshich and Hunt (1941:1) it is a known fact that children of similar ages may have totally different body dimensions and stances. Retailers agreed that these aspects cause confusion for consumers and result in compromises, with the outcome being poorly fitting garments, consumer dissatisfaction, decrease in sales and an increase in returns. Consequently, the existence of standards are of vital importance so that a consumer does not have to buy, for example, a size four (years) at one retailer and a size five (years) for the same child at another. An urgent need existed for a uniform and improved sizing system, as well as a suitable range of fit dummies for the South African children's wear market. No obvious evidence was found to be reported on a national South African anthropometric survey of children with the purpose to measure and determine specific body measurements for the development of sizing systems with body measurement tables as a basis for fit dummy development. However, evidence was found that surveys were conducted by either individual researchers or departments of certain clothing retail companies. The results were recorded as “in-house” documents that were declared as trade secrets or were kept as unpublished government documents. It was, consequently, impossible to embark on comparative studies or a shorter term, smaller scale, repetitive anthropometric study with the aim of improving the development of current sizing systems and fit dummy ranges.

It was therefore decided to undertake an anthropometric survey in South Africa to determine the body sizes of children and to establish new body measurement tables. The focus was on the children’s wear market because an urgent need for current and accurate information about the body sizes of actual and potential children’s wear consumers in South Africa existed amongst the leading clothing retailers. In addition, due to the importance of verifying size charts about every 10 years (Workman & Lentz, 2000:251), this study was undertaken to develop standard methodologies for measuring and standardised practices for developing sizing systems, fit dummy ranges and, eventually, size charts for application in the children’s wear clothing industry. It should also be suitable for future comparisons with subsequent studies. This important aspect will enable clothing manufacturers and retailers to identify the specific areas of growth of a specific market sector over time, in an effort to constantly improve the sizing systems and fit of garments for constantly changing market needs.

Therefore, given the need in the South African children’s wear market sector for standardised size designation systems, as well as sizing systems, based on body measurements obtained from well founded anthropometric data recognition had to be given to the gap which existed. This led to the formulation of the following research questions that will serve as the focus of the problem statement and investigation:

> *How can existing anthropometric surveys methodologies be refined to achieve well-founded and reliable data with specific reference to the children’s wear clothing industry? What are the body measurements of the South African children’s wear consumers of both genders between the ages two and 14 years? Should age be implemented as the basis for sizing systems in this market sector? What body measurement(s) are the most important to use as basis for developing sizing*

systems, size designations and fit dummies to benefit the manufacturers, retailers and consumers? What age can be identified as the age of gender split and how important is this gender dimorphism when developing fit dummies?

To be able to answer these questions, broad objectives and specific aims for this exploratory study were formulated and will be discussed in the next section.

1.3 OBJECTIVES

The broad objective of this study was to develop standardised measuring methodologies and techniques relevant to the development of reliable and accurate body measurement tables to implement as a basis for the development of new sizing systems and fit dummy ranges for application in the South African children's wear market.

To achieve this broad objective, the following specific literature related aims were formulated:

1. To review, evaluate and develop relevant methodologies, which can be applied in the empirical study.
2. To discuss all aspects regarding the development of sizing and size designation systems.
3. To describe all aspects pertaining to the reliability and accuracy of anthropometric data collection for analysis.

The specific aims set for the empirical study were formulated as follows:

1. To develop methodologies and standardised procedures for measuring children between the ages two and 14 years.
2. To conduct an anthropometric survey of body measurements relevant to the development of a sizing system for children's wear.

The specific aims set for the analysis of the results of the empirical study were formulated as follows:

1. To identify key measurements as a basis for the development of a sizing system for children's wear.
2. To develop and establish body measurement tables.

3. To identify growth patterns.
4. To development fit dummy prototypes for children's wear.

The specific aims formulated regarding the implications of this research were:

1. To formulate a suitable size designation for children's wear.
2. To formulate the implications of the new sizing systems, size designations and fit dummies for children's wear manufacturers and retailers.
3. To formulate recommendations for future research.

The aim of all the above actions was that South African children's wear manufacturers, retailers and consumers alike should benefit from the introduction of a new and uniform sizing system as a basis for fit dummy development and size designation systems for stores.

1.4 HYPOTHESIS

The hypothesis stated for this study is that a sizing system for application in the South African children's wear market should be based on specific height ranges as size criteria for the development of a range of fit dummies to facilitate the product development in this market sector.

1.5 DEFINITIONS OF TERMS

Before terms such as sizing surveys, sizing systems and size designation systems can be studied detailed definitions should be given to prevent confusion and misinterpretations. These are listed below, in alphabetical order.

1.5.1 Anthropometry

The word "anthropometry" means measurement of the human body. It is derived from the Greek words *anthropos* ("man") and *metron* ("measure") (Bridger, 1995:71) and is thus known as the science of measuring the human body and its parts in specific (Beazley, 1997a:56 & Bioanth, 2002: 1). Anthropometry, the study of human body measurement, is a branch of anthropology, the study of human social and physical development (Anderson, 1999:16). This three-dimensional measuring process studies the range of human physical dimensions, such as size (for example height), breadth (for example shoulder width) and distance between anatomical points (for example upper arm length). According to Tsang, Chan and Taylor (2000:144), the study of anthropometry is confined to width, length and girth measurements. This view is in contrast with somatotyping (Paragraphs 1.5.9), which refers to the physique and appearance (body shape) of the human body. Anthropometry, therefore, defines body size and measurements.

The term anthropometry can be expanded to include both static and dynamic anthropometry. Static (or structural) anthropometry is the measuring of the dimensions of a human being, while dynamic (or functional) anthropometry is the measuring of the stretch and movement of a human being (Beazley, 1997a:56). This study is an investigation of and report on a static (or structural) anthropometric survey.

1.5.2 Body measurement tables

A body measurement table is, in essence, a size chart (paragraphs 1.5.6 and 2.3). For the purposes of this study, the term body measurement tables was introduced to describe the *preliminary* size charts developed as a basis for the fit dummy development. These body measurement tables were based on "raw" measurements derived from the analysis of the anthropometric data and were used as a starting point for the fit dummy development, as implemented in paragraph 4.6 over a full range of sizes. In this study, body measurement tables were applied within minimum and maximum values for each key measurement range. Once the fit dummies had been developed, these body measurement tables could be implemented, subject to minor manipulations within the minimum and maximum value ranges, and confirmed as more specific size charts.

1.5.3 Fit models and fit dummies

Fit models refer to the models (professional (live) models or moulded "dolls") used to fit garments on for the technical assessment of the garment fit and comfort. The professional models participating in these garment-fitting sessions can be of various sizes and different genders and ages. They are selected as fit models because their specific body measurements and body mass distribution (body silhouette) and stance represent the requirements of a sample size chosen from a specific study population.

The term, “Fit models”, on the other hand, also refers to fit dummies, dress making dummies, dress stands or dress forms. These are manmade “dolls” that are specially moulded according to a specific set of body measurements and dimensions representing a sample size of a specific study population. For the purposes of this study, these types of fit models have been referred to as fit dummies.

1.5.4 Increments and grade rules

In paragraph 2.3.3 increments are referred to as the intervals between sizes comprising a size chart. For the purposes of this study, these were applied as the differences between the sizes comprising body measurement tables used as basis for fit dummy development. Increments are not necessarily equal in size and value and, depending on the specific measurement and study population under study, may be consistent or inconsistent.
When size charts are developed for application as a size designation system and product development, increments are generally referred to as grade rules between sizes. This aspect was, however, not covered in this study but has been identified as a field for further study **(paragraph 5.5)**.

1.5.5 Study population

As reported by the National Clothing Federation (NCF) of South Africa, girlswear and boyswear contribute to 16% and 9% respectively of the total sales in clothing (NCF, 1995:2). The South African children’s population (birth to fourteen years) is divided in the ratio 1:1 boys to girls with a total population of 13 766 447 according to the 1996 Census statistics issued by Statistics South Africa (2006:1). Due to the sensitivity surrounding the new democracy and historical racial inequalities, the specific study population identified for the purpose of this study was based on language (paragraphs 3.2.2.3, 3.4.2.3 and 3.6.3.3). Mother tongue was therefore used as a variable to divide the study population into two categories referred to as sectors. Further selections within each of these two categories were done according to gender (boys and girls) and age (two to 14 years). Combined with the consumer profile of the participating children’s wear retailers, it was possible to distinguish between the two sectors of the study population.

Participants whose mother tongue was one of the black indigenous African languages were grouped into one category known as Sector 1. These participants were referred to as Black participants. Those participants with the mother tongue other than the black indigenous African languages were grouped into a separate category, known as Sector 2, and were referred to as Non-Black participants.

1.5.6 Size charts

A size chart consists of all the measurements taken of a body over all the different sizes (or ages) in the selected population. These measurements will at least represent the height, length and girth measurements. Size charts can also be constructed and designed for height, girth, or combined height and girth requirements, depending on the degree of fit required. The size chart will show the incremental changes between sizes. These can be equal or inconsistent. The chart will also contain information needed for the design and construction of patterns and the grading increments for the pattern grader (Taylor, 1990:58-59). For the purpose of this study, a size chart can also be called a body measurement chart (paragraph 1.5.2).

1.5.7 Size designation systems

Winks (1997:2,24) described a size designation system as a system of size labelling for a garment or accessory. The size designation system is concerned with the informative labelling on the garment. This refers to the size indicator on the garment label or the swing ticket kimbled to the garment. This size label is designed to provide information that will allow consumers to select the correct size efficiently (Workman & Lentz, 2000:251-258).

The South African Bureau of Standards (SABS) (1973:66) stated that the fundamental principle of size designation is related to the body shape of the wearer as indicated by the basic body dimensions. Differences in the actual measurements of garments bearing the same body size designation and which arise from variations in style, cut or other fashion elements, do not, therefore, influence the size designation.

To summarise, Winks (1997:2) described one essential difference between a sizing system and a size designation system. The size designation system is merely a type of informative labelling on the garment. It requires no reference to size intervals. Conversely, intervals are a basic feature of a sizing system.

1.5.8 Sizing systems

In its simplest form, a sizing system (also called a size roll) is a set of pre-determined body sizes designated in a standard manner. It consists of a range of sizes from the smallest to the largest with fixed “steps” or intervals between adjacent sizes. The essential elements of a sizing system can be set out simply as comprising a size range with specified size intervals and a standard method of designating the size of the garment (size labelling). These elements show that size designation is a component of a sizing system (Winks, 1997:1-2,24).

1.5.9 Somatotyping

The classification of the variations of the human physique on a continuous scales expressed in simple numerical values is called somatotyping. It is a description of the human physique, its appearance or body shape, which reflects the effect rather than the cause on the physique of each subject as a unified whole (Carter & Heath, 1990:340).

1.6 RESEARCH REPORT SEQUENCE

In accordance with the specific aims and broad objective set for this study, a research report sequence was developed as illustrated in Figure 1.1 below. This overview of the study illustrates the sequence and components of the different chapters. Each component as recommended and recorded in this diagram will be discussed in depth in the consecutive chapters.

The purpose of this study and aspects leading to the anthropometric survey, are explained in Chapter 1. This chapter comprises the problem statement and motivation for the study, objectives and aims as well as definitions of important terms relating to the study.

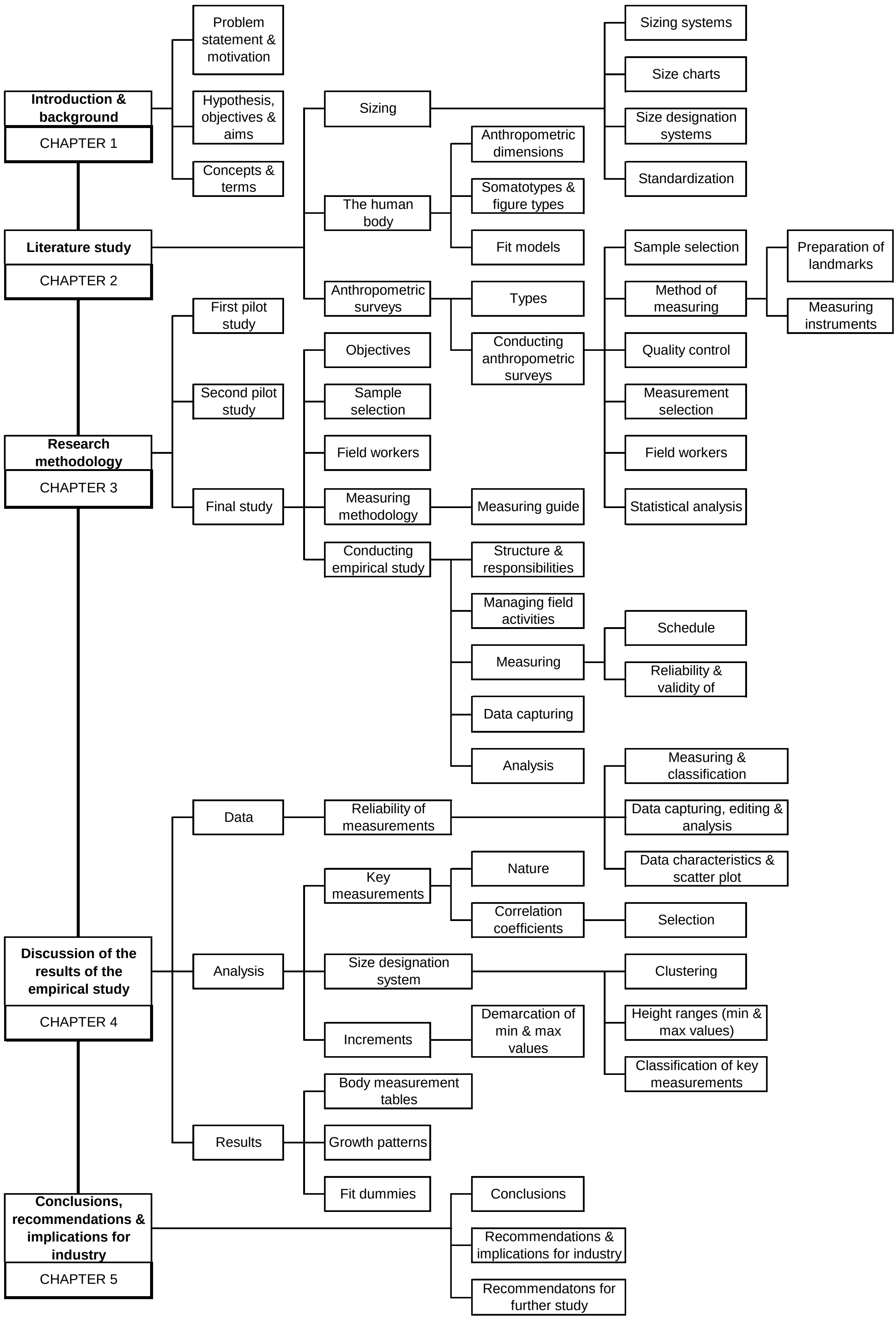


FIGURE 1.1: OVERVIEW OF THE STUDY

Chapter 2 focuses on the theoretical foundation of the study and consisted of the literature study dealing with the important aspect of sizing, which includes discussions on sizing systems, size charts, size designation systems and standardisation. The discussion of the human body focuses on anthropometric dimensions, different figure types and fit models. Anthropometric surveys are discussed in terms of the different types of surveys and all aspects pertaining to conducting anthropometric surveys. Furthermore, the literature study includes concepts, such as sample selection, methods of measuring and measuring instruments, quality control during measuring, measurement selection, all aspects regarding field workers and the statistical analysis.

The research methodology of the empirical study is recorded in Chapter 3. This includes detailed record keeping of the first and second pilot studies as well as an in depth discussion of the final study in terms of the specific aims, sample selection, field workers, measuring methodologies as recorded in the measuring guide and all aspects pertaining to how the final study was conducted. Conducting the empirical study included aspects such as the structure of the study, the responsibilities of each field worker, how the field activities were managed, the measuring process (focusing on the reliability and validity of measurements), data capturing and, finally, the analysis of the captured data.

The discussion of the results of the statistical analysis is recorded in Chapter 4. This includes the reliability and accuracy of the anthropometric data as well as the identification of key measurements to serve as a basis for the development of the size designation systems and the development of body measurement tables suitable for the development of fit dummies.

To conclude, Chapter 5 comprises a final summary, conclusions and recommendations regarding the body measurement tables compiled for fit dummy prototype development, the proposed size designation systems for the South African children’s wear market as well as recommendations for further study.

CHAPTER 2

LITERATURE STUDY

2.1 INTRODUCTION

Chapter 2 deals with the theoretical description of the different concepts this particular study comprises. Important issues regarding sizing systems, size charts, size designation systems, as well as standardised sizing and size designations, are thoroughly investigated. These concepts are the basis and focus of the outcomes relating to the empirical study. The success of the implementation of the results of the empirical study will depend on the understanding and proper application of these concepts. Expanding on this, a description of aspects such as the anthropometric dimensions of the human body and somatotyping is given. Knowledge of these will support and improve fit dummy prototype development to facilitate improved pattern drafting and better garment fit, resulting in improved consumer satisfaction.

An anthropometric survey can only be successfully structured and completed if it is conducted with accuracy, consistency and reliability as cornerstones. These aspects are part of the discussions regarding the scope of sizing surveys, guidelines for conducting a sizing survey, quality assurance and measurement selection. Body surface landmarks, measuring instruments and equipment are also discussed in this regard. A brief history and summary of anthropometry surveys are included as further reference. The employment and training of field workers, the geographic area to be covered in such a survey, as well as the analysis of captured data, concludes the discussion on anthropometric surveys. All these aspects will lead to the structuring, development and implementation of the two pilot studies and the empirical study as described in Chapter 3.

Since this particular study investigates the development of sizing systems for application in the South African children's wear market sector, examples and special references in this chapter will therefore be associated with this group. Before any specific sizing system can be developed, it is important to investigate the nature of sizing systems as such to avoid any misinterpretation or digression on the topic. Since the focus of this study is on the manual method of measuring, most references in this chapter relate to this particular method of measuring (paragraph 3.1). However, limited reference is made to 3-D scanning as a method of measuring.

2.2 SIZING SYSTEMS

2.2.1 Definition

A sizing system is a set of pre-determined body sizes designated in a standard manner (Winks, 1997:24), which is based on the body measurements taken on a cross section of the target population (Kunick, 1984:1). As interpreted by Winks (1997:1-2), this means that the system consists of a range of sizes from the smallest to the largest with fixed intervals between adjacent sizes.

It can thus be argued that a sizing system consists of essential elements, which comprise a size range with specified size intervals and a standard method of designating the size labelling of a garment. A sizing system gives details of garment measurements in relation to the body measurements of a specific target population (Boughey, 1981:69). Therefore, a sizing system in clothing can be defined as body measurements representing a specific target population recorded as a size range with set intervals for use in a specific market sector of the garment industry.

2.2.2 Nature

Sizing systems used in the design and distribution of ready-to-wear clothing are generally based on a selection of dimensions from an anthropometric study of the population for which the garments are designed. Key body dimensions are selected to divide the population into size groups. According to Ashdown (1998: 325), the goal of any sizing system is to choose these size groups in such a way that a limited number of sizes will provide clothing that fits most individuals in the specific target population.

Sizing systems are largely based on what a particular garment industry is prepared to accept as standard. Countries may differ in this respect, depending on the technical development of their garment industry, as well as the expectations of the consumers.

When developing a sizing system certain aspects need to be determined, as identified through studies done by Beazley (1997a:56) and Kunick (1984:16). Firstly, the scope of the sizing system needs to be determined. This refers to the body measurements of a target population that has been artificially divided into groups. This will establish the number of sizes the whole system should contain. It is important that the size range of a particular system should address the needs of the specific target population. Secondly, the selection of the measurements contained in each size should be determined. Worldwide, sizing systems are developed on the basic principle that they must be three dimensional in structure if they are to meet the requirements of any target population. Thirdly, the garment labelling system should be determined. Labelling of garments should be done in such a manner that the potential consumer can immediately recognise a size that gives a reasonable fit. It is, however, important to realise that these three aspects of a well-structured sizing system are interrelated. One aspect can, therefore, not be resolved without the inclusion of the others.

2.2.3 Structure

Although sizing systems developed in different countries vary in the body dimensions chosen to divide the population, the basic structure of most sizing systems is very similar.
To create a sizing system, the population is first divided into different body types based on dimensions, such as height. Alternatively, the division can be based on ratios between certain body measurements. A set of size categories is therefore developed with each containing a range of sizes from small to large. The size ranges within a size category are based on one key dimension. The sizes are generally evenly distributed from the smallest size to the largest (Ashdown, 1998: 325). Once sizes have been identified, the remaining body dimensions necessary to design the pattern for the garment must be determined. Dimensions proportional to the key body dimensions are chosen, so that the garment patterns will be proportional to one another. In addition, the key dimensions necessary to develop fit dummy prototypes should also be added. These will be the three-dimensional measurements including height, width, breadth and length measurements.

If these aspects are not in place, it is not surprising that when shopping for ready-to-wear fashion, consumers often feel that they cannot find an appropriate size and are therefore forced to try on multiple garments. Ashdown (1998: 324) believes that this problem is a result of many factors, such as the use of a sizing system created from outdated anthropometric data, the lack of standardised garment size labelling, the lack of body measurements on swing tags and the lack of sizes appropriate for the full range of variation in body types that exists in the population of the specific target market. The perception of garment fit also differs between any two wearers. Devarajan and Istook (2004:3) report that people seek different benefits from their clothing, including fashion image, figure flaw compensation, sex appeal, clothing preference and fashion innovativeness. Age, geographical location, body shape, fashion and culture play an important role in people's preferences of fit. More fashion conscious women might prefer clothing that fits them, while others might prioritise comfort over fashion. Furthermore, women more comfortable with their body shapes are more likely to wear form-fitting garments, whereas dissatisfied women may prefer looser fitting garments. Apart from body measurements as a basis for apparel sizing, the consumer's perceptions of physical and psychological comfort and appearance will all impact on the consumers' decision on fit. Therefore, a sizing system that can reflect body types of current populations is important to accommodate these particular fit preferences.

The compilation of a sizing system begins with a scientific study of data obtained from a recent anthropometric survey focussing on a specific target population (Winks, 1997:24). Worldwide, the outcome of such studies is compared and results in many conflicting conclusions, not only because the proportions of the populations of different countries vary, but according to Kunick (1984:16) also because there is disagreement among technologists as to what the conclusions ought to be. In many cases these experts are required to conform to a predetermined opinion, or to a national trade practice. Therefore, experts in different garment industries tend to reach different conclusions from similar statistical information. It is thus important to understand that a scientific study, by itself, does not necessarily guarantee any general improvement in the end product it is aimed at.

A sizing system should also be designed for economy by covering the maximum number of people with the minimum number of sizes. Limiting the number of sizes to those distributed around the average can do this, but would not meet the needs of the population as a whole. As confirmed by Winks (1997:24), only the bulk of the population, as apposed to the total population, can be expected to be catered for, the extremes being excluded, e.g. from the 10^{th} to the 90^{th} percentile, thus catering for 80% of the population. An increase in size intervals will give the widest fitting tolerance with an acceptable margin of error. The specific garment type and fit will determine the number of sizes required. Taylor (1990:49) summarises this problem of sizing in mass production, which increases with the degree of fit: the tighter or closer the garment fits to the body, the greater the need for more sizes; the looser fitting garments will look acceptable on more people, so fewer sizes will meet the requirements.

Another important aspect of developing a sizing system for use in the garment industry is the development of size charts for the specific market sector. Worldwide size charts differ from retailer to retailer and country to country. It is, however, true that many of these charts are based on outdated statistics, resulting in standards which are unreliable and inapplicable for use today in comparing body dimensions with size designations. The following section deals with this aspect.

2.3 SIZE CHARTS

Referring to paragraph 1.5.6, a size chart for use in clothing is based on body measurements and can thus only be developed once a proper scientific and current anthropometric survey of the human body has been completed (Taylor, 1990:58). There is no hard and fast rule on the number of body measurements required for any specific size chart. Depending on the particular end use and purpose, each author selects those considered to be essential and most relevant (Kunick, 1984:1). However, Taylor (1990:58) states that the size charts used by technical staff will contain as much data as possible, sometimes up to forty measurements or more. The size chart shows incremental changes between sizes and contains important information needed for pattern design and drafting, as well as grading increments for the pattern grader. It also indicates the measurements of fit dummy prototypes and live models for fit.

2.3.1 Definition

A size chart is a body measurement chart recorded as a specific range of sizes for a specific target population. There are two types of size charts which should be developed for use in clothing. The one type is based on actual body measurements and is for the use of pattern technologists and graders. This chart is also the basis for selecting body dimensions for the live fit model and fit dummy prototype. The other type indicates the finished garment dimensions, which refer to the body measurement chart with added allowance for fit. This chart is used for size control and quality purposes (Taylor, 1990:58).

2.3.2 Designing size charts

When designing a size chart, Taylor (1990:49) recommends it is best to place the sizes as close together as possible. This recommendation is obviously based on close-fitting garments. Such a size chart lends itself to all degrees of fit, since sizes can be grouped together to indicate the range of body sizes that a garment will be suitable for.

There are various configurations in which size charts can be constructed, depending on the body types of the particular market sector. The one configuration is to construct a size chart for height only. In this instance the size chart could be based on only one set of girth measurements, but have several height options. The second configuration is to design a size chart for girth only. Here the height remains constant throughout and the rest of the measurements are related to the girth changes. These two options can be applied to adult bodies and are not necessarily applicable to growing bodies. The third configuration is a size chart based on a combination of height and girth measurements. In this instance the height increases with each increment of the girth. This is a logical application when dealing with size charts for growing bodies, but is not necessarily applicable when applied to adult sizes (Taylor, 1990:49). Four important factors can be identified that control the design of a size chart (Taylor, 1990:58-60) and are discussed in the following sections.

2.3.2.1 Range of sizes to be covered

Size charts should be developed according to the end use and the requirements of the specific target market. The size ranges to be covered will therefore depend on the type of clothing bought and worn by this specific market sector. In women’s wear it is possible that size ranges can start at 91 cm hip and end at 129 cm hip. It is, however, unlikely that many styles will lend themselves to such a wide size span, since garment fit and comfort, styling and silhouette as well as fitness for purpose, differs at either end of the size chart (Taylor, 1990:59).

2.3.2.2 Degree of fit

The more closely a garment fits, the more size options will be required, with closer size increments. The degree of fit influences the size of the increment between sizes. This will determine how many sizes are offered between the two extremes of the major girth that is being used. A size chart can also offer dual sizes, such as small, medium and large for looser fitting garments. In ladies wear this relates to a combined sizes 8 and 10 as size small, 12 and 14 as size medium and 16 and 18 as size large. This option results in offering only three sizes, instead of the original six usually offered over the same girth range (Taylor, 1990:58-9).

2.3.2.3 Fabric characteristics

The most important factor that has any great influence on the sizing of a garment, is the degree of stretch of the fabric. When using fabric with a recoverable stretch characteristic, close-fitting garments can be designed with larger spacing between sizes, and with fewer sizes. Alternatively, when there is no stretch or when what is known as non-recoverable stretch fabric is used, the size chart will be designed with smaller spacing between the sizes, with more sizes in the size range (Taylor, 1990:60).

2.3.2.4 Age group

This is determined by and developed for retailers with specific market profiles and needs. The main consideration here is which age group or size range potentially has the greatest financial benefit. Children and babies are the most difficult to classify regarding sizing because of the growth factor and the large number of sizes that must be offered. The financial returns in this sector are debatable, since much specialized expertise is needed in areas such as comfort and safety in terms of design, use of fabric and trims, suitability of styling and fitness for purpose.

Taylor’s (1990:58-60) study revealed that the group spending most money on clothing is the unmarried group in the 18 to 25 year age range. The married end of the market in the childbearing age (up to about 40 years), when the children absorb a lot of the family income, does not appear to be so lucrative for the fashion field. Above that age, up to 65 years and retirement, is deemed good, but spending falls rapidly after that. It is therefore realistic to suggest that the ideal operating zone remains the statistically average size in the 18 to 25 year age group.

By implication, the chosen age group of the specific target market will dictate the number of sizes per size range. This, in turn, is determined by the type of garments more suitable for the specific target population, which will be determined by the characteristics of the fabric suitable for each style.

2.3.3 Increments in size charts

The increments of any size chart should be based on the results of a current anthropometric survey. Kunick (1984:16) identifies the magnitude of the size intervals as the most important component of a size chart. It is responsible for the range of sizes in a sizing system and the acceptance or rejection of such a system by the clothing industry it is developed for. Size intervals are very much a matter of trade practice in individual countries. Fitting trials, to test the efficiency of various size intervals, should be carried out and recorded to confirm the increments.

The division of the sizes in a system is entirely artificial. Taylor (1990:58) identifies the incremental changes between sizes as being equal or variable. Equal (consistent) increments are used in size charts for grown bodies (adults) whereas variable (inconsistent) ones are used in size charts for growing bodies (children). In this regard Kunick (1984:19) reports that the most convenient intervals between the sizes would be consistent ones. Consistency in size charts has a great advantage in practice because it enables a pattern grader to work to a standard difference between sizes, making their memorisation easy and frequent reference to a size chart unnecessary. Further, once the standard grading quantities are known, a size can be easily extended by consistent increases to cover an indefinite number of larger sizes if required. The use of inconsistent size intervals and variation in shape within a single size chart should therefore be avoided for practical reasons where possible.

However, there is a minimum increment that can safely be put between sizes. This should not be less than the over body tolerance added to the body measurement for movement and comfort on the major girth (Taylor, 1990:49). Kunick (1984:19) points out that style and fashion also play an important part in affecting the dimensions of the finished garment.

2.3.4 Verifying size charts

In keeping size charts up to date it is important to verify them from time to time. Body measurement charts need to be revised at least every 10 years. The United Kingdom (UK) retailer, Marks & Spencer (M&S), measures about 6000 consumers every 15 years to keep their size charts current. It is reported that both Sweden and West Germany found important changes in body measurements when they updated their apparel sizing systems to reflect physical changes that had occurred in their populations. It is also reported that increased participation in physical exercise, changes in dietary habits, geographic migrations and other lifestyle factors produced changes in the United States population's anthropometry and made existing apparel sizing standards obsolete (Workman & Lentz, 2000:251).

Verifying size charts also impacts on the specific size designation system which has been developed based on these charts. With each change to the size chart, depending on the type of change, it is expected to see changes to the size designation system. Once a size chart is developed or updated, both manufacturers and retailers use this information to base their size designation systems on. The following section is an in depth study of size designation systems.

2.4 SIZE DESIGNATION SYSTEMS

2.4.1 Definition

A size designation system is a system of size labelling for garments or accessories (Winks, 1997:24) and gives information on the size of the person the garment is intended to fit (Boughey, 1981:69). These garment size labels contain no information about body measurements on which the garments' sizes are based. They only provide the size designation that will allow consumers to select the correct size garment efficiently (Workman & Lentz, 2000:251). However, a size designation system is a component and element of a sizing system. One essential difference between these two systems is that a size designation system is merely a type of informative labelling and requires no reference to size intervals. On the other hand, intervals are a basic feature of a sizing system (Winks, 1997:2).

If the size designation does not represent the same body dimensions from one label to the next, consumers are likely to be frustrated (Workman & Lentz, 2000:251). To avoid confusion and consumer dissatisfaction, a clear and unambiguous system of indicating the size of garments is essential. Terms such as “small”, medium” and “large” are therefore not preferred size indicators, since they only give a very vague idea of size.

As reported by Workman and Lentz (2000:252) researchers Chun-Yoon and Jasper (1995) found that size labels of women’s garments have inadequate information to guide consumers in initial selection of the correct size. These researchers recommended an anthropometric size description system as a solution to the problems of high return rates caused by consumers purchasing the incorrect size and damaged merchandise caused by the frequent trying on of garments. They speculated that a more informative size label would ultimately result in greater profits for both manufacturers and retailers. It is suggested that such labelling can either be done by a pictogram or by indicating the appropriate control-dimensions and their numerical values (Winks, 1997:3). Boughey (1981:69) reported, furthermore, that detailed sizing is also important from a safety aspect. This applies specifically to sensitive target markets such as infants, children and the disabled.

Since size designation systems are merely concerned with informative labelling of the garments on swing tickets, this is of prime importance to the potential purchaser. Matters pertaining to sizing systems bear more directly on manufacturing interests (Winks, 1997:2). The designation, while of prime consumer interest, is also of considerable use to the manufacturer and distributor because it identifies the size of the garment and is used for reference in paperwork, in ordering and stocktaking, as well as in garment production.

2.4.2 Nature

An accurate size designation system can only be developed once the raw data of an anthropometric survey has been statistically analysed to develop a sizing system and a size chart. According to research done by Winks (1997:2,4&5), size designation systems can be founded on one or more of the direct or indirect parameters, such as body dimensions, age of subject, body mass (weight), garment dimensions and codes (numbers, alphabetical letters or words). The following summary is an elaboration on the outcome of Winks's research.

2.4.2.1 Body dimensions

Vertical (height and length) and horizontal (girth, breadth and depth) dimensions of the body seem to be the most logical and most common parameters on which to base the fitting of clothes. The human body is three dimensional in the sense that it has height and girth, with girth being a combination of "width" and "thickness", which varies within the length of the body.

Height or stature is used in many countries as the principal sizing dimension for growing children, and is the basis of the Centilong system, which originated in Sweden. It is now used extensively in other European countries and the UK (Winks, 1997:5). The height designation is an indication of the garment length to be made, but height alone does not cater for any width or girth dimension, which is necessary before appropriate garments can be produced.

Height, apart from the obvious relevance for growing bodies, is an important control dimension for adults' clothing as well. Height covers not only the whole body but either of the upper or the lower parts, forms the subject of an interesting opinion according to Winks (1997:5). It is reported that several countries including Poland, are of the opinion that height is an adequate control for jackets and trousers, while Canada strongly opposes this contention. The Canadians believe that leg length and total height are not always proportional and stress that for a group of men of similar height (within a narrow range of 1.8cm), the crotch height (inside leg length) can vary as much as 21.8cm.

Girth measurements are also very important sizing dimensions. The chest girth is the main control dimension used for men's outerwear garments in most countries, while the bust girth, the equivalent for women's wear, is used as a control measurement. However, there is a difference of opinion as to which girth dimension, bust or hips, is more important to the fitting of full-body garments for women's wear. Winks (1997:5) is of opinion that the criterion used to determine which of the girth dimensions is of most importance in the sizing of women's garments covering the whole body is the greatest girth dimension, which should be as static as possible, i.e. the least variable measurement.

In this regard, Winks continues to report that the bust is known to be subject to change in girth and shape over the years, while the hips are generally larger in girth than the bust and are more static. The upper thighs, particularly of young women, often constitutes the greatest body girth.

An obvious deficiency of systems using only a single girth dimension for sizing is the exclusion of the height dimension. By using just one girth dimension for sizing, the manufacturer expects the garment to fit women having the same bust measurement but of any height between say, 140 and 175cm. This practice totally ignores the problem of waistline location (Winks, 1997:4).

There are *other* body dimensions, which are required for different garment types such as for shirts and pants. The neck girth is applied as the control dimension for sizing garments of which fit at the neck is important. This was common practice to size men's shirts by collar size. For sizing trousers, the inside leg length for men's and outside leg length for women's trousers are now established body controls (Winks,1997:5).

2.4.2.2 Age

In sizing children's and infant's garments, age is a common indicator used in conjunction with others, such as body mass (weight) and height. It is, however, common practice to often designate clothing by age alone. Winks (1997:4) regards this method as, at best, only a rough guide to the body size. The dual designation of age and mass is considered to be only a slight advance so far as sizing is concerned. Neither gives a direct indication of body dimensions or body shape, on which the garment fit depends. In Figure 2.1 the irrelevance of age alone as the body size indicator can best be illustrated graphically as in the American study reported by O'Brien *et al.* (1941:1).

FIGURE 2.1: THREE EIGHT-YEAR-OLD GIRLS (O'Brien *et al.*, 1941:1)

There is a noticeable difference in body shapes and sizes between these three girls and it is reported that anthropometric data show that the heights of 8-year children can vary as follows: Boys: 102 – 129cm and Girls: 103 –127cm, providing a range of 27cm for boys and 24cm for girls, all of the same age. According to Winks (1997:4), a French report testifies to this variability among children to the extent of between 126 and 160cm for 12-year old boys. Also, that for a height of 138cm there are girls between the ages of 7 and 15 years; and yet, to this day, children's wear is sized by age in some of the advanced countries of the world.

O'Brien *et al.* (1941:34) reports that on final data analysis, not only are lengths more highly correlated than age with all measurements considered, but if a length, such as stature or arm length, is used as a basis for sizing garments, the further knowledge of a child's age will add very little in predicting his other measurements. It is argued that, on the other hand, if sizes are based on age, then the further knowledge of the child's height may be of great significance.

2.4.2.3 Body mass (weight)

Worldwide several standards use body mass utilized in conjunction with one or more other parameters particularly in the case of infants' wear. Because body mass is not a body measurement by which clothes may be fittel directly, its use is very limited in the sizing of clothes. Winks (1997:4) reports that body mass merely gives a rough indication of body volume, particularly if used in conjunction with height. However, body mass provides no indication as to its distribution throughout the body height.

2.4.2.4 Garment dimensions

Internationally, numerous national specifications are used in setting out a range of garment sizes according to the garment measurements and these are designated in various ways. Winks (1997:4) reports that in Japan some correlate tables of garment measurements with corresponding "reference bodies" which the garments are designated to fit. In India some correlate garment measurements with body measurements, but designate by garment dimensions. In Turkey some give garment measurements and designate by one of the garment measurements and in Canada some give various garment measurements against corresponding body measurements, but designate by code number.

However, the specification of garment measurements remains valuable only for internal use of the garment manufacturer or retailer. It is of little or no value to the user, unless correlated and designated according to body size.

2.4.2.5 Codes (numbers, alphabetical letters or words)

Regardless of what the size designation system is based on, whether body or garment measurements, some industries choose to designate in ways other than those already mentioned. Traditionally, hats and gloves have not been designated in any direct or logical manner. A hat of metric size 60 is designated 7, 3/8 or 6½ depending on whether it is sized according to the British, American or French system, respectively (Winks, 1997:2). Such size numbers may justly be described as coded designations, for they do not relate directly to the relevant body dimensions. Apart from codes, designation by words or letters of the alphabet, such as the SSW, SW, W, WX, OS and XOS of the British old style designation for women's coats, has been in fairly widespread use.

It is also common practice in many countries to designate garments in ways using descriptive terms such as "small", "medium" and "large". Alternatively, codes such as XS, S, M, L, XL and XXL, or 8, 10, 12, 14, etc. are also used as designated sizes without referring to any particular body measurements. In this regard, there is a definite variability of designations by the different international size designations for women's wear, men's wear and children's wear.

Not all the codes can be broken down to meaningful body measurements. Winks (1997:3) believes that they must be quite bewildering to the average consumer with no "key" to the codes and it is believed that codes are not for the consumer's benefit. Manufacturers and retailers use codes mainly for ease of reference for stock control and ordering purposes, but not all codes are brief. It would appear that codes are intended more for the convenience of the manufacturer and stockist than of the consumer.

In the South African clothing industry, garments are generally designated according to either the imperial or the metric system. The imperial system refers to garments to fit an individual with specific body measurements recorded in inches, while the metric system records these measurements in centimetres. The measurements can reflect the chest, waist, hip or neck measurements, depending on the garment type. These are used mostly for women's and men's wear, while it is common practice to designate children sizes according to age, for example to fit age 3-4 years, 4-5 years, etc. when designated as single sizes and to fit age 3-4 years and 5-6 years, etc. when designated as dual sizes. This method is most common for boys and girls outerwear, while the S, M, L and XL size designation is sometimes applicable for sportswear. In the infants market sector, it is common practice to combine the age size designation system with weight, for example, 6-12 months and weight 8-10kg. However, the use of body measurements are most commonly used in underwear for children, were the "*to fit hip*" measurement is more applicable. Generally children's wear retailers apply all these size designation systems according to their own in-house requirements and standards.

2.4.3 Factors influencing size designation

Body dimensions are known as the most important and key factor influencing size designation. The source and method from which body dimensions are developed should be reliable. As recorded by Workman and Lentz (2000:255) Jarnow and Dickerson (1997) reported that, besides the source used for body dimensions, other factors that contribute to variation in correspondence between size designation and body dimensions are quality control, fabric, styling, price and marketing techniques. Price, for example, can affect size designation in that when the price of a garment increases, the size designation on the label may decrease. A woman who wears a size eight of a less expensive range may wear a size six in the more expensive collection (Fellingham, 1991:160).

Within a company, lack of quality control can occur at several stages in the process (e.g. cutting, sewing, specification tolerances). Although designers may be meticulous regarding size consistency within company lines, discrepancies still occur due to variability in styling and fabric (Fellingham, 1991:160). Another growing trend in garment sizing is the practice of vanity sizing, where centimetres are added to clothing to make it appear that a woman wears a size smaller than she actually does ([TC]², 2004:1). It is also true that manufacturers of designer price garments may deliberately label garments one size smaller to appeal to consumers' vanity (Workman & Lentz, 2000:255). This marketing technique has a psychological basis; that is, if someone is purchasing an expensive garment, she wants to feel good about herself. Some people have a need to feel slim and this motivates certain manufacturers to increase the dimensions within a size and produce garments that fit two to four sizes bigger than they did ten years ago. George Simonton, designer for Paris Suits Ltd., confirms this practice, stating that very often design houses cut garments a bit fuller to make the consumer feel she is wearing a smaller size (Abend, 1993:79).

An anthropometric labelling system would, however, not eliminate the need for consumers to try on clothing, because they have varied preferences in fit. Workman and Lentz (2000:252) report that Asdown and DeLong investigated the difference in fit that could be perceived by individuals in 1995. It was found that individuals had varying tolerances for fit variations at different locations on the body. Participants were able to distinguish variations as small as 1.0cm at the hip and crotch and about 0.5cm at the waist. Just as individual fit is a subjective decision, manufacturers' and retailers' size designation is also a subjective decision, depending in part on decisions regarding allowable tolerances. Many of the measurements required for making a decision about size designation are garment measurements, not body measurements, and many of the decisions regarding allowable tolerances relate to consumer comfort, aesthetics and personal preference.

These apparent inconsistencies in body dimensions and size designations can be attributed to the fact that each manufacturer or retailer independently decides on the measurement specifications and size designations for its prototype body. This problem will be reduced or may even be prevented with the development of standardised sizing systems. The aspect of developing standardised sizing systems and size designation systems will be discussed in depth in the following section.

2.5 STANDARDISED SIZING SYSTEMS AND SIZE DESIGNATION

2.5.1 Need for standardisation

Over the years and in various parts of the world, sizing systems have been devised with variations on the parameters on which they are founded, the size intervals and the means of designation. These variations could occur from one garment to another within the same garment type; not only from one country to another, but within the same country and often within the same shop (Winks,1997:2). Nor does the sizing system for one branch of the clothing industry coincide with that for another. The systems for men's wear, women's wear and children's wear also differ considerably. Likewise, different industries such as knitwear, hosiery, foundation wear, socks, gloves and hats each have their own ideas of sizing and size labelling and are sometimes hampered by traditional practices.

Worldwide size designations also vary greatly, insofar that they may be codified or partly so, may relate to a garment measurement, without stipulating which, or may relate to a body measurement. In women's outerwear, the size could relate to the body hip measurement of British manufactured garments, or to the bust if made in France or Germany. Although opinions vary, it seems that lower numbers represent smaller sizes. Sometimes equivalent sizes of different manufacturers vary in size designation. In other instances the size designations are very similar, e.g. the British and American dress sizes. This can be very confusing when purchasing by mail order catalogue or the Internet where simple, direct size designation is a prerequisite (Winks, 1997:3-4). Abend (1993:79) reports that mail order business returns can be up to 30% with a good proportion resulting from poor fit due to the confusion regarding garment sizes.

Not only does the multiplicity of size designations cause confusion to the consumer, but it also creates serious trade barriers on world markets. The need for standardisation of the labelling system could not be more clearly demonstrated than from the consumer's point of view.

2.5.2 Standardised clothing sizing

There has always been a need for standardised products and methods. Through standardisation the aims remain to simplify, to clarify, to diminish the risk of errors and to capitalize on lessons already learned (Sanders, 2000:63). Undoubtedly one of the principal aims of standardisation is to give assurance to the purchaser that the goods bought are of the quality which is claimed for and are satisfactory for the use to which they are to be put Sanders (2000:85). In clothing this is interpreted as having the correct size and fit as well as the fitness for purpose of garments for a specific market sector.

Standardisation becomes necessary where clothing manufacturers and chain stores are inconsistent in clothing size designation and sizing. This is illustrated where traditionally a woman's wear consumer would wear a size 12, but may have to purchase a size 14 in a particular outlet. Standardisation can, therefore, ensure that clothing manufacturers and chain stores are more consistent in terms of sizing of garments. Theoretically, standardisation would solve sizing problems by providing a variety of fittings for any type of body but, because human bodies vary in size, shape and proportion, even within the same age group and ethnicity, standardisation seems difficult (Otieno & Fairhurst, 2000a:143).

At present there is no common international sizing code and each country has set up its own system of sizing clothes. This is illustrated in a study completed by the British Standards Institution (BSI). It was recognised that a woman with a bust of 88 cm, a waistline of about 72 cm and hips of about 96 cm is a dress size 12 in the UK and 38 (38 inches, ±95 cm) in Germany, the Netherlands, Norway, Sweden and Finland, 40 (40 inches, ±100 cm) in Belgium and France, 44 (44 inches, ±110 cm) in Italy and 46 (46 inches, ±115 cm) in Portugal and Spain (BSI, 2004:1). In South Africa (SA) and the United States of America (USA) the equivalent would be a size 10 (±95 cm) ([TC]^2, 2004:1). However, it would be advantageous if all countries used, for example, the metric system and had a common sizing code to overcome this problem. Currently, various websites offer services to automatically convert sizes to facilitate this inconsistent international size coding.

However, since mid 2004, European clothes vendors will switch to a new standard system for designating the size of garments. For the UK, this new system is defined as BS EN 13402 and based on body dimensions measured in centimetres (Kuhn, 2003:1). The BSI would be setting their own standard tables of measurements from which clothing sizes can be taken. An International Organisation for Standardisation (ISO) pictogram (Figure 2.2) would appear on clothing labels and shows clearly to which part of the body the garment size refers to. By implementing a standardised set of measurements and sizes based on them, the BSI aims to make life easier for the industry and consumers (ApparelReacources.com, 2004:1).

This is all progress in terms of standardising clothing sizes world wide, but there will probably never be an international sizing code, as the surveys in the different countries highlight different characteristics in the relationships of the major body measurements. Survey data can also be interpreted in different ways when designing a sizing system for general use. Therefore, by definition, it is impossible to mass-produce garments to fit everyone worldwide (Taylor, 1990:48-49). The complexity and multiplicity of market sectors worldwide also hamper standardisation of garment sizes and size designation systems. Without a uniform and clearly defined consumer base and consistent tolerance of garments regardless of fit and fabric reaction, which remain highly confidential as the competitive edge of retailers, it is nearly impossible to strive for uniformity in any instance. Furthermore, standardisation of garment measurements cannot be done because silhouettes change from season to season (Abend, 1993:79).

Economic circumstances and political changes can also cause movements influencing the possibilities of standardisation. The political changes in South Africa during the past ten years, which have resulted in a new emerging black market with different body shapes and sizes. This trend is proof of changing conditions and needs within markets making standardisation virtually impossible.

2.5.3 International Organisation for Standardisation (ISO)

International standardisation began in 1906 in the electrotechnical field when the International Electrotechnical Commission (IEC) was created. Since 1926 the International Federation of the National Standardisation Associations (ISA) in other fields, mainly mechanical engineering, has carried out pioneering work. Due to World War Two, the ISA's activities ceased in 1942. In 1946 delegates from 25 countries met in London to create a new international organisation. The objective was to facilitate the international co-ordination and unification of industrial standards and the body began to function officially on 23 February 1947, the first standard being published in 1951 (ISO, 2002:1). The ISO has played a key role in an effort to achieve standardised clothing sizing internationally.

According to the South African Bureau of Standards (SABS) (SABS,1973:66), the need to rationalise the size designation of garments was recognised by the ISO in October 1969. A Technical Committee was then set up to study and prepare international standards. A historical development in sizing started when the ISO constituted a section to establish international standards for the sizing of men, women and children. It became clear at the outset that the establishment of a comprehensive sizing system for universal acceptance was unobtainable because of the wide variation in size intervals used in different countries. A single size interval in one country can be equal to two sizes in another (Kunick, 1984:12-13). The hope of compiling tables of body measurements for garment production had therefore been abandoned and efforts were made to devise a size-coding scheme only. This was also met with resistance since all countries wished to retain their own established size codes. It was once again confirmed in 1995 by Chun-Yoon and Jasper that there is little likelihood of agreement on standardised body dimensions for each size because manufacturers prefer their own prototype body image as represented by its own fit model (Workman & Lentz, 2000:255).

With regard to an international sizing designation system, the fundamental principle agreed upon was that size designation is related to the body shape of the wearer - as indicated by the basic body dimensions (SABS, 1973:66). According to Kunick (1984:13) defining the size of a garment by the control body measurements included bust, waist, hip and height measurements. This was the same method as used by the BSI for coding women's outerwear since 1963. Originally the BSI published measurements in inches, but in 1974 this was converted to centimetres. These basic body dimensions, known as "control body dimensions" should be taken in a standard manner and used as direct measurements, expressed in centimetres, to indicate the appropriate size designation, to be shown on the garment label. The numbers, in centimetres, are the body size measurements which the dress is made to fit – and are not to be confused with garment measurements (SABS, 1975:100). Differences in the actual measurements of garments bearing the same body size designation and which arise from variations in style, cut or other fashion elements, do not therefore influence the size designation.

In order to overcome language differences, the control body dimensions in centimetres are illustrated by pictograms (Figure 2.2). Provision was also made for supplementary information and national size codes to be added in the interest of clarity, providing that such additional information did not take precedence over the main control measurements. Kunick (1984:13) reports that the objective behind the use of pictograms is two-fold; it not only overcomes the language barrier, but also gives more precise information on body measurements. This problem can also be overcome, by listing the manufacturer's size range of control measurements on a swing ticket under the appropriate size codes. It is then a simple matter to designate the size by inserting the desired size code number as is universally done at present. The final ISO recommendations for size coding were then to use pictograms in conjunction with control measurements (in centimetres).

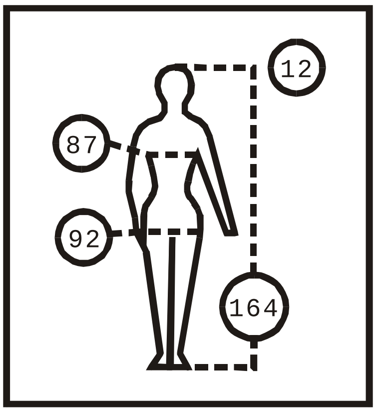


FIGURE 2.2: ISO MEASUREMENT PICTOGRAM (Kunick, 1984:13)

The children's sizing committee of the ISO followed the procedure laid down for women's clothing, with the addition of size charts based on stature as the key control measurement, for children up to the age of 15 (Kunick, 1984:13). However, British children's wear manufacturers insisted on retaining a reference to age in addition to stature, on the grounds that children's clothes are often bought as gifts, and age as a size indicator is therefore helpful. It is quite true that stature, as a predictor of size, is better than age, but it does not make a system based on stature less valid, if the appropriate age is indicated on a swing ticket. Unlike adult classification, age can act as a code number since parents know when a child is not an average height and because they use the last purchase as a guide for the next. In addition, size charts, which indicate the relevant ages, are more meaningful than others that do not.

The concepts of size charts, size designation systems and standardisation of sizing and size designation systems were discussed in the preceding paragraphs. The problems with which manufacturers, retailers and consumers are faces due to the lack of these were highlighted. However, it is important that the anthropometric dimensions of the human body are considered when developing sizing systems. This aspect will be discussed in the successive paragraphs.

2.6 ANTHROPOMETRIC DIMENSIONS OF THE HUMAN BODY

Anthropometry refers to the measurement of the human body and has been described briefly in Paragraph 1.5.1. Furthermore, anthropometric dimensions of the human body are influenced by several factors. The most important factors were identified and discussed in more detail in the following section. An in increase in the height of populations has been witnessed around the world over the years. Although the exact cause of this accelerated growth has not been pin pointed yet, Tanner, Taylor and Editors of LIFE (1966:178) stated that the body size and shape of a human are determined by the complex interaction of environment and genetics (heredity). Environmental changes, such as improvements in public health, nutrition and childcare are according to Tanner *et al.* (1966:186) unquestionably responsible to some degree. Others, such as changes in climate, diet or disease, impact on the genetic possibilities by encouraging some and inhibiting others. Other influences include genetic factors, industrialization and changes in body size due to migration. Carter and Heath (1990:197) also viewed this interaction between genetics (genotype) and environment (phenotype) as apparent in the outcome and variation of somatotypes. This continuous change of body shape and size is confirmed by the comparative study of Devarajan and Istook (2004:2).

2.6.1 Factors influencing the variation in anthropometric dimensions

2.6.1.1 Genetic factors

Genetics stands for all the causes of individual differences that may be associated with inherited characteristics. Lohman, Roche and Martorell (1988:104) describe the genetic effect for a given anthropometric phenotype as the average contribution of heredity in the population, irrespective of environmental conditions and variations in lifestyle. Thus, genetics is a population parameter reflecting the extent of transmissible genetic variance from one generation to the next. It represents the contribution of genetic variation to inter-individual differences under average environmental conditions. The genetic variation for any individual will vary depending upon that person's unique characteristics and life history. However, the estimate of the genetic population parameter for a given anthropometric trait requires a complex database. Data currently available never meet the stringent conditions, and Lohman *et al.* (1988:104) (suggest that any estimates of genetics (or heritability) for anthropometric characteristics must be viewed with caution.

2.6.1.2 Environmental factors

It is generally assumed that the environmental effect on the human body is caused by variation in surroundings, lifestyle and environmental conditions. It is, therefore, difficult to assess the full extent of the environmental effect on a given anthropometric dimension, because there are potentially several contributing factors, which can seldom be controlled in a given study (Lohman *et al.*, 1988:103). Sometimes harmful environmental factors, such as malnutrition can act directly to disrupt normal growth patterns (Tanner *et al.*, 1966:178). On the other hand, it is true that man can govern his own growth to some extent by controlling his diet and health.

Bad diet can cripple the genetic possibilities for human growth. Chronic malnutrition in the early years can keep children from reaching their full genetic growth potential, such as the effect of the protein deficient nutritional disease kwashiorkor. If a child remains protein starved until the age of five, the damage is irreparable, and its genetic expectations will never be realised (Tanner *et al.*, 1966:188). On the other hand, Tanner *et al.* (1966:190) reports the Japanese sumo wrestlers, as an example of the effect a controlled diet can have on size and shape. Genetics do play a part, since wrestlers are picked from among bigger-than-average youths with a long torso to facilitate the squatting position. To achieve their optimum bulk they consume more than 5000 calories a day in a special diet and train to develop their back leg muscles. Although some generalizations can be made, it remains impossible to predict exactly how any individual will grow.

2.6.1.3 Interaction between genetic and environmental factors

In some instances heredity and environment collaborate over long periods of time to develop a particular characteristic, such as the great height of the tall, thin and long limbed physique of the Nilotics (Tanner *et al.*, 1966:178). Carter and Heath (1990:343) are of the opinion that both genetics and environment are important influences on the present somatotype. The extent of their respective contributions to the somatotype over a lifetime is uncertain. Although the environment plays an important role, understanding the role of genetics depends upon advances in assessing the heritable contribution to the development of the body tissues that make up the somatotype.

Understanding the causes of the physical variation of the human body is a continuing search in many fields of study. It is, however, true that anthropometric traits do vary within as well as between populations. Both genetic traits as well as environmental effects can have a meaningful influence on these anthropometric traits (Lohman *et al.*, 1988:103; Tanner *et al.*, 1966:180; Carter & Heath, 1990:344).

2.6.2 Effects of within (intra-) and between (inter-) populations' variations on anthropometric dimensions

Since the introduction of ready-made clothing and with growing expectations of a reasonable fit, attention has been fixed on body shape, the differences in body shape within a population and the differences existing between different population groups (Winks, 1997:7). Lohman *et al.* (1988:104) concur that attention should be focused more on the within (intra-) population and between (inter-) population heterogeneity to better describe the importance of race or human group differences in total human phenotype variance. Due to the comparative focus and nature of morphological variation studies, variations within and among populations are questioned. In this regard questions relate to which dimensions best differentiate among populations and whether these differences have a genetic or environmental explanation (Lohman *et al.*, 1988:99).

It is reported by Winks (1997:12) that variability exists within (intra-) and between (inter-) populations. It was reported that intra-population variation is relatively limited and an appreciable proportion of it follows a regular pattern. This may be of relevance to problems of design required for peoples in different parts of the world. It is estimated that only about 10% to 15% of human variation in single gene systems is specific to populations or races, whereas all humans regardless of race or population share the remaining variation.

A wealth of data has been accumulated world wide on body dimensions of individuals of all cultural (racial and ethnic) groups. Even though there are often mean differences for anthropometric measurements among populations, the ranges of values overlap considerably (Lohman *et al.*, 1988:104). Consequently attention should be given to the effect of culture on anthropometric dimensions.

2.6.3 Effect of cultural influences on anthropometric dimensions

Cultural influences on anthropometric dimensions can be best understood as influences dictated by the terms racial and ethnic, which have significant social and very often political overtones. The term *racial* implies membership of groups (i.e. tribe, family or gender) in which there are substantial genetic similarities among individuals. Groups so defined vary genotypically (in heredity) and phenotypically (in characteristics). The term *ethnic* is applied to cultural rather than genetic affinity. The two terms, racial and ethnic, are often confused because geological and cultural homogeneity quite frequently overlap or coincide. Although individuals are labelled as belonging to a particular racial (genetic) or ethnic (cultural) group, the considerable variation within each category must be recognised (Lohman *et al.*, 1988:99).

Internationally, many anthropometric studies have been conducted over the years indicating the differences in body shapes and sizes among various population groups. Most of these studies were, however, conducted on male military personnel during and post World War Two. Comparatively little information is publicly available on civilian populations, more specifically women's and children's body dimensions. Winks (1997:9) indicates that as a result of the increase in international trade and the interchange of sophisticated equipment during the 20th century, problems associated with inter- and intra-population variations have emerged. With globalisation and the formation of the global village, closer contact between different parts of the world is inevitable and this increases the possibilities of personal exchange and friendships between "global citizens". This spreading of multiculturalism occurs through greater international travel and immigration, which results in better individual access to cultural diversity. This eventually causes some reduction in diversity through assimilation and hybridisation of cultures with a definite impact on the inter- and intra- population variation (Wikipedia, 2004:1&2).

Population variation in anthropometric dimensions that may be ascribed to genetic differences occurs primarily in proportions and fat patterning. Population variation in overall body size is more difficult to attribute to race, given the many environmental factors that can influence weight and stature during growth. Body proportions vary among cultural (racial or ethnic) groups, although most data are limited to comparison of blacks and whites. Lohman reports that several studies indicate blacks having, on average, short trunks, longer upper and lower extremities, and more slender hips. Hence, for the same structure, blacks have relatively longer extremities, and for the same biacromial breadth, blacks have relatively narrow bicristal breadths. Data for other racial / ethnic groups are more limited and refer primarily to relative leg length, that is, sitting height / stature ratio. These data indicate that Asiatic populations have relatively shorter lower extremities (Lohman *et al.*, 1988:99).

Fat patterning refers to the relative distribution of subcutaneous fat on the body as opposed to absolute amounts of fat. The available evidence suggests that the major cause of variation in fat patterning is genetic rather than environmental. Variation in fat patterning relates primarily to the distribution of subcutaneous fat on the extremities and the trunk, although more recent efforts compare the ratio of lower to upper body subcutaneous fat. Whites, for example, tend to have relatively more fat on the extremities than on the trunk compared to blacks, who have relatively more fat on the trunk than on the extremities (Lohman *et al.*, 1988:99-100).

According to Winks (1997:9) studies concerning the dimensions of indigenous populations throughout the world have shown that longitudinal limb (arm and leg length) measurements tend to be greater in proportion to overall height in peoples living in warmer climates. Girth dimensions, however, tend to be greater again, relative to body size, in peoples living in cold environments. His explanation is that the body adjusts to the climate to maintain the body heat balance – suggesting genetic differences developed over many generations. Studies were done on flying personnel, measuring the sitting height in relation to total height and investigating the effect and relevance this has to equipment design and sizing of clothes, since this relates leg length to height. American and German men appear to have long legs in comparison with those of French and Italian, Japanese, Taiwanese and Vietnamese populations, while Japanese men have short legs for the same height in comparison with the other populations. Another study on military flying personnel, found that Belgian pilots tend to be the tallest and Vietnamese the shortest in stature. It is reported that the torso is relatively constant in length and that the major difference is in the leg length of these men (Winks, 1997:10, 12).

When studying population groups, the principal population groups are men, women and children as well as the obese sector of the population which can be added as a fourth group (Winks, 1997:8). Some examples of such studies done within these population groups are listed below:

In South Africa, Winks (1997:12) reports that it has been shown by anthropometric surveys that the body dimensions of the South African (SA) Black male are, in general, significantly smaller than those of Caucasian males. A study of data, however, shows that they are not proportionately similar, the ratio of sitting height to total height of Black males being significantly less than that of both the United States (US) and SA White personnel. This indicates proportionately greater leg length for the Blacks, which support the findings of Tildesley (1950:14-18) that the longitudinal limb measurements tend to be greater in proportion to overall height in peoples living in (i.e. indigenous to) warmer climates. However, the US Negro is stated to exhibit clear differences in body proportions compared with Whites living under similar climatic conditions, with hybrids showing intermediate values.

Samples from populations around the world reflect extensive variations suggesting differences due to genetics, gender, nutrition, physical activity and aging. In studies of somatotypes, varying degrees of sexual dimorphism are seen in paired samples of male and females, with females more endomorphic (H-shaped) and less mesomorphic (V-shape) than males. Carter and Heath (1990:343) report that a distributional overlap exists between some somatotype samples and clear differences between others. Almost no overlap exists among the somatotype distributions of the Eskimos, Indians, Manus and Nilotes, and each population is confined to a relatively small number of somatotypes. The greater variability in European and North American somatotype samples is probably due to the combined effects of genetic heterogeneity, environmental differences, age and occupational differences, and variation in physical activity.

Anthropometric data, particularly for children and youth, are useful for monitoring social and economic circumstances in society. Developmental processes are quite plastic and pliable, responding readily to environmental stress. An extension of this relates to the monitoring of anthropometric changes over time. Analysis of intergenerational changes or secular trends can reveal increases in size, reductions in size, or lack of change (Lohman *et al.*, 1988:100).

Children's growth rates vary due to hereditary and environmental influences. Identical children, other than identical twins, do not exist, whilst childhood presents a continuous variation of measurements. Average body measurements for children cannot be characterised by a mean value obtained against age. Numerical age has no great significance when evaluating children's sizes – although clothing is not infrequently sized by age. According to Winks (1997:13) the latter can act only as a rough guide to supplement the appropriate body dimensions on which the garments are sized. A variation in body shape is present in any age group and in either gender. Small differences in body proportions at birth are continuously multiplied by differential growth rates up until maturity, after which body shape changes are influenced by age, quality and quantity of food intake, exercise, etc.

It is reported that a child's height increases about three times from birth to maturity, mainly because of rapid growth in leg length. On average, maturity in growth is reached at 21 years for males and 17.4 years for females. It is suggested by Winks (1997:12) that, according to studies on USA populations, at age two, the child has reached about one-half the adult standing height. Limbs grow at different rates from the rest of the body. Infants, for example, have arms slightly shorter than their trunks. On average, at age three children's arms are 15% longer than their trunks. At age seven, their arms are 25% longer. Adults' arms are 28% longer.

There is evidence of the effect of geographic or socio-economic environment on total body growth. Winks (1997:13) reports that there have been indisputable increases in growth rates in the more prosperous countries, and there is a trend towards earlier maturation and greater total body build. This does not mean that an increase in nutrients will always produce an increase in body tissue. Genetic and environmental factors combine to inject a series of unknowns into growth rates of children from a similar population – equally well nourished or not. There are also regional differences in growth that cannot be explained in terms of nutrition or climate but would appear to depend on genetic factors peculiar to the region. There can be some delay in growth rates of children in hot climates. These differences may be in part responsible for the range of physique to be seen globally. The findings of anthropometric surveys of children at adolescence in the UK show that a superior environment can produce an increase in height between 3.8 and 5.1cm. An inferior environment, on the other hand, might cause a loss of expected height of 3.8cm.

Anthropometry as the study of the body measurements of the human body was discussed in the preceding paragraphs focussing on the variety of factors by which it can be influenced. Genetic or environmental factors were discussed in depth. To understand the human body, and the variation in the shapes and sizes of different body types, it is important to give an overview of somatotypes and figure type classifications. In contrast with anthropometry, somatotypes refer to the physique of the human body and its appearance or body shape. In the following paragraphs, somatotyping and figure type classification will be discussed.

2.7 SOMATOTYPING AND FIGURE TYPE CLASSIFICATION

2.7.1 Introduction

Somatotyping (figure typing) is the study of human body types; a body "blueprint" which is determined at birth. Although body composition can change with exercise and diet, the basic structure will always remain the same (Ivillage, 2004:1). The concept "somatotype" was introduced in 1940 by Sheldon who recognised the need for classifying the variations of human physique on continuous scales expressed in simple numerical values. Earlier classifications characterised a total physique as belonging to a broad category or type based on some anthropometric measurements plus visual impressions (Carter & Heath, 1990:30,341). In the 1960s, the research team of Lindsay Carter and Barbara Heath collaborated on continuing the modification of Sheldon's somatotype methodology (Simmons *et al.*, 2004:3). Somatotype research in relation to apparel was first done towards the latter part of the 20th century. Helen Douty from Auburn University was the major contributor. A method called "visual somatometry" was developed which aimed to improve the fit of custom-made clothing (Devarajan & Istook, 2004:3).

Somatotypes are useful for the description and comparison of populations, for monitoring growth and aging changes as well as changes due to exercise and physical training. This data can lead to hypotheses related to differences between samples, relationships between somatotype and performance in its broadest sense, incidence of disease and behavioural characteristics of specific categories of subjects (Carter & Heath, 1990:345). Somatotypes are superior to individual anthropometric dimensions for general differentiation of physiques. It has proved to be a good descriptive and classification system for learning about relative shape and body composition and their variation in samples of populations.

In contrast with somatotyping, which refers to physique and its appearance (body shape), anthropometry defines body size and measurements. The joint application of anthropometry, together with somatotyping is, however, very rare in the clothing field. Tsang *et al.* (2000:146) is of the opinion that somatotyping could not be done by anthropometry alone, but the measurements can be useful as supporting evidence for defined somatotypes.

2.7.2 Definition

A somatotype is a quantitative overall appraisal of body shape and composition. It has been described as an anthropological “classification label” which is a useful description of human physique (Carter & Heath, 1990:340). Somatotyping reflects the effect rather than the cause and represents the physique of each subject as a unified whole. As stated by Carter and Heath (1990:351): “It reminds us of the important ‘wholeness’ and unique individuality of those persons studied for whatever reason, and that each part of a body, whether an organ or a cell, is related in probably unknown ways to the ‘wholeness’ we call somatotype”. Sheldon, Steven and Tucker (1940:4) defined somatotyping as “… a quantification of three primary components determining the morphological structure of an individual expressed as a series of three numerals, the first referring to endomorphy, the second as mesomorphy and the third to ectomorphy”. Figure 2.3 illustrates Sheldon’s “cluster chart” of somatotypes (Sheldon, Hartl & McDermott, 1949:16).

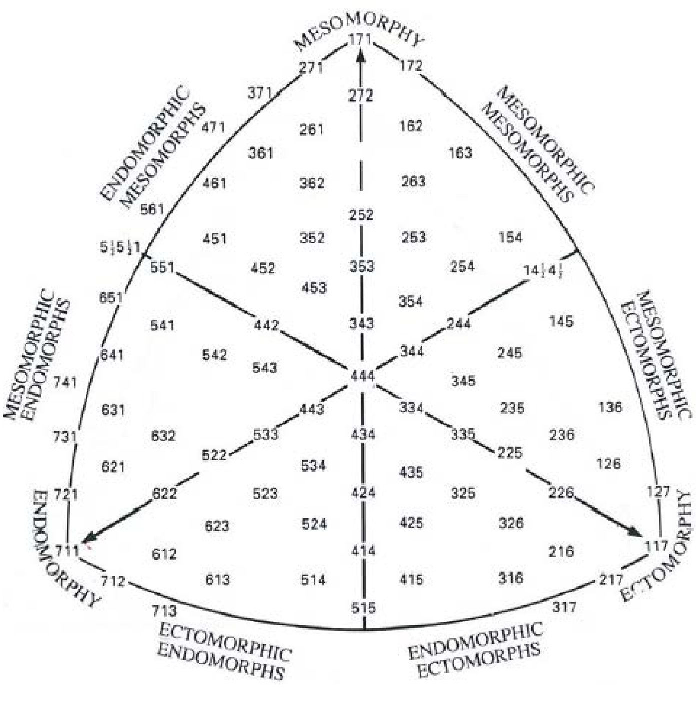


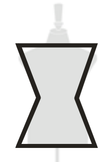
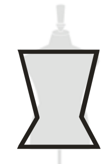
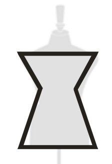
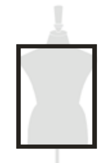
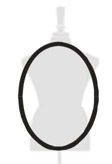
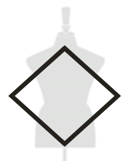
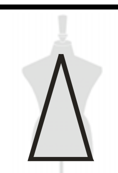
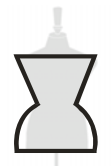
FIGURE 2.3: SHELDON’S “CLUSTER CHART” OF SOMATOTYPES (Sheldon *et al.*, 1949:16)

2.7.3 Figure type classifications

The endomorph appears soft, curvy and often with the hips wider than the shoulders, while the mesomorph’s shoulders are often wider than their hips. The ectomorph appears long, wiry and narrow with a delicate bone structure and shoulders and hips of approximately the same width (Ivillage, 2004:1). In clothing, the terms endomorph, mesomorph and ectomorph are not very commonly used to describe the different body or figure types. In women's wear it is rather classified (based on front views) by terms such as "Missy, Junior, Women or Half size" which indicate approximate age. Other classifications are done according to geometric shapes (rectangle, oval, circle, diamond, triangle and inverted triangle), according to distinctly shaped objects (hourglass, bean, barrel, spoon, ruler, cone, Christmas tree or heart), or according to names of fruit (apple and pear). Classifications can also be done according to numbers or letters, such as figure 8 or "X", "H", "O", "A" and "V" depending on whether the bust is greater than (V), equal to (H), or less than (A) the hip girth (Simmons *et al.*, 2004:4; Devarajan & Istook, 2004:4).

None of the classification methods mentioned use mathematical formulas, ratios or expressions to facilitate body shape identification. Based on the Female Figure Identification Technique (FFIT) for Apparel developed by the North Carolina State University, nine classification categories were identified. Using mathematical criteria in this development and the tacit knowledge of experts in apparel design, development and fit, they defined a preliminary set of shapes with mathematical descriptors. The bust, waist, hip, stomach and abdomen circumferences were used in combinations to describe each shape (Simmons *et al.*, 2004:11). Table 2.1 is a summary of these, based on research done by Simmons *et al.* (2004:4-5, 12-13) as well as Devarajan and Istook (2004:7). The summary is based on the initial figure types identified, which expanded into a further nine with a classification and illustrations based on Better Half Fashions (2004:1-2) and Simmons *et al.* (2004:6-13).

TABLE 2.1: CLASSIFICATION OF FIGURE TYPES (Simmons *et al.,* 2004:4-5, 12-13; Devarajan & Istook, 2004:7)

	Classification according to:				
Figure Types	Shape & objects	Letters & numbers	Fruit & vegetables	Illustration	Description of body shape
Hourglass	Hourglass	Figure 8 or "X"			There is a small difference in the comparison of the bust and hip circumferences. The bust-to-waist and hip-to-waist ratios are about equal.
	Bottom hourglass				The hip circumference is bigger than the bust circumference. The bust-to-waist and hip-to-waist ratios are significant enough to produce a definite waistline.
	Top hourglass				The bust circumference is bigger than the hip circumference. The bust-to-waist and hip-to-waist ratios are significant enough to produce a definite waistline.
Rectangular	Rectangle or ruler	"H"			The bust and hip measurements are fairly equal. The bust-to-waist and hip-to-waist ratios are low. There is no clearly defined waistline.
Rounded	Oval or circle	"O"	Apple		The average of the stomach, waist and abdomen measurements is less than the bust measurement.
	Diamond				The stomach, waist and abdomen measurements are more that the bust. There are several large rolls of flesh in the midsection protruding away form the body.
Triangular	Triangle or Christmast tree	"A"	Pear		The hip circumference is bigger than the bust circumference. The hip-to-waist ratio is small. The hips appear larger than the bust without a definite waistline.
	Spoon				There is a larger circumferential difference in the hips and bust. The bust-to-waist ratio is lower than the hourglass shape and the hip-to-waist is higher.
	Inverted triangle or cone	"V"			The bust circumference is larger than the hips. There is a small bust-to-waist ratio.

2.7.4 Changes in somatotyping

Although researchers such as Walker (1978:113) believes that a person's somatotype never changes, the philosophy supporting changes to somatotypes during the growth and development stages from childhood through adolescence to adulthood is adapted for this study. The range of childhood somatotypes is more limited than that of adults. Longitudinal studies show that children's somatotypes change in a generally consistent pattern that is different for each gender. Up to about age twelve there is less gender dimorphism than in adolescents and adults. During growth some somatotypes change dramatically in an unexpected manner, while some are relatively stable and change predictably. However, the changes in somatotype in children can provide valuable information for understanding their growth and maturity (Monyeki, Toriola, De Ridder, Kemper, Steyn, Nthangeni, Twisk & Van Lenthe, 2002:37). According to Carter and Heath (1990:344) the change and stability of somatotypes appear to be functions of nutrition, exercise, and health status.

An obvious gender dimorphism in somatotype distributions within studies of a single ethnic group is also visible. Although differences at ages two to six years are somewhat less than at ensuing ages, they are apparent from the earliest years. The somatotypes of many children change during adolescence, and often reverse component dominance more than once. In general, it is evident that boys are more mesomorphic (from the growth in muscle) and less endomorphic than girls. These differences increase after adolescence.

Figure 2.4 depicts Sheldon's schematic representation, which illustrates the movement and general pathway of children's somatotypes from infancy to adolescence into adulthood. This form of gender dimorphism is well known in adults. It appears that somatotype reflects the general biological differences in shape and composition of boys and girls. This process extends over three or four years, probably longer in some individuals. There are no definitive data on early and late maturing somatotypes, fast and slow maturing somatotypes, or variability of individual somatotypes (Carter & Heath, 1990:176-177).

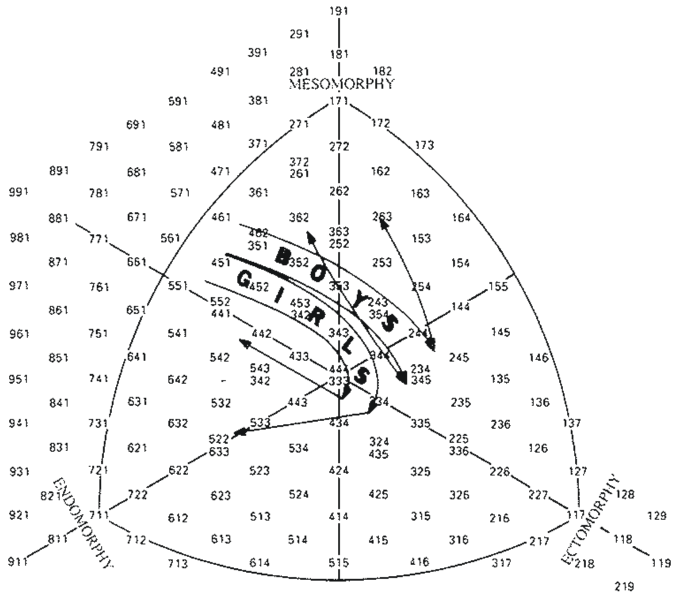


FIGURE 2.4: SHELDON'S SCHEMATIC REPRESENTATION OF THE GENERAL PATHWAY OF CHILDREN'S SOMATOTYPES FROM INFANCY INTO ADOLESCENCE AND INTO ADULTHOOD (Carter & Heath, 1990:176-177)

It is also believed that ethnicity does influence somatotypes. Carter and Heath (1990:177) reported that there appear to be some ethnic differences within samples from European populations. The variations in body size and shape of different geographical populations, and of different ethnic groups located within a single geographic area, is less apparent. According to Winks (1997:7) it is therefore important to study these populations and to establish the significance of the differences if clothes are to be manufactured for the bulk of the population.

With knowledge of the somatotypes and the variation in human body shapes as described in this section, it is important that clothing manufacturers and retailers understand the the impact thereof in product development for their specific target populations. The following section deals with this aspect in discussing fit models, including life models, fit dummy prototypes and dress forms.

2.8 FIT MODELS

The prototype body on which clothing size designations are based is the fit model chosen by clothing manufacturers or retailers chose to fit their styles. Fit models represent those body dimensions a clothing company has determined would provide the proportional relationships needed to achieve the company's preferred garment fit. Fit is known as garment cut and refers to the way a garment conforms to or differs from the body dimensions. Garment fit allows a company to differentiate its products from competitors' products. For this reason the same size garments from different companies are not likely to have the same fit (Workman & Lentz, 2000:252&255).

2.8.1 Body dimensions of fit models

Key dimensions are good predictors of measurements of other body parts but must be convenient to measure, correspond to integral parts of the garment, have a high degree of correlation with other dimensions important in design and sizing, and not be highly correlated with one another. There is no single key dimension, which can accurately predict both vertical (height, length) and horizontal (girth, breadth, depth) measurements. At least two measurements are needed, one of a vertical index and one for a horizontal index. Height has often been chosen as a vertical key dimension because it is related to most other vertical dimensions and most people know their height. Horizontal key dimensions include weight, bust girth, abdominal extension, hip girth, base of arm scye girth and waist girth (Workman & Lentz, 2000:252, O'Brien *et al.*, 1941:34).

Weight could be used as a dimension indicator but is more variable than height. Bust and hip circumferences can, however, be used as key dimensions in place of weight because these two dimensions offer flexibility for varying size relationships between the upper and lower body. Specifications for fit model measurements therefore include height plus three of the horizontal measurements (bust, waist and hip) shown to predict other proportional measurements. These body dimensions, from which fit model measurement specifications and size are designated in, for example, women's wear can, however, vary considerably among manufacturers, among divisions of the industry and among countries (Workman & Lentz, 2000:252 & 253).

2.8.2 Sources of body dimensions

A company's target consumer can provide information on which the company can base its prototype body. Variance in sizing results appear from brand to brand because companies fit their sample garments on models, who are perceived to be physically similar to their target consumer. It is a manufacturer's or retailer's responsibility to consider its target when developing appropriate specifications to customize its sizing and fit. Anthropometric surveys of target consumers are therefore considered an important way to collect such information. In mass customisation, each individual consumer is his/her own "prototype body" and provides the body measurements from which fit is determined.

Internationally, there are various sources of body dimensions, which apparel manufacturers and retailers can access. These sources can be body measurements of professional fit models, statistics provided by governments, databases compiled by private non-profit organizations, standard industry fit dummies or competitors' garments. For example, stylists can purchase a competitor's garment, make a pattern from it, order similar fabric, and mass-produce the garment at a lower cost. In knocking off such a design, companies also knock off the company fit. Other sources can be a company target consumer's body dimensions for prototype bodies, as well as databases from industries, such as automotive, aeronautical, architecture and environmental design that use body dimensions in designing their products (Workman & Lentz, 2000:253; Devarajan & Istook, 2004:4). Apart from professional fit models, fit dummies are also very successfully used for developing the initial fit and for trying out designs. A standard size fit dummy prototype can be used or it can be custom made to company specifications.

In order to achieve a high level of consumer satisfaction, it is important for manufacturers and retailers to identify and implement the best and preferred fit for their products. This section discussed the importance of the fit models employed in this process. To be able to select the most suitable life model or to be able to develop the most accurate fit dummy prototype, it is important to use scientific data and body measurements representing the target population. The following section deals with various aspects in this regards as well as the importance of anthropometric surveys in this process.

2.9. ANTHROPOMETRIC SURVEYS

2.9.1 Introduction

An anthropometric sizing survey in clothing is conducted on a specific target population or market sector. It involves the measuring of human bodies, during which data will be captured and analysed. Through analyses, a range of body measurements will be developed and classified in different sizes with specific intervals between sizes. These are then recorded as a size chart for the specific target population surveyed. When sizing surveys are developed and executed with statistically analysed results, it is also common practice to compare results with similar investigations carried out in other countries, for example, to confirm results. Because the body shape of all humans is basically the same, comparative anthropometry is made much simpler. Good anthropometric surveys are, however, difficult to conduct, expensive when applied to civilian populations and few in number.

In this part of the chapter anthropometric surveys will be discussed with specific focus on the manual method of measuring. This particular focus is important since this study is about measuring child subjects manually which, for various reasons, is believed to be the most successful method to date. The manual method of measuring is also chosen as the most suited and cost effective method of measuring, particularly for conditions in South Africa with the relatively small and widespread population.

2.9.2 Anthropometric surveys and their uses

Companies which use anthropometric research in product design are improving their ability to create custom products. The development of a reliable sizing system based on anthropometric principles contributes to customised clothing to meet the needs of specific user groups, to optimise the number of items of a certain size to be manufactured and to improve the fit, comfort and reliability of clothing (Anthrotech, 2002:1).

Anthropometric data have varied uses in research of the human body. Although some of these applications are specific to the study of infants, youth and children, the general uses can be summarised as follows (Lohman *et al.*, 1988:111):

- Assessing present conditions or status of individuals or groups: Comparison of specific dimensions of individuals or groups to those of a group or standard.
- Description of changes over time: Information about the rate of change in individuals or populations which is often more valuable than knowledge about current status.
- Documentation of variation in samples or populations: Knowledge about, within and between population variations, which will enrich knowledge about the process of normal growth and the relative importance of genetic and environmental factors.
- Derivation of proxy measures that are expensive, dangerous, difficult, or otherwise prohibitive, which may be estimated by one or more anthropometric indicators (e.g. obesity, body density).
- Accurate prediction about growth and maturation may be possible if the relevant growth process is orderly.

2.9.3 Types of anthropometric data

There are three types of anthropometric data. Firstly, *structural* (or static) anthropometric data, which is based on the measurements of the body dimensions of subjects in a fixed (or static) position. Measurements are taken from one clearly identifiable anatomical landmark to another or to a fixed point in space (i.e. the height of the back of the knee above the floor). Some examples of the use of this type of data are to specify furniture dimensions and ranges of adjustment and human body dimensions used for the development of clothing sizing systems and size designations.

Secondly, *functional* (or dynamic) anthropometric data, which is collected to describe the movement of a body-part with respect to a fixed reference point (i.e. data available on the maximum forward reach of standing subjects). This type of data is useful for designing workspaces and positioning objects within them, such as in the design of vehicle interiors. The third type of data is known as *Newtonian* anthropometric data, which are used in mechanical analysis of the loads on the human body. The body is regarded as an assemblage of linked segments of known length and mass (sometimes expressed as a percentage of stature and body weight). Newtonian anthropometric data may be used, for instance, to compare the loads on the spine resulting from different lifting techniques (Bridger, 1995:73&75).

2.9.4 Types of anthropometric surveys

Various types of anthropometric surveys can be conducted, of which short-term surveys are most often conducted when smaller market sectors are investigated. The short-term anthropometric survey is normally planned with a relatively short measuring period in mind, such as six to twelve months. Therefore, short-term anthropometric surveys are relatively inexpensive, but time consuming and labour intensive at the time of measuring subjects. During short-term anthropometric surveys, fewer measurements are taken and these are mostly done by a manual method of measuring. These surveys are normally focused on addressing the needs of a specific industry or market sector. Table 2.2 is a summary of examples of such anthropometric surveys.

Accuracy of measurements through consistency of the measuring techniques applied is of the utmost importance for a useful outcome of such an anthropometric survey. Field workers need to be trained extremely well, tested and calibrated to conform to accuracy and consistency standards. Individual fieldworkers should be marking and measuring the same measurements on all bodies during the survey. In this instance, observer error is the most troublesome source of anthropometric error, since this includes imprecision in landmark location and marking, subject positioning and measuring instrument application (Simmons & Istook, 2001: 98).

The size of the team of fieldworkers for manually measuring subjects depends on the amount of money and time available for the survey. This will also influence the numbers of subjects to be measured during the survey as well as the number of measurements taken from each subject. Repeating short-term surveys with a great deal of accuracy and consistency is very difficult when comparative analysis and studies are done over time. In this instance it is recommended that the same field workers should be measuring subjects using the same measuring equipment and techniques as previously (Taylor, 1990:53).

The success of long-term anthropometric surveys, on the other hand, became more of a possibility with the application of 3-D scanning equipment, provided that the same scanning equipment is used during the entire survey and for staggered and comparative surveys. These types of surveys are more expensive, mainly because of the equipment. The time period of the measuring as well as the extent, for example the number and types of measurements taken, also influence the cost of the survey. Although fewer, but well trained, field workers are employed to operate the scanning equipment, no impact on the accuracy and consistency of land marking measuring techniques is evident with field worker changes. Long-term anthropometric surveys can be focussed on more than one industry at the same time, due to the amount of information extracted when scanning (measuring) subjects.

2.9.5 Anthropometric surveys of the 20th and early 21st centuries conducted to develop body measurement charts and size designation systems for the clothing industry

Since the middle of the 20th century, various different government departments and industries worldwide, including clothing industries, have carried out several anthropometric surveys. In recent years, with the development of 3-D scanning equipment, there has been a change in the number and time frame of surveys conducted. Generally most of the survey results have been recorded either as government documents or as in-house publications and, therefore, as trade secrets, due to the competitive advantage they give. In other instances data is sold at a considerable price. Although few surveys are focused exclusively on the clothing industry, valuable information can also be extracted from clinical anthropometric surveys.

In South Africa, some of the clothing retailers conducted small-scale measuring exercises through the years of which most were not recorded scientifically. Retailers, such as Woolworths and Cape Union Mart or retail groups such as Edcon and The Foschini Group and others mostly conducted these exercises in conjunction with Figure Forms, primarily to develop or improve fit dummy prototypes. The results of all these exercises were confidential and recorded as unpublished documents.

TABLE 2.2: A SUMMARY OF EXAMPLES OF ANTHROPOMETRIC SURVEYS CONDUCTED DURING THE 20th AND EARLY 21st CENTURIES

Country	Year	Institution / persons conduction survey	Subjects	Principal method of measuring	Implementation / Uses	References
France	1965-1966	Centre d'Etude Techniques des Industries de l'Habillement (CETIH)	7283 Males ages 22-64 years	Manual	Publishing body measurements for men	**Winks, 1997:8**
France	1969-1970	Centre d'Etude Techniques des Industries de l'Habillement (CETIH)	8037 Females ages 18-65 years	Manual	Publishing body measurements for women	**Winks, 1997:8**
France	1977	Centre d'Etude Techniques des Industries de l'Habillement (CETIH)	14 000 Boys and girls ages 4-21 years	Manual	Developing G03-002	**Winks, 1997:8**
Germany	1957-1958, 1960-1961	Hohenstein Research Institute	Women and girls	Manual	Preparing size tables for women's and girls outerwear, published in 1963	**Winks, 1997:8**
Germany	1966	Textile Distributor's Association	10 000 men and boys	Manual	Preparing size tables for men and boys outerwear	**Winks, 1997:8**
Germany	1970	Unknown	Women	Manual	Size table published in 1971	**Winks, 1997:8**
Germany	1981-1982	Unknown	10 000 Women and girls	Manual	Preparing size tables for women's and girls outerwear, published in 1983	**Winks, 1997:8**
Hong Kong China	1961-1967	Unknown	School children and university students	Manual	Publishing anthropometric data of the children and students	**Richard *et al.* , 2004:1**
Hong Kong China	1981-1986	Pheasant	Hong Kong Chinese population (details unknown)	Manual	Publishing anthropometric data of the population	**Richard *et al.* , 2004:1**
India	Unknown	National urban and rural growth data	835 Boys and 894 girls ages 3-20 years	Manual	Analysing the average growth pattern of children	**Begum & Choudhury, 1999:203**
Iran	1990-1992	National Health Survey	1702 Boys and 1599 girls ages 2-18 years	Manual	Developing body mass index charts for chilren	**Hosseini, 1999:527**
Italy (Part of **NedScan** & **CEASAR**)	2000-2001	Government departments and industry	2000 Male and female adults ages 18-65 years	3D-scanning	To develop a database of human body dimensions and measurements	**Nedscan, 2004:1**
Kenya	1999	Otieno and Fairhurst	618 Girls ages 2-6 years	Manual	Documenting anthropometric data, formulating body-measurement tables and formulating garment size charts	**Otieno & Fairhurst, 2000a:145**
Korea	1998	Ministry of Education and Human Resource Development	Children ages 4-12 years	3D-scanning	National Anthropometric Survey	**Kang *et al.* , 2001:95**
Mexico	1992-1993	Educational institutions in Mexico and the USA	349 Boys and 162 girls ages 6-12 years	Manual	To assess the growth status of urban Mixican children	**Pena Reyes *et al.* , 2002:11**

South Africa	1927	Transvaal Department of Education	Boys and girls ages 9-15 years	Manual	Comparison of measurements based on socio-economic groups	**Grobbelaar, 1964:1-2**
South Africa	1935	Cape Provincial Department of Education	1800 Boys and girls ages 6-18 years	Manual	Measurement comparisons with corresponding groups in Australia, England and the United States	**Grobbelaar, 1964:1-2**
South Africa	1938	Unknown	Boys ages 8-11 years	Manual	A comparative study determining height	**Grobbelaar, 1964:5**
South Africa	1945, 1946 & 1950	Cluver, Manpower and Postma	Unknown	Unknown	Unknown	**Grobbelaar, 1964:1-2**
South Africa	1952-1955	Unknown	3249 White school boys ages 10-18 years	Manual	To determine height and weight curves	**Grobbelaar, 1964:viii**
South Africa	1952-1955	Unknown	1570 White male university students ages 19-26 years	Manual	To determine height and weight curves	**Grobbelaar, 1964:viii**
South Africa	1966-1967	Unknown	1555 Girls ages 6-20 years	Manual	Comparison of weigth, height and certain girth measurements	**Grobbelaar, 1964:1**
South Africa	1980-1981	Unknown	669 Black mineworkers	Manual	Updated survey	**Winks, 1997:8**
South Africa	1993	Edcon and Ergotech	100 Black women ages 18-45 years	Manual	To acquire body size data for the development of fit dummies for the black market sector	**(*) Paulson, 2004:1**
South Africa	1993	Academic institutions in South Africa	542 Boys and 466 girls ages 7-19 years	Manual	To describe and compare stature, sitting height and leg length of Northen Sotho children	**Monyeki *et al.*, 1997:141**
South Africa	1996	Academic institutions in South Africa and The Netherlands	408 Girls ages 4-10 years	Manual	To assess the stability of somatotypes of rural South African girls	**Monyeki *et al.*, 2002:37**
South Africa	1997	Edcon and Ergotech	1000 White women ages 18-45 years	Manual	Acquiring and merging body size data with black data for fit dummy development	**(*) Paulson, 2004:1**
South Africa	1998-2002	Group of nine leading children's wear retailers: G9	1500 Boys and 1500 girls ages 2 - 14 years	Manual	Sizing survey and dummy development project	**Van Huyssteen, 2003: 1**
South Africa	2000	Academic institutions	523 Boys and 451 girls ages 3-10 years	Manual	To investigate the stability of anthropometric indicators of the nutritional status of rural African children	**Monyeki *et al.*, 2000:28**
South Africa	2003	Tembeka Mlauli and CSIR	Black women ages 20-54 years	Manual & 3D scanning	Investigating irregularities in clothing sizes	**CSIR, 2004:1**
Sweden	1972	Swedish Textile Research Institute (TEFO) and Clothing Industries Federation (KIF)	1000 Women	Manual	1977 Published women's garment sizing system with market distribution charts	**Winks, 1997:8**
The Netherlands (**NedScan** part of **CEASAR**)	2000-2001	Government departments and industry	2000 Male and female adults ages 18-65 years	3D-scanning	To develop a database of human body dimensions and measurements	**Nedscan, 2004:1**

USSR (former)	1957-1965	Unknown	Men, women and children	Manual	Development of PC3137 and PC3138 for publication in 1973	**Winks, 1997:8**
United Kingdom	1950's	Board of Trade	5000 Women	Manual	Developing sizing and grading systems in the United Kingdom (UK)	**Winks, 1997:8; Taylor & Shoben, 1990:11**
United Kingdom	1986	Marks and Spencer	6800 Women ages 17 - 69	Manual	Collecting information about body sizes of actual and potential women customers.	**Shaw, 1997:1**
United Kingdom	1993/4	Manchester Metropolitan University	100 Young women	Manual	Formulating sizing systems and body measurement tables.	**Beazley, 1997b:260**
United Kingdom	2000	Marks and Spencer	2500 Women	3D-scanning	Scanning of volunteers	**Textiles Unlimited, 2000:17**
United Kingdom **(SizeUK)**	2000-2002	Bodymetrics in collaboration with UK Government, major UK retailers and leading academics	5500 Men and 5500 women ages 16-90 years	3D-scanning	To develop sizing standards representing the UK population	**Bodymetrics, 2004:3; Devarajan & Istook, 2004:6**
United States of America	1929-1930	Bureau of Home Economics (US Department of Agriculture)	US Women Survey measuring 14698 women	Manual	Developing a standard system of body measurements for garment and pattern sizing	**Winks, 1997:14**
United States of America	1937-1939	Works Progress Administration (Clothing and Textile Division of the US Department of Agriculture)	National survey with 147 088 boys and girls participating	Manual	Establishing a sizing system for childrens clothes based on height and hip girth	**O'Brien *et al.*, 1941:1, 111**
United States of America	1941	Ruth O'Brien and William Shelton	10 042 Women	Manual	Data for sizing and grading systems	**Taylor & Shoben, 1990:11; Devarajan & Istook, 2004:2**
United States of America	1960-1962	Health Examination Survey (HES)	6672 Men ages 18-79 years	Manual	Clinical examinations	**HES HANES RESULTS, 2004:1**
United States of America	1971-1975	Health and Nutrition Examination Survey (HANES)	6913 Men ages 25-74 years	Manual	Clinical examinations	**HES HANES RESULTS, 2004:1**
United States of America	1976-1977	US Army	1331 women	Manual	To develop standard body size measurements for the purpose of sizing women's field clothing	**Abend, 1993:78; Lee, 2004:3**
United States of America	1992	ASTM Institute for Standards Research	Women 55 years or older	Manual	To develop a standard table of measurements to improve fit in this market segment	**Abend, 1993:80; Workman & Lentz, 2000:251**
United States of America **(CEASAR)**	1997	Government departments and industry	3000 Male and female adults ages 18-65 years	3D-scanning & manual	To develop a database of human body dimensions and measurements	**Nedscan, 2004:1; Devarajan & Istook, 2004:6**
United States of America **(SizeUSA)**	2002 -2003	TC2 and US Department of Commerce	12 000 Women ages 18-66+ years	Scanning	To gather accurate and statistically significant US population size and shape data	**Size USA, 2002:1; [TC]^2, 2004:2; Devarajan & Istook, 2004:6**

(*) The information was obtained through a telephone conversation because it was recorded as unpublished documents and trade secrets.

Other developments were done by the military in conjunction with Ergotech to develop specifications for garments. However, these results were recorded as confidential military documents**.** Ergotech and educational institutions such as the University of North West and the University of Pretoria also formed the independent body, African Body Dimensions, planning to conduct a national measuring survey measuring subjects by means of 3D scanning.

As illustrated in Table 2.2, various Departments of Education in South Africa were also involved in smaller scale anthropometric surveys in the earlier years. In terms of children's body measurements, and although these surveys did not in particular focused on specific measurements needed in the clothing industry, valuable deductions and conclusions can be made in this regard when interpreting the data. With reference to other industries in South Africa, various studies were conducted in the medical, human movement and dietary fields. These studies were conducted mainly by academic institutions and focused on children. Examples of such studies were listed in Table 2.2 below.

According to Workman and Lentz (2000:250) anthropometric surveys should be verified at least every ten years to be useful and up to date. Table 2.2 is only a brief summary as an example to illustrate the nature and types of surveys conducted in various parts of the world. This summary includes a brief description and outcomes of each survey with the focus on the implementation and use of the results. Since the focus of this study is on anthropometric surveys conducted by means of manual measuring the summary is reflecting this. Mention is, however, made of some of the important surveys done by 3-D scanning in recent years as reference due to their significant contributions.

2.10 CONDUCTING ANTHROPOMETRIC SURVEYS

Anthropometric data and the sizing systems based thereon are very important components of clothing quality. Clothing cannot be top quality unless it fits the potential wearer satisfactorily (Lee, 2004:1). When conducting an anthropometric sizing survey, the extent of the required sizing system needs to be established. This should relate to the number of sizes the whole system should contain, which is largely based on what a particular clothing industry is prepared to accept. According to Kunick (1984: 16) countries may differ in this respect, depending to some extent on the technical development of their clothing industry.

It is argued that size intervals are therefore very much a matter of trade practice in individual countries. Even so, garment manufacturers and retailers tend to avoid producing and stocking the less popular sizes and fittings, which are not adaptable to mass-production. Based on some of Taylor's (1990:49-51) recommendations, the following sections deal with some important aspects which need to be addressed and clarified when setting up an anthropometric survey for use in the garment industry.

2.10.1 Aim of anthropometric surveys

Surveying the size, shape and weight of the human body is generally done for two basic reasons. The first is for medical reasons, such as determining growth rates related to age and diet, while the second reason relates to clothing and ergonomics (Taylor, 1990:49). With regard to clothing, the aim of such a survey should clarify three aspects. Firstly, the specific target population to be surveyed should be identified, including the age, gender, size and height of the subjects to be measured. Secondly, the sizing system to be developed may be either a review of the current sizing system or the development of a new sizing system for the specific target population. Thirdly, the purpose and focus of the analysis should be identified, such as the development of fit dummy prototypes, the drafting of basic pattern blocks or development of a sizing system for the specific target population.

2.10.2 Balanced sample selection

The process followed in selecting any sample population to survey must be described in detail to facilitate data interpretation and comparisons with other surveys. Data on the degree of subject participation in the survey is also essential for assessing bias. It is recommended that all possible characteristics, which may be related to the outcomes of subjects who refuse to participate, should be coded for later analysis.

The sample selected should be described adequately for all relevant key factors pertaining to the specific survey. Although the description will vary from survey to survey, it should include basic aspects such as date of examination, date of birth and age at date of measuring, gender, ethnicity and geographic location as well as socio-economic status. In this regard it is recommended that the statistical random sampling technique be applied in order to select the sample population for equal coverage of all aspects (Lohman *et al.*, 1988:108).

2.10.2.1 Body types

When surveying the growing bodies of infants and children, it is mainly the size of the child's skeleton in relation to its age and weight that will be measured. Any size chart constructed for the growing bodies of children will reflect mainly the changes in bone-structure, and will therefore be based primarily on height increments. The girth increases will be relatively small in relation to the height changes. If required by the specific sizing system, inclusion of girth options within each height category can make allowance for fat distribution and muscle development.

When surveying the grown bodies of adults, on the other hand, the growth of bone structure is complete, and measurement is easier to handle. In this group the problem of sizing revolves around muscle development and the deposits of fat. For this particular sample population, the size chart can be constructed in two different ways. Firstly, height measurements can be kept static and provision made for different girth categories within each height category. Alternatively girth, measurements can be kept static with provision made for different height categories within each girth category. To achieve specific survey aims, it is therefore important to define the specific body type selected as target population (Taylor, 1990:50).

2.10.2.2 Gender

When surveying growing bodies, it is advisable to measure both genders, regardless of age. Although the size and shape of children up to the age of seven or eight is basically regarded as unisex, it is still necessary to develop separate size charts and fit dummy prototypes, especially for older children (Taylor, 1990:50). All surveys beyond this age range should therefore be measured separately, according to gender. It is therefore important to define the target population of each gender properly according to age to achieve the aims set for a specific survey.

2.10.2.3 Age group

Although the specification of age is important for most anthropometric surveys, its accuracy is especially critical for infants (Lohman *et al.*, 1988:112). Body size, shape and composition change rapidly during infancy and the relationships of these characteristics to age changes from birth onward. An error of a few weeks in the determination of post conception age can make a great deal of difference in the interpretation of anthropometric measurements on a new-born. The relative age dependence of most measurements diminishes rapidly with increasing age; thus the same amount of error might introduce only minor bias into the interpretation of data on, for example, a four-year-old child and may be completely insignificant for an adult.

Age has a considerable effect on size, body shape, stature and silhouette. When surveying growth areas, defining averages by age can be very misleading owing to the large variances that can be encountered and is therefore not advisable. However, Taylor (1990:51) believes that when a survey of growth is carried out, the data should be averaged out according to height, usually at 5 to 10 cm intervals. According to Lohman *et al.* (1988:108) age should be expressed in days up to the age of one month; thereafter decimals of years should be used, employing if necessary, tables for their calculation. Distribution statistics based on decimal ages should be reported for each age group.

2.10.2.4 Geographical area to be covered

It is important, regardless of the method of measuring, the size of the survey and the number of subjects to be measured, to decide on the geographic area to be covered by the survey. Taylor (1990:54) points out that there do seem to be local physical characteristics to bear in mind when planning a survey. He identifies a tendency to be taller or thicker hipped, for example, in different parts of the world, so it seems necessary to spread the sample evenly across the country where the survey is planned. The study by Pena, Cardenas, Cahuich, Barragan and Malina (2002:1) confirms that a gap in the growth status (height) of children between well-off and lower socioeconomic status regions do exist. This indicate the impact of living in different geographical areas and.

The impact of factors such as socioeconomic status, urban versus rural environments and ethnic differences, should therefore not be ignored. Public health studies in developing countries indicate the occurrence of stunting, a low-height-for-age measurement, and wasting, a low weight-for-height indicator. In the South African context, the study by Monyeki, De Ridder, Kemper, Steyn, Toriola, Twisk, Van Lenthe and Griebenauw (2000:28) identifies the existence of stunting and wasting in rural African children. This confirms the inclusion of subjects form different geographical areas when selecting a sample population for an anthropometric survey.

There are certainly cultural (racial and ethnic) characteristics to bear in mind, which may distort a survey and decisions have to be made regarding the influence of this factor (paragraph 2.6.3). In the study by Monyeki, De Ridder and Pienaar (1997:141) ethnic differences in stature between Northern Sotho and other groups of children were pointed out due to their anthropometric uniqueness. Therefore, it has to be decided whether or not to omit racial and ethnic characteristics from the final analysis or just to exclude them from the start.

2.10.3 Measuring subjects

The traditional method of measuring human bodies is to measure subjects manually. During the 1990s the introduction of three-dimensional (3-D) scanners introduced a new, more versatile method of measuring human bodies or any other object. Before any decisions can be made regarding the selection of measurements or the measuring instruments needed for measuring, it should be decided whether measuring should be done manually or by using 3-D scanning equipment or a combination of both methods. Because the manual method of measuring is considered most suitable for children's wear (Beazley, 1997a: 82), this study focuses only on this practice while merely a brief mention will be made of 3-D scanning.

All body measurement surveys conducted world wide operate on the premise that the basic principle of a sizing system, if it is to meet the requirements of a population, must be three dimensional in structure, using the bust girth, hip girth and stature as the main control measurements (Kunick, 1984: 16). The type of survey planned determines the method of measuring, as long as three-dimensional measurements are taken accurately and consistently. The purpose of the survey will also dictate what type of measurements should be included in the measuring schedule. Different methods of measuring are normally applied for short-term and small-scale anthropometric surveys than for long-term and larger scale anthropometric surveys. It is, however, important that in order to be useful the same method of measuring should apply for repetitive comparative surveys.

2.10.3.1 Measuring subjects manually

Although the manual techniques were the only method of measuring used in the first anthropometric survey in clothing, they are still used today, but mainly for small-scale surveys (Taylor, 1990:52). These surveys are normally less expensive by nature because they are done over a shorter period of time and are usually only once off. They would therefore be executed by using effective but relatively inexpensive standardised equipment and methods. When the manual method of measuring is applied, the chosen measuring procedures and techniques should be easy to master as well as being unambiguous, in order to prevent problems with data capturing and analysis. Field workers should be properly trained in the methods and standards of measuring and able to execute the measuring process consistently. Beazley (1997a:82) suggests that manual measuring is at present still the most reliable method available for small-scale projects. This has specific relevance when measuring babies, infants and children. The fact that it is relatively difficult to keep children standing still for the period required for scanning and that scanning equipment might scare children is evident enough. The effect of scanning on babies and smaller children has also not yet been determined as harmless to the child.

2.10.3.2 Measuring by means of three-dimensional (3-D) scanning

With the arrival of computers and other electronic developments it became possible to scan shapes and three-dimensional objects (Taylor, 1990:52). 3-D scanning is achieved by using white light or laser that captures as many measurements as are needed to build an accurate computer image, which is “measured”, recorded and stored. The 3-D scanning device is, therefore, ideal for anthropometric surveys for use in the clothing industry. This method of measuring is more likely to be used in large-scale and long-term anthropometric studies. 3-D scanning equipment is the preferred equipment used in this type of study, since it can be executed sucessfully for comparative studies applying the same standards and measuring techniques. According to Beazley (1997a:82) these electronic scanning or photographic methods are not as yet fully reliable for pattern construction and are far too expensive for small-scale and short-term surveys.

The change of field workers will, in most instances, not affect the accuracy and consistency of measurements, since the field workers merely “supervise” the scanning device. Only in instances where scanning equipment is combined with manual measuring methods will the change of field workers potentially impact on the consistency and accuracy of measurements.

The main advantage of a 3-D scanning device is in collecting survey data, since the amount of data that can be collected is almost limitless. The scanned figure can be stored in the computer memory, and the three-dimensional (3-D) image generated on the screen can be rotated and viewed from any angle (Taylor, 1990:53). The facility to measure the image from any point in real scale is available, thus allowing detailed analysis when and where required. It is also possible to store individual scanned figure information, and in this way a large reference library can be built up.

Regardless of the choice of measuring methodology, the fit dummy prototype manufacturers also benefit greatly from the results of such a survey. It facilitates the design and construction of more realistic fit dummy prototypes for use in pattern development and clothing manufacture.

2.10.3.3 Quality control during measuring

The most suitable order for recording the measurements selected for a particular study should be determined beforehand. Factors which may influence the measurements should be identified and recorded, while reliability and accuracy should be established. Measurement reliability is essential and should be clearly defined and maintained. These estimates must be published as a component of the recorded methods. All procedures should be recorded to ensure consistent practices. These records not only provide a reference during the course of the survey, but serve as an important record of survey procedures for those who will use the data.
Analysis of variance techniques should also be done and may be used to identify significant sources of variance (e.g. within subject, between observers). The availability of

information on reliability will facilitate informed decisions about whether or not to include particular variables in the survey. The timely collection and analysis of reliability data throughout the survey is also recommended since it is a useful quality control measure. By adopting the method of reporting measurement-error results, it would be easy to compare anthropometric surveys in terms of adequacy of measurement (Lohman *et al.*, 1988:86).

When taking measurements manually, the measurements should be made carefully, in a quiet room, without overdue haste, and without the presence of unnecessary people. The measurer should also note any bruising, swelling, oedema, scarring, or muscle atrophy that might affect the measurements being made (Lohman *et al.*, 1988:1). For quality control of any type of anthropometric surveys involving a number of measurers or multiple teams, training and evaluation sessions should be done both initially and during the course of the survey.

It is suggested by Lohman *et al.* (1988:109) that four kinds of training and evaluation sessions should be done to successfully complete an anthropometric survey. These include 1) initial training sessions to achieve standardisation to a trained measurer, 2) a set of "dry runs" at the outset of the survey, 3) periodic sessions throughout the survey that involve repeated measurements of the same subjects and 4) periodic retraining sessions throughout the survey. However, for any successful anthropometric survey where measurements are taken manually, practice is necessary.

Initial training sessions should be conducted in a didactic manner. The measurers are informed about the rationale for each measurement, what it indicates, and why it has been included. They learn measurement techniques and practice them while being observed and corrected as necessary. These sessions should be repeated as often as needed. The "dry runs" consist of carrying out all procedures with subjects who could have been part of the sample but whose data will not be included in the survey database. The purpose is to allow measurers to become comfortable with the protocol and proficient in taking measurements within the allotted time. Measurement techniques are evaluated and refined at this stage. It is, however, important to have discussion sessions later to allow more general problems to be resolved.

It is further recommended that periodic assessments should be made, because reliabilities may change during the course of the survey (Lohman *et al.*, 1988:1&109). As a result, periodic re-training sessions should be held. In these sessions trainers observe measurers as subjects are measured. Corrections in technique are made immediately, and problems that have arisen are discussed. This provides for ongoing quality control and helps keep systematic errors at a minimum. Throughout the survey there should also be periodic sessions reserved for the collection of data on measurement reliability. At these sessions, each subject is measured by at least two measuring technicians, following the standard protocol without interruption for error correction or other discussion. In other words, conditions are identical to regular survey sessions. The analysis of these data permits the quantification of error and measurement reliability. When analysed, the data will allow identification of measurers with unusually large systematic errors. If necessary, appropriate adjustments could then be made in the data editing or analysis phase.

2.10.3.4 Reliability and accuracy of measurements

The term *reliability* refers to the variation between measurements taken over time (Hogan, 1999:202) and has two components, precision and dependability (Lohman *et al.*, 1988:84). Precision is the consistency between the repeated measurements taken within a very short time span, while dependability means the physiological fluctuation within an individual (Kouchi, Mochimaru, Tsuzuk & Yokoi, 1996:156). Reliability is thus the degree to which repeated measurement of the same trait are reproducible under the same measurement procedure.

There are two pieces of information that will provide knowledge about the reliability of a particular variable. These are (a) the Technical Error of Measurement (TEM), which provides information on reliability in the units of measurements, much like a standard deviation, and (b) reliability, which provides a correlation-like coefficient that allows comparison of measurement errors for different variables and an estimate of the degree to which the inter (between)-subject variance is compromised by error. Whether to estimate reliability, precision, or dependability will depend on the needs of the particular research project (Lohman *et al.*, 1988:85).

Intra (within)-subject variability, called unreliability, can be broken down into two components of variance: measurement error variance (imprecision) and physiological variance (undependability). Unreliability and its two components, imprecision and undependability, are given in the units of measurement such as cm, mm or kg (Lohman *et al.*, 1988:83). Imprecision is inherent in anthropometry of the living because of the fact that the human body is not rigid (Kouchi *et al.*, 1996:155) and it is the within-subject variance obtained from replicate measures taken within a very short span of time. The square root of this term is called the TEM. The main sources of error of imprecision are random imperfections in the measuring instruments or in the measuring and the recording techniques. Undependability, the component of error due to physiological variation, cannot be estimated directly. Rather, unreliability is first estimated from within-subject variance in subjects measured within a span of time long enough to capture physiological variation. Subtracting imprecision from unreliability yields estimates of undependability (undependability = unreliability – imprecision) (Lohman *et al.*, 1988:83).

The term *accuracy* refers to the extent to which an observer achieves the “true” value of measurement (paragraph 2.10.3.5). The true measurement can be approximated only if many observations are taken on the subject by a well-trained observer. This is impractical in any study. Rather, comparing the values obtained by a well-trained supervisor and the observers being evaluated will assess accuracy. A simple way to assess differences is by paired t-test. If a systematic difference exists, careful observation of measurement techniques is required to identify the problem. In studies that involve several observers, an effort should be made to obtain replicate measurements for all observers on the same group of subjects. These data can then be used to test the significance of within-observer and between observer sources of variation in an analysis of variance (Lohman *et al.*, 1988:85).

There are, however, problems that can be singled out regarding the accuracy of measurement locations when measuring bodies manually, as singled out by Taylor (1990:51). Firstly, the human body has very few precise landmarks from which to measure and, secondly, the individual measurers will vary in their interpretation of where body surface landmarks are. Bearing this in mind, when planning an anthropometric survey it is important to accommodate these two aspects, to ensure accurate results.

It is recommended that measurements should be re-measured to confirm the measuring accuracy. If measuring in millimetres and centimetres, a variation of $\pm$5 mm on both long and short measurements is considered acceptable. A variation of $\pm$10 mm is acceptable on full all round girth measurements. This error of measurements allows for the movements of the subject and the tension and positioning of the measuring equipment. It is, however, very difficult to measure the human body manually with absolute accuracy Beazley (1997a:59).

2.10.3.5 Measurement error

Different measurement techniques are applied when measuring subjects manually in different age groups. Measurement error is likely to be higher in infants and young children because they are less likely to maintain a standard position. Measurement techniques for older children and youth are similar to those for adults. Kouchi *et al.* (1996:155) confirms that measurement errors are unavoidable, regardless of what age group is measured.

Special situations are encountered in obtaining and interpreting anthropometric measurements of infants in comparison with older children and adults. The small size and variability in size of the infant result in measurements in relation to which the measurement error is large, ie there is far less difference between the actual measurement and the allowable error than there would be with measurement of larger bodies. The physical, anatomical and behavioural immaturity of the infant makes it difficult to dictate special positioning of body and limbs for measurements and prescribe measurement techniques in comparison with the requirements for older children and adults. The necessity for accurate assessment of the age of infants is vital. Infants grow rapidly and a mistake in miscalculating age by, say, a month can make a big difference to the accuracy of measurements at a given age (Lohman *et al.*, 1988:112).

The most basic indicator of an anthropometrist's expertise is the TEM, which is the measure of precision (paragraph 2.10.3.4). Precision refers to the observed variability in repeated measurements taken on the same subject and is therefore the consistency between the repeated measurements taken within a very short span of time (Kouchi *et al.*, 1996:156). TEM is however recorded in units of measurement of the variable. High precision indicates low variability (low inconsistency) in successive measurements. Lohman *et al.* (1988:85) points out that the TEM of observers should be compared with the values obtained by a well-trained anthropometrist. If the observers come close to this reference value in a series of repeated measurements taken in the field, and if there are no biases in measurement, then they are trained and set to go. Also, knowing measurement error values for each variable under study allows the investigators to set permissible limits in order to correct or retake measurements in which differences between replicates are greater than expected. The limits may be set at the discretion of the investigator as one or more magnitudes of the measurement error.

Intra (within)-observer reliability is evaluating the results of assessments by the same observer while inter (between)-observer reliability refers to the evaluation of the results by comparison between the assessments of different observers (Chen, Lear, Gao, Frohlich & Birmingham, 2001:651). Intra-observer precision in anthropometry is actually due to both the observer and subject. It is influenced by such factors as the inconsistency of the observer in locating the landmarks or in the pressure applied to the instrument as well as the inconsistency of the subject due to respiration and fluctuations in posture (Kouchi *et al.*, 1996:156).

The TEM can be applied as an intra-tester or an inter-tester. The TEM squared gives the imprecision variance, if the repeated measurements are taken very close together in time or the unreliability variance, if the time between measurements is longer (Lohman *et al.*, 1988:84). TEM as intra-tester refers to measurements taken by the same anthropometrist on the same subjects with the same variables influencing the process while the same measurement procedure is applied. This is the most basic indicator of an anthropometrist’s expertise. If one of the anthropometrists is a criterion anthropometrist, the Inter-Tester TEM can be used as a measure of accuracy.

2.10.3.6 Which side to measure when measuring subjects manually

When measuring subjects manually it is important that the extent of measurement bias associated with side of measurement is determined in order to interpret previous studies. The purpose of this technical note is twofold. Firstly, the bias associated with side of measurement is estimated for a number of anthropometric dimensions. Secondly, the necessity for recommendations on side of measurement is discussed in light of the findings. Some investigators systematically measure subjects on the right, whereas others measure on the left side of the body and this may be an insignificant detail. On the other hand, some anthropometric dimensions may be influenced by handedness of the subject, and values obtained from the dominant side may be significantly larger than those of the non-dominant side. In this case, studies based on the right-side measurements would have systematically larger average values than those based on the left-side measurements (Lohman *et al.*, 1988:87).

Evidence presented by Lohman *et al.* (1988:88) convincingly points out that handedness does influence some anthropometric dimensions, particularly dimensions of the arm. For such variables, measurements on the right can exceed those on the left by up to 0.2 to 0.3 standard deviation units. This is not a large difference as regards the purposes of most anthropometric studies. If concerns exist regarding the comparability of studies, adjustments of the data could easily be made. An answer to the question of whether to measure on the right or the left is that the choice matters very little, if at all. In all cases, the bias associated with side of measurement is believed to be less than measurement error. Although it would be advisable, simply on the grounds of greater scientific uniformity, to recommend one side for measurement, consensus would be difficult to achieve. Lohman *et al.* (1988:91) reports that some researchers in the United States of America (USA) measure on the right side of the body while the large national surveys of the USA population, Health Examination Survey (HES) and Health and Nutrition Examination Survey (HANES), which form the basis for worldwide reference data, took measurements on the right side. The vast majority of anthropometric measurements in developing countries are carried out on the left side. The International Biological Program recommends measurement on the left, as the general practice in Europe. In conclusion, because it matters little on which side measurements are taken, it is best to leave the choice of side to the discretion of investigators. The investigator should tell the observer which side to measure on for the observer to be consistent regarding the side measured.

2.10.4 Measurement selection

A key issue in the use of anthropometry is the selection of measurements. Measurement selection mainly depends on whether the measuring will be done manually or by means of 3D scanning and the purpose of the study. The measurements selection should provide specific information within the context of the study design.

2.10.4.1 Measurement selection in general

No single battery of measurements will meet the needs of every study. As a consequence, Lohman *et al.* (1988:100) is of the opinion that it sometimes makes sense to take an extensive battery of measurements simply because one has the opportunity to measure. In making the appropriate measurement selection, the following guidelines by Lohman *et al.* (1988:111-112) proved to be useful:

- The variables selected should be valid indicators and useful descriptors of all the aspects being studied.
- If an overall descriptive profile is desired, the measurement patterns should include the four components of body size and shape, which are length, breadth, circumference and skin-fold thickness.
- The dimensions to be measured should lend themselves to precise definition, which will result in reliable measurements.
- When studying growing children, the variables selected should show sufficient change during the phase of growth to warrant their inclusion in the measurement battery.
- The measurements chosen should by no means endanger or embarrass the subjects.

Using these recommendations as guide, it is important to include certain key measurements in the battery of measurements regardless of the type of anthropometric survey is conducted and whatever method of measuring is employed. Based on recommendations of Lohman *et al.* (1988:4,8-11,27-28,39-40) the following key measurements as summarised in Table 2.3 are important in all types of anthropometric surveys when studying humans. Refer to Appendixes 1 and 2 for descriptions of anatomical terms and bone drawings respectively.

TABLE 2.3: KEY MEASUREMENTS (Lohman *et al.*, 1988:4,8-11,27-28,39-40)

Measurement type	Specific measurements	Uses
Stature, recumbent length and arm span	Stature	* This is the major indicator of body size and bone length. * Important in screening for disease or malnutrition. * Important in interpretation of weight. * Variations from normal ranges can have social consequences.
	Recumbent length (length when lying down)	* Measure when stature cannot be measured, mainly for ages up to two years. * Between ages two and three recumbent length or stature can be measured. The choice must be noted because they differ systematically.
	Arm span	* Measure when stature cannot be measured and when it is not practical to measure recumbent length. * Is highly correlated with stature.
Weight		* The most commonly recorded anthropometric variable. * Generally measured with sufficient accuracy due to detailed measurement technique. * This is a composite measure of total body size. * Used in screening for unusual growth, obesity and under-nutrition.
Segment lengths	* Measurement should be made directly from landmark to landmark. * Subject should stand in the erect position.	
	Upper extremity	* Measure the total upper length (acromiale to dactylion) - the most distal point on the middle finger (including the nail). * Measure the upper arm (aromiale to olecranon). * Measure the forearm, the most distal point on the lateral margin of the styliod process of the ratius (radiale to stylion). * Measure the total arm (acromiale to stylion). * Measure the hand (stylion to dactylion).
	Lower extremity	* Measure thigh length from the inguinal ligament to the patella. * Thigh length can be projected as the difference between iliospinale and tibiale heights, or as the difference between inguinale and tibiale height. * Measure calf length directly from tibiale (most superior point on the medial border of the medial condyle of the tibia) to the sphytion (most inferior point on the medial malleolus) with the subject seated and the ankle resting on the opposite knee. * Measure the foot length directly as the maximum distance from the most posterior point on the heel (acropodion) to the tip of the most anteriorly projecting toe (pternion). Measure with or without weight bearing. * Stature minus sitting height is often used to provide an estimate of the lower extremity (subschia) height. * Sitting height is a composite of trunk, neck and head heights and can be used to measure the length of the upper segment of the body.
Body breadth measurements		* Use to determine body types, frame size for estimating desirable weight from standard stature-weight charts, and in estimating the potential for lean weight gains in various populations, e.g. athletes and anorexics.
Circumferences		* Important measurements that record the size of the cross sectional and circumferential dimensions of the body. * One of the measures of growth and provide indices of nutritional status and level of fat patterning.

2.10.4.2 Measurement selection for manual measuring

Measuring the body manually is no easy affair, because the human body is a very complex three-dimensional shape that varies considerably within the limits of normality. For this reason the more measurements on the body that are taken, the better the final definition of shape and size will be. On the other hand, if not enough measurements are taken, fairly accurate picture of the size and height of a human being will be given, but the actual body shape, dimension and stance will not be very clear. It is, therefore, recommended that photographs of the bodies be taken during the measuring process to supply more information regarding body shapes, dimensions and stance.

Without photographs, to get even a rough indication of shape would entail taking many measurements from each individual based on triangulation. According to Taylor (1990:51) this practice would make the survey very difficult and extremely expensive, since it is recommended that at least 3000 people should be measured if a useable statistic is to be arrived at. With fewer measurements it would be possible to gather data related to size and height but very difficult to define the body shape and silhouette successfully with any degree of accuracy.

To facilitate the systematic and accurate approach to manual measuring, the measurements of the body can be divided up into four main categories, that is height, girth, width, and depth measurements. Table 2.4 summarises a selection of measurements as used in different surveys in the USA and UK when measuring manually. The table also has recommendations as proposed by the researcher of the measurements to be taken when measuring children and youth manually.

TABLE 2.4: SELECTION OF MEASUREMENTS WHEN MEASURING SUBJECTS MANUALLY (O'Brien *et al.*, 1941:11-16,18; Kunick, 1984:38-55; Taylor, 1990:52; BSI, 1990:17,177-254 & Beazley, 1997a:64-81)

Girth measurements (Horizontal)

O'Brien *et al.* (1941:11-16,18)	**Kunick (1984:38-55)**	**Taylor (1990:52)**	**BSI (1990:17,177-254)**	**Beazley (1997a:64-81)**	**Recommended for children**
		Head girth	Head girth	Head girth	Head girth
		Neck girth	Mid neck girth	Neck girth	Neck girth
Neck base girth	Neck base girth		Neck base girth	Neck base	
			Neck girth (at larynx)		
Maximum chest girth		Chest girth			Chest girth (boys)
	Bust girth	Bust girth		Bust girth	Bust girth (girls)
Chest girth at arm scye	Chest girth at scye		Chest girth	Chest girth *(high bust)*	
			Under bust girth	Under bust girth	Under bust girth (girls)
		Rib cage girth			
Waist girth	Waist girth	Waist girth	Waist girth	Waist girth	Waist girth
	High hip girth	Upper hip girth	High hip girth	Upper hip girth	
Hip girth	Hip girth	Hip girth	Hip girth	Hip girth	Hip girth
Thigh girth	Maximum thigh girth	Thigh girth	Thigh girth	Thigh girth	Thigh girth
Knee girth	Knee girth	Knee girth	Knee girth		Knee girth (straight and bent)
Maximum calf girth	Calf girth	Calf girth		Calf girth	Calf girth
	Ankle girth	Ankle girth	Ankle girth	Ankle girth	Ankle girth
				Instep and heel girth	Instep and heel girth
Arm scye girth	Arm scye girth	Arm scye girth	Arm scye girth	Armhole girth	Armhole girth
Upper arm girth	Upper arm girth	Bicep girth	Maximum upper arm girth	Upper arm girth	Bicep girth
Elbow girth	Elbow girth	Elbow girth		Elbow girth *(bent)*	Elbow girth (straight and bent)
	Wrist girth	Wrist girth	Wrist girth	Wrist girth	Wrist girth
		Hand girth	Hand girth	Palm girth	Hand girth
Vertical trunk girth					Vertical trunk girth

Height measurements (Vertical)

O'Brien *et al.* (1941:11-16,18)	**Kunick (1984:38-55)**	**Taylor (1990:52)**	**BSI (1990:17,177-254)**	**Beazley (1997a:64-81)**	**Recommended for children**
Stature	Stature	Height	Stature	Height	Height
Cervicale height	Cervical height			Nape level to ground	Nape to floor
	Dress length				
				Nape CB ground length over body contour	
				Nape to front ground level over body contour	
				Straight back length from nape to ground	
				Straight front length from nape to ground	
Waist height	Side seam	Waist to floor	Side seam / waist height (babies)	Side waist to ground	Waist to floor
Extreme bend					
Hip height	Hip height			Iliac crescent to ground	Hip to floor
			Inside leg	Inside leg from ground	Crotch to floor
Tibiale height	Knee height		Knee height		Knee to floor
					Ankle to floor
		Top head to nape		Head length	***Head height***
		Top head to chin			
	Nape to bust	Nape to bust	Back neck to bust point	Bust level	Nape to bust point
				Under bust level	Nape to under bust point
				Halter line	
				Back neck rise	
				Front neck rise	
				Front chest level	
Posterior waist length	Nape to waist	Nape to waist	Back length (back neck to waist)		Nape to waist
			Back neck to front waist		
Anterior waist length	Front waist length	Front waist length	Front neck to waist		Stern to waist
	Cervical to waist		Cervical to waist		
		Nape to centre front waist		Nape to front waist level	
	Shoulder to waist				
	Arm scye to waist				
Waist to hip	Waist to hip	Waist to hip	Waist to hip	Centre back waist to hip	***Waist to hip***
		Waist to knee		Side waist to knee	
					Thigh length
					Mid thigh position
					Calf length
					Mid calf position
				Waist to ankle	
				Nape to arms scye level	
				Nape to elbow prominence	
				Nape to wrist	
Upper posterior arm length			Elbow length		Shoulder to elbow (straight and bent)

Total posterior arm length	Arm length	Outer arm length	Arm length		Shoulder to wrist (straight and bent)
				Nape to end of extended hand	
	Underarm length	Inner arm length			
Trunk line			Trunk loop		
				Back scye level to waist	
				Back waist to shoulder	
				Back waist over shoulder to front waist	
Total crotch length	Crotch length	Crotch length	Crotch arc	Crotch length	Crotch length
Anterior crotch length					
	Body rise	Body rise	Waist to crotch		
Crotch height			Crown to crotch length (Cervicale to foot)		***Crotch depth***
			Shoulder to waist		
			Upper torso length		

Width measurements (Horizontal)					
O'Brien *et al.* (1941:11-16,18)	**Kunick (1984:38-55)**	**Taylor (1990:52)**	**BSI (1990:17,177-254)**	**Beazley (1997a:64-81)**	**Recommended for children**
		Head width			
				Front neck width	
				Back neck base	
				Back neck width	Back neck
					Shoulder circumference
	Bust arc front			Across front midway between CF neck and bust level	
Anterior chest width	Across chest	Across chest	Auxiliary width (front)	Across front	Across front
Anterior chest arc	Width of bust prominence	Bust width	Chest width	Width of bust prominence	Inter-nipple position
			Shoulder breadth (fleshy)	Cross back shoulders	Shoulder breadth
			Shoulder width	Across back midway between nape and scye level	
Posterior chest width	Across back	Across back	Back width		Across back
			Auxiliary width (back)		
		Scye width	Arm scye width	Scye width	
	Abdomen-seat diameter	Abdominal (seat) diameter	Hip width		
Bitrochanteric diameter	Bitrochanteric width	Bitrochanteric width			
	Interacromion width	Interacromion width	Interacromion (bony shoulder width)		
				Across back to right elbow	
				Across back to right wrist	
			Waist width		
			Hand width		
			Middle finger width		
			Bust arch width		
			Chest width (anthropometer)		

Depth measurements (Vertical)					
O'Brien *et al.* (1941:11-16,18)	**Kunick (1984:38-55)**	**Taylor (1990:52)**	**BSI (1990:17,177-254)**	**Beazley (1997a:64-81)**	**Recommended for children**
		Head depth			
			Head arc	Over head measurement from right neck point to left neck point	Head arc
Scye depth	Depth of scye	Scye depth	Arm scye depth	Depth of scye to ground	Scye depth (height)

Other					
O'Brien *et al.* (1941:11-16,18)	**Kunick (1984:38-55)**	**Taylor (1990:52)**	**BSI (1990:17,177-254)**	**Beazley (1997a:64-81)**	**Recommended for children**
			Cervicale brow	Nape to front hair line length	Cervicale brow
				Nape to neck point	
				Nape to end of shoulder	Nape to shoulder point
			Back neck to neck point		
				Nape to upper arm level	
Shoulder length	Shoulder length	Shoulder length	Short shoulder length	Left and right shoulder length	***Shoulder length***
			Shoulder length (to acromion)		
Shoulder slope *(degrees)*	Shoulder slope	Shoulder angle		Shoulder slant	
Weight *(pounds)*	Weight	Weight	Weight		
			Arm scye length		
			Foot length		
			Hand length		
			Middle finger length		
Number of measurements recommended					
35 Measurements	42 Measurements	44 Measurements	60 Measurements	65 Measurements	45 Measurements
					8 Derived measurements

The summary in Table 2.4 illustrates that there is no single list of measurements that is appropriate for every type of anthropometric survey, whether small or large-scale surveys, short or long term surveys. It is, however, important for every selected measurement to provide useful information congruent with the purpose of the survey. Anthropometric indicators generally exhibit high sensitivity in that they are often very responsive to environmental effects (Lohman *et al.*, 1988:100). For the most part variation in human morphology relates to the development of bone, muscle, and fat tissue, as well as the viscera. Although the viscera comprise a significant portion of the body mass, suggested measurements for specific surveys focus mostly on bone, muscle and fat. The suggested measurements also consider regional variation in morphology; hence both trunk (upper and lower) and extremity (upper and lower) dimensions are indicated. The measurements should also be selected on the basis of ease of site location and accessibility, although specific cultural preferences may, at times, limit the accessibility of some sites for measurement.

The recommended list of anthropometric dimensions as proposed by the researcher to be used when measuring infants, children and youths (Table 2.4), is probably longer than would be necessary for any one particular study. In Table 2.5 this list is divided according to the instrument to be used for each measurement. Each sub-category is listed in the order recommended for ease of measurement. The time required for measurement is kept to a minimum if an observer does not have to switch instruments constantly and if the subject remains basically in the same position for a subset of measurements. Table 2.5 refers to the recommended equipment for the preferred battery of measurements for studies of infants, children and youth (Lohman *et al.*, 1988:112).

TABLE 2.5: RECOMMENDED EQUIPMENT FOR THE BATTERY OF MEASUREMENTS WHEN STUDYING INFANTS, CHILDREN AND THE YOUTH (Lohman *et al.*, 1988:112)

Equipment	Specific measurement
Scale	Weight
Sliding callipers	Biacromial breadth Biiliac breadth Elbow breadth Wrist breadth
Anthropometer	Sitting height Stature Lower extremity Upper extremity
Measuring table (Infants)	Crown-rump length Recumbent length
Tape measure	Chest circumference Waist circumference Buttock (hip) circumference Calf circumference Arm circumference Head circumference

Further to the above measurements, there are a few aspects that should be implemented in order to optimise the measuring results. The following recommendations are based on Beazley's (1997a:59) survey results:

- Most measurements should be taken in a static position. The only exceptions include arm length and elbow or knee girths, which are taken while the arm or leg is bent.
- Girth and horizontal measurements should be taken flush, close to the body contour.
- Some length or vertical measurements should be taken perpendicular to the ground, such as height and crutch height. Others, not perpendicular to the ground, should be taken flush and close to the body contour, such as nape to waist.
- When short measurements cannot be measured accurately directly on the body they could be derived by subtracting one controlled and accurate measurement from another.
- Some measurements should be included as check measurements to test accuracy.
- For consistency of measuring and results, the same team of measurers should be measuring all bodies, being responsible for the same measurements repeatedly.

- "Ease allowances" to measurements for body movement, comfort and styling should *not* be added during measuring but only later on, only once the body measurement charts are complete and before pattern drafting.

2.10.5 Projected versus direct measurements

When measuring bodies manually, two types of measurement are taken. Firstly, direct measurements, referring to the actual body measurements taken on the body of the individual. Secondly, proportional measurements that are short measurements derived as a proportion of, for example, a girth or length measurement. Since short measurements are very often difficult to take unless under very controlled situations, proportional measurements are useful, even when drafting patterns (Beazley, 1997a:58). Using both direct and proportional measurements is therefore a good method of verifying the accuracy of measurements taken manually.

Segments of the human body can be measured as heights or lengths (segment lengths). Heights are vertical distances from the surface upon which the subject stands or sits to the particular landmark. Lohman *et al.* (1988:9) describes the differences between the heights of two landmarks as an estimate of a segment length. Lengths can be measured in the long axis of the segment as the distances between specific landmarks. As a rule, segment lengths measured directly between landmarks are greater than those derived as the differences between pairs of heights. Estimates of segment lengths from specific pairs of heights are called projected measurements. Height measurements are perpendicular distances between pairs of landmarks, although the specific bone represented by the bony landmarks commonly has a slightly oblique (slanted) orientation.

The biggest problems with projected measurements relate to the positioning of the subject being measured, as well as measurement errors. Most subjects have difficulty holding the standard erect posture for the time necessary to take a series of height measurements. This is particularly true in children and the elderly. And, because two measurements are involved in deriving any projected segment length, there are two sources of measurement variability (Lohman *et al.*, 1988:10). Where possible, directly measured segment lengths are preferred over projected lengths.

2.11 PREPARING SUBJECTS FOR MANUAL MEASURING

2.11.1 Marking body surface landmarks

The preparation of the subjects is very important for accuracy of measurements. The initial preparation is by marking important body surface landmarks to ensure all measurements are taken between two constant marks. It is recommended that one well trained and experienced person best do the land marking so that the points are as consistently placed as possible (Taylor, 1990:53). Before measuring, the subject must be made to feel at ease and relaxed. Subjects can be allowed to move between most measurements, so they do not become rigid or fatigued. Beazley (1997a:61) recommends that good rapport should be developed and maintained between the measurer, scribe and the subjects. It is important that all subjects should be treated in the same way.

Before any body measurements can be taken, it is important to prepare subjects. Body surface landmarks on the body are defined with reference to definite points on the skeleton and are made manually on the subjects' skin surface regardless of whether the subjects are being measured manually or by means of 3-D-scanning. The body surface landmarks are located by inspection or palpation on the skin surface. The tips of the index fingers first identify these landmarks and then the projections of the anthropometer / calliper are positioned at those points. Sufficient pressure should be applied to assure that the blades of the anthropometer / calliper are measuring bony breadths and that the underlying muscle, fat, and skin make minimal contributions to the obtained dimensions (Kunick, 1984:34 & Lohman *et al.*, 1988:28).

Because the bones and muscles of the human body compose a very complex three-dimensional system, it is possible that a slight change in position may affect the whole system and change its equilibrium and form. In order to understand the human body and to be able to locate and correctly position body surface landmarks, it is important to understand the relevant anatomical terms to avoid confusion. These anatomical terms are relevant to any type of anthropometric survey to facilitate the location of landmarks, regardless of the means of measuring applied. Note that the starting point of any description is in the simple standing posture. Appendices 1 and 2 can be used as reference guide. The series of bone drawings Appendices 2 are to illustrate the definitive points on the skeleton used to define the body surface landmarks and are these illustrated by front, side and back views. Although various authors, such as BSI (1990: 175-6) and O'Brien *et al.* (1941:8) presented bone drawings to illustrate the location of important points on the skeleton, the most applicable reference, chosen for this study, is by Kunick (1984:35-37).

Although landmarks are specifically defined anatomically, some are difficult to locate. Some of the landmarks are not yet ossified at young ages. They are present as cartilage but are difficult to palpate. Hence, according to Lohman *et al.* (1988:10), radiographic methods may be more appropriate to study extremity segment lengths in children younger than 10 years. There are, however, limitations to radiography that include irradiation, correction for distortion and magnification, consistent positioning and cost. It is important to select body surface landmarks that are palpable in both lean and obese individuals. For consistency of positioning of body surface landmarks it is recommended that the same fieldworker locate these marks for the duration of any survey (Lohman *et al.*, 1988:28).

These body surface landmarks can facilitate length, width and depth measurements. Table 2.6 is a summary of different types of body surface landmarks as recorded in various studies. Included in this table are recommendations for use specifically when preparing children for measuring.

TABLE 2.6: LANDMARK LOCATIONS (O'Brien *et al.*, 1941:11-16,18; Kunick, 1984:34; BSI, 1990:167-168; Beazley, 1997a:64-81)

Landmarks of the neck			
O'Brien *et al.* (1941:11-16,18)	**Kunick (1984:34)**	**BSI (1990:167-168)**	**Beazley (1997a:64-81)**
Neck base	Cervicale	Cervicale (nape)	Nape (7th Cervicale)
		Larynx (the Adams Apple)	
	Neck base at left and right clavicle	Neck point	Neck joint
	Front neck base	Front neck	Center front neck
	Neckline		Neckline

Landmarks of the trunk			
O'Brien *et al.* (1941:11-16,18)	**Kunick (1984:34)**	**BSI (1990:167-168)**	**Beazley (1997a:64-81)**
Arm scye	Arm scye	Bony shoulder	
Shoulder line	Shoulder line	Shoulder point (upper arm scye mark)	Long shoulder
			Short shoulder
	Underarm midpoint		
	Depth of scye		
Average waist level	Waist level	Waist level	Waist level (elastic band)
Level for the measurement of width of chest		Across chest and back mid-points	Chest level (elastic band)
Level for the measurement of maximum chest girth	Bust (and level at CB)		Bust level (elastic band)
			Under bust level (elastic band)

Landmarks of the upper extremity			
O'Brien *et al.* (1941:11-16,18)	**Kunick (1984:34)**	**BSI (1990:167-168)**	**Beazley (1997a:64-81)**
Olecranon		Elbow	Elbow
Distal extremity of the ulna	Wrist	Wrist (ulna point)	Wrist
Midanterior wrist point		Wrist crease	

Landmarks of the lower extremity			
O'Brien *et al.* (1941:11-16,18)	**Kunick (1984:34)**	**BSI (1990:167-168)**	**Beazley (1997a:64-81)**
Average hip level	High hip	Metacarpophalangeal	Upper hip level
Crotch centre	Hip	Hip	Hip level
Knee centre posterior		Knee crease	Knee level
Right tibiale	Tibiale	Tibiale	
		Axillary fold level	
			Ankle level
		Anterior superior iliac spine	

Additional for preparation			
O'Brien *et al.* (1941:11-16,18)	**Kunick (1984:34)**	**BSI (1990:167-168)**	**Beazley (1997a:64-81)**
	Neck chain touching all landmarks	Chainette placement of the chainette around the neck	

2.11.2 Position and stance of the subject being measured

Most measurements are made with the subject standing in a position called the standard erect posture. This position is also described as the military position and implies the position of attention, with the shoulders drawn back, the chest projected forward, and the palms facing anteriorly. The subject’s head is in the Frankfort Horizontal Plane line of vision (“looking straight ahead”) and is approximately horizontal with the sagittal plane of the head vertical. Positioning of the upper extremities is important in the measurement of segment lengths. In the standard position, the upper extremities are pendant at the sides, with the palms facing medially. Some segment lengths are measured with the subject in the seated position versus sitting height (Lohman *et al.,* 1988:10).

2.11.3 Measuring instruments, equipment and procedures

The measuring instruments and equipment used for manual surveys are distinctively different to those used for three-dimensional scanning. There are two instruments mainly used for taking body measurements manually. The first is the tape measure, which is used for taking the girth measurements, normally on the body contour. The second instrument measures the straight measurements such as the length and width measurements and is called an anthropometer (Taylor, 1990:52). Some of these measurements are measured perpendicular to the floor, whilst others are measured on the body contour. While using this traditional method of measuring, namely the manual method, a metre rule is also used for positioning various landmarks on the body (Beazley, 1997a:58). The traditional method of landmarking the body is with a pen and an adjustable square, which can be used to measure the angle of the shoulder. Referring to the recommended measurements for children and youths as illustrated in Table 2.4, the traditional measuring instruments, equipment and procedures as discussed in the following section can be used.

2.11.3.1 Measuring area, furniture and changing facilities

To enhance convenience and speed, and to reduce measurer and subject fatigue, the measuring area has to be planned. The flow of the measuring area should ensure that no bottlenecks form and should have enough space for each measurer to effectively and accurately measure the subject. The lighting in the measuring area should be bright and no direct sunlight should enter the area, since unwanted shadows could interfere with the accuracy of measurements. These shadows may also hide the subject’s body contour on the photographs (Beazley, 1997a:61).

The required *furniture* is chairs and tables. A chair is required for each of the participating recorders. It is important for the recorder to be comfortable, since the measuring process can be quite lengthy. When measuring smaller subjects, it is recommended to have a small table for these children to stand on to facilitate the accuracy of measuring.

The *changing facility* consists of a screened off dressing cubicle big enough for the subjects to move in easily. Provision should be made for the safety of the subject's own clothes and carry bags are recommended in this instance. A chair should also be provided. Subjects may need a chair for comfortable dressing, for example putting on socks and shoes. When measuring smaller children, it is suggested that there is someone (preferably a parent) helping them to get undressed and dressed.

2.11.3.2 Measuring gear and preparation of subjects

Skin measurements are required for anthropometric surveys. For reasons of modesty and consistency *measuring gear* in different sizes should be provided. When leotards are provided it is recommended that they be of a dark colour so that the landmarks and tape levels are easily identified on the body. If two-piece measuring gear is provided, the landmarks should be either dark or light as contrast, depending on the subjects skin colour. It is recommended a *hair clip* be used when measuring subjects with long hair. The hair clip should be used in such a way that it does not to interfere with any measurements taken (Beazley, 1997a:60&61).

2.11.3.3 Free standing measuring equipment

The recommended freestanding equipment for manual measuring is an anthropometer and a mirror. The *anthropometer* is a manual measuring device most often used for measuring length measurements of the human body. In some instances it can be adjusted and used as a pair of callipers to measure width measurements as well. It can vary in its design depending on the purpose and the specific measurements taken for each survey, but the basic framework and parts that make up an anthropometer is the same in all instances. According to (Beazley, 1997a:59) the anthropometer consists of a series of detachable vertical interlocking rods of varying lengths. The length of these rods depends on the anticipated height of the specific bodies to be measured. Mounted on top of these rods is a calibrated ruler to which a horizontal arm can be attached. The arm is divided into sections and can be adjusted in length. More than one arm can be attached to the rod, depending on the number and height of measurements to be taken. The calibrated rod can be removed and a second arm attached to form a pair of callipers. The anthropometer is mounted on a base, upon which the person being measured stands.

Lines are drawn across this base as a guide to standing positions for height, nape and shoulder measurements.

A full-length *mirror* can be positioned to the side of the anthropometer or where girth measurements are being taken. This enables the measurer to observe the position and level of the measuring tape on the opposite side of the subject (Beazley, 1997a:59). Greater accuracy and consistency of measurements can be achieved when using a mirror.

2.11.3.4 Instruments used to locate and mark the body surface landmarks

The use of elastic tapes, a landmarker and a measuring chain is recommended for locating important body surface landmarks in preparing the subjects for measuring. Beazley (1997a:60) recommends the use of adjustable *elastic tapes*, which are attached around major girth measurements to locate measuring positions. The most common positions are the chest, waist and or hip areas.

Landmarkers are used to mark the relevant position for measuring according to sites described in a list of body surface landmarks. Most of these marks can be located under the skin by inspection or firm palpation (BSI, 1990:15). Marks may be a line or a cross, marked with eyeliner, water-soluble felt tipped pens or tailor's chalk, depending on the position of measuring. Landmarks can be marked on the body surface or on the clothing worn during measuring and should be clearly marked. They should be without fuzzy edges and be clearly visible to help the fieldworker to measure at the correct point. Beazley (1997a:60) also recommends the use of coloured adhesive circles marked with a central cross that are placed on the relevant positions of the body and leotard as landmarks. These landmarks indicate either the beginning or the end sites of measurements or can indicate the levels of the girth measurements.

When marking body surface landmarks on babies and infants, certain limitations are experienced since the prominent points are often less obvious than in older children and adults, being softer and more cartilaginous and covered by proportionally more soft, sub-cutaneous fatty tissue (BSI, 1990:15).

Whilst measuring the human body manually is not an easy task, much is left to the judgement of the measurer, such as the landmarking of the body, positioning of the equipment and the tension of the tape measure. Landmarking the body, in particular, is very difficult since the landmark positions are under the skin and indicated by certain bones. This is, however, left to the judgement of the fieldworker. With training, practice and precision, land marking and measuring errors can be minimised.

A small *measuring chain* is required for neck girth measurements (Beazley, 1997a:61). The links of the chain should be small so as not to distort the girth measurement at all. This chain should be measured from a standard consistent link to the other end. It helps to indicate standard measurements on the chain beforehand, in order to facilitate the actual measuring of the subject.

2.11.3.5 Small measuring instruments

Use of a *tape measure* is recommended for manual measuring. The units in which measurements are recorded, inches or centimetres, will determine the type of tape measure used. Various lengths and widths of tape measures can be used for measuring, depending on the length and type of measurement taken. A retractable metal tape measure is useful when measuring short measurements (Beazley, 1997a:61). All tape measures should have an extension of some kind at the beginning, to ensure no interference of the fingers when taking the measurement. The tape measures used should be reinforced to prevent stretching during the course of the measuring period. In any event, tape measures should be checked regularly to ensure that the tape measures are correctly calibrated.

2.11.3.6 Recording equipment

The scribe requires a *clipboard* to which are clipped the record sheets (Beazley, 1997a:59). All measurements are recorded in inches, centimetres or millimetres and noted with a pencil or pen. The scribe should repeat each measurement quoted by the measurer in order to reduce error.

The scribe records each measurement on *record sheets*, which are clipped to a clipboard. Beazley (1997a:59) recommends a second record sheet, on to which check measurements are recorded. It is recommended that six to ten measurements should be re-measured to confirm the measuring accuracy. If measuring in millimetres and centimetres, a variation of ±5 mm on length and short measurements is considered acceptable. A variation of ±10 mm is acceptable on full all round girth measurements. This error of measures allows for the movements of the subject and the tension and positioning of the measuring equipment.

The recording form should be in a format that facilitates entry of the data into a computer. The form should provide for records of the date of birth and the dates of examinations, so that ages in years can be calculated to two decimal places. It is recognised that a computer best does these calculations (Lohman *et al.*, 1988:1).

2.11.3.7 Photographic equipment

Photographs of the subjects' bodies are essential and should be taken from different angles during the measuring process to supply as much as possible information regarding the body shapes, dimensions and stance of the subjects. Based on ethical guidelines, permission for photography should be sought. It is best to take digital photographs, since these are more cost effective and because the quality and clarity of photographs can be assessed immediately with the result that photographs can be retaken if needs be. Because these are digitally stored, they can be used for all requirements during the development stage of, for example, somatotyping and fit dummy prototype development.

2.11.4 Field workers

The function and type of field workers selected to participate in any anthropometric survey depend on the type of survey planned. In a multi-lingual society, it is recommended that fieldworkers should be able to communicate with subjects in their mother tongue. Apart from the basic skill requirements for field workers, they should be selected on this basis to ensure effective communication with subjects who will thus better understand instructions and to be able to be measured effectively.

If an anthropometric survey is to be carried out by means of manual measuring, two types of field workers, namely a measurer and a scribe are involved. A team of measurers will have to be employed and well instructed and trained in the methodology of taking measurements. The number of measurers in a team depend on the number of measurements to be taken on each subject. It is desirable to confine each measurer to taking only a few measurements, since this will enable them to refine the process and reduce the field of error. The number of recorders employed will entirely depend on the number of measurers employed. For each measurer employed, a recorder (scribe) should be employed. Besides the number of measurements to be taken from each subject, the size of the team will depend on the amount of money available for the survey as well as the number of subjects to be measured in the survey (Beazley, 1997a:59 & Taylor, 1990:53).

Depending on the size of the measuring team, a supervisor or head measurer and/or scribe is appointed to ensure consistency within the measuring process and management of the activities within the measuring area. If photographs are taken during the measuring process, a trained and experienced photographer needs to be employed as well.

2.12 ANALYSIS OF DATA

It is essential that enough of the correct type of data should be collected when conducting any anthropometric survey. It is suggested that there should be an even spread of captured data over the age range and the girth sizes when surveying grown adult bodies. When surveying the growing bodies of infants and children it is recommended that the spread of collected data should be over an even spread of age ranges and height intervals (Taylor, 1990:54). If insufficient data is recorded during an anthropometric survey, then the survey will not be of much use.

The body measurements recorded form only the basis for size charts. The captured raw data has to be analysed to formulate sizing systems and size charts for use of fit dummy prototype development. These should then be further adapted before being advanced for use in pattern drafting and clothing production (Beazley, 1997a:82). Proven statistical methods should be applied to divide the raw data into useable and cost-effective sizing categories that will accommodate the largest possible number of users within the target population (Anthrotech, 2002:1). The recommended statistical methods identified as most suitable for this study are listed and discussed in Chapter 4.

When it concerns the sizing of clothes, data on single measurements are of limited value. Winks (1997:13) points out that tables of individual body measurements give no indication of the inter-relationships or correlations with other body measurements. Normally, however, two or three (control) dimensions are involved for body fitting garments. Height, chest and waist measurements are normally used as the main controls in the sizing of men's outerwear, while controls for women's outerwear are normally height, bust and hips. One exception is headwear, for which a single body dimension, the head girth, suffices to provide a range of fittings. The correlations between relevant body measurements are clearly critical for the manufacture of body fitting clothes. It is of interest to determine how much correlation exists. Some body measurements are closely related while others have only minimal correlation.

Comparing the analysis of different anthropometric surveys is possible and sometimes advisable, but because manual anthropometric surveys can be carried out using different, non-standard methods of measurement, Winks (1997:14) states that the comparison of data is very difficult or not at all possible. With the introduction of three-dimensional scanning, it will become easier to compare analyses of different anthropometric surveys.

2.1.3 CONCLUDING SUMMARY

Chapter 2, as a literature study, is a summary of the most important aspects which should be addressed and implemented when planning and executing an anthropometric survey by means of measuring subjects manually, as described and implemented in Chapter 3. The literature study consists of an overview of sizing systems, size charts and size designation systems. In this regard, aspects such as standardised sizing and size designations are highlighted. Anthropometric dimensions of the human body are identified with a further discussion on somatotyping, figure type classification and fit models. Anthropometric surveys are described with the focus on how to conduct anthropometric surveys as well as how to prepare subjects for manual measuring. This chapter concludes by highlighting the most important aspects regarding the statistical analysis of data, as implemented in Chapter 4. Chapter 3, which follows, discusses the methodologies utilised in this study.

CHAPTER 3

RESEARCH METHODOLOGY

3.1. INTRODUCTION

In an attempting to obtain accurate and current information about the actual body measurements of a specific target population, this chapter focuses on the research methodology that was implemented according to international anthropometric standards. The emphasis fell, firstly on establishing the best method of measuring by which to compile a proper sizing system and accurate body measurements to be used for the development of fit dummies which represented the typical South African children’s wear consumer as target population. The sample was selected using the broad consumer base of nine leading South African children’s wear retailers as target population. Secondly, an anthropometric survey was conducted through which data, the actual body measurements of children, was collected. It was then possible to develop sizing and size designation systems for the specific target population.

The anthropometric survey was executed by means of measuring children manually. At the time it was evident that manual measuring was the most reliable method available for short term and a relatively small-scale surveys (Beazley, 1997a:82) such as this study. For more practical reasons it was decided to select this method of measuring for reasons such as the time frame set by the collaborating parties for data collection and analysis, the size of the planned survey and the purpose of the survey. It was not the intention to build an ongoing database, but rather to determine the current body measurements of the target population. Other reasons, such as budget constraints dictated that the selected method of measuring should be cost effective in terms of manpower, time, equipment, processes, procedures and tasks. Equipment had to be relatively inexpensive, providing ultimate accuracy as well as easy to operate and understand. Computerised 3D scanning was considered too expensive for this once off, relatively short and small-scale survey. Field workers were to measure subjects in different geographic centres in South Africa and needed to move equipment between centres. Therefore the simplest, yet most reliable, method in terms of measuring and data collection had to be used. The use of scanners was not advised, since smaller children between the ages two and five would need guidance and physical help with instructions and also because these children are easily frightened by strange and unknown equipment.

In this chapter the development of procedures and systems is recorded. The first pilot (exploratory) study was initiated to test the viability of the anthropometric survey and as this study progressed, a second pilot study seemed necessary to complete certain aspects before valid and reliable data could be captured. The second pilot study was executed to refine all planned procedures and systems for the empirical study. On completion of this second pilot study, the final (empirical) study was conducted and thereafter the statistical analysis of the captured data was done. All these procedures were done in close co-operation with industry, who supplied expert advice and were actively involved at different stages of the process as indicated throughout this chapter. Collaboration was also established with tertiary institutions such as Stellenbosch University and the North West University. Through these valued partnerships a solid basis for capturing correct and reliable data at any stage of the development and execution of the final empirical study was established.

3.2. FIRST PILOT STUDY

3.2.1 Motivation and aims

The first pilot study was a project initiated for the South African children's wear section of the clothing industry in November 1998 and was implemented during the first quarter of 1999 in Cape Town. In an effort to come to agreement on the so-called average body measurements, size and shape of the typical South African children's wear consumer, it was decided to investigate the possibility of measuring children from this specific target population, as well as testing and confirming the current practices. During the planning of an exploratory study it became apparent that the specifics of data capturing which had been used for the current systems and fit dummy ranges were unknown. It was therefore impossible to confirm the reliability of the information in use and a comparative study could not be done.

In accordance with the specific aims set for the empirical study the first pilot study was conducted to initially develop methodologies and standardised procedures for measuring children. Thereafter, the aim was to conduct an anthropometric survey of body measurements relevant to the development of a sizing system for children's wear. Consequently, the broad objective of this first pilot study was then established: to develop a methodology and standardised procedures for execution of the survey. This important development had to be undertaken before it was possible to capture reliable data for statistical analysis and related implementations such as the development of body measurement tables, size charts and fit dummies as well as the compilation of a size designation system.

The main focus of this study was specifically to develop, test and assess measuring processes and techniques; the equipment used and the sequence of measuring as well as to determine the most effective (not necessarily the accuracy) method of data capturing. The specific aims guiding the planning and implementation of the first pilot study included the following:

- To identify suitable measuring methodologies for measuring children between the ages of two and 14 years.
- To develop standard procedures and proper guidelines for measuring and data capturing.
- To select and develop standardised measuring instruments and equipment.
- To determine the sequence for all measuring activities.

The statistical analysis of the captured data was not considered important for the first pilot study. The focus was on the method of capturing data rather than the data analysis. The accuracy of captured data, as well as the analysis, were assessed and tested at a later stage (paragraph 4.2).

3.2.2 Sample selection and description

3.2.2.1 Selection of schools

It was decided to use a convenience sample for this exploratory phase of the study. Consequently, two nursery schools in the Northern suburbs of Cape Town were selected to participate in this first pilot study. These schools were located in Tyger Valley (Bellville) and Parow, each representing different socio-economic groups. One school, *Kinderland* in Parow, had a predominantly black profile while the other, *Kiddies Campus* in Bellville, was predominantly non-black and more affluent at the time of the study (paragraph 1.5.5). The schools were recruited about four weeks before measuring commenced. The principals were properly briefed on all the measuring processes, activities and requirements. A liaison teacher was appointed at each school as contact person.

At each school a classroom was made available to be set up as a measuring centre. One part of the classroom was used for undressing the children while another was used for measuring the children and a third section for photographing each child. Photographs were taken in that part of the classroom with the best lighting. Photographs were taken with all windows and doors directly behind the photographer. It was a requirement that a liaison teacher, representing the school, was present at all times during measuring. Each school and each child was given a small token of appreciation once the measuring process had been successfully completed.

3.2.2.2 Indemnity

Parents and/or guardians granted indemnity and permission to the measuring team to measure the children by signing the indemnity forms included as Appendix 3a and described in paragraph 3.2.5.2. These forms were issued to the schools for distribution to parents and/or guardians. The forms had to be studied, completed and signed before children were allowed to participate. There were instances where teachers completed these forms on behalf of the parents/guardians. Teachers were, however, required to obtain permission telephonically from the parents/guardians before signing the forms.

3.2.2.3 Selection of children

A sample comprising of 140 children was identified for participation in the first pilot study. The frequency table below indicates how the selection was done.

TABLE 3.1: FREQUENCY TABLE OF CHILDREN SELECTED FOR MEASURING (FIRST PILOT STUDY)

		STUDY POPULATION													
		SECTOR 1 (Black)							**SECTOR 2** (Non-Black)						
AGE (years)		2	3	4	5	6	7	8	2	3	4	5	6	7	8
GENDER	Boys	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Girls	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Total (age/sector)		10	10	10	10	10	10	10	10	10	10	10	10	10	10
Total (per sector)		70							70						
Grand Total		140													

The sample consisted of a selection of 70 children from each participating school. Thus the study population was divided into two categories with an equal number of children selected to represent Sector 1 (Black) and Sector 2 (Non-Black). Children representing Sector 1 were measured at *Kinderland* and children representing Sector 2 were measured at *Kiddies Campus*. At each school an equal number of children were selected from each of the two genders (boys and girls) of the first seven different age categories (two to eight years). Due to the sizes of the classes at both schools, five children of each of the two gender and age categories were chosen for participation. This particular selection was decided on to be able to compare the activities at these two measuring centres.

The selection of children from the two categories of the study population was to ensure representation of children speaking a black indigenous African language, such as Xhosa or Zulu as their mother tongue, in one group. The second group of children spoke languages other than black indigenous African languages, such as Afrikaans or English as their mother tongue (paragraph 1.5.5). An equal number of children were measured per sector (Table 3.1). This specific split in the study population was based on South African demographics, to establish what if any difference there was in body shapes and sizes between the two different categories of the sample population.

It was decided to focus on the children in the age group two years (pre-primary school) to eight years (first primary school). The age of the child filled in on the indemnity form was the child's actual age on the day of measuring and was recorded as such on the measurement chart. It was decided to measure an equal number of boys and girls in the different age categories with a minimum of 20 (black and non-black) children per age group. A minimum of five children per age group category was selected (Table 3.1).

Due to the specific focus of this exploratory pilot study, the minimum requirement was that 100 indemnity forms have been successfully completed before measuring commenced. It was anticipated that for unknown reasons some of the children willing to participate would not be able to do so and therefore it was decided to prepare about one third more forms than necessary. This was an estimated figure, the main reason being to ensure that there were no disappointments and delays on the actual day of measuring. More than 70 indemnity forms had, however, been prepared and therefore the correct number of participants could be selected. There were single instances of children without completed indemnity forms wanting to be measured, and these were not being excluded from the process. Some children could not be measured for reasons such as absenteeism on the measuring days, participation in extramural activities during the scheduled measuring times, incomplete indemnity forms and children simply not wanting to be measured.

The factors mentioned were anticipated, but the impact as such could not have been quantified beforehand. The primary aim of this first pilot study was, however, to develop the structure within which, and procedures according to which, an anthropometric study can be executed. It was to standardise the procedures and methodologies to achieve the highest level of accuracy and reliability of data capturing applying the manual method of measuring child subjects.

3.2.3 Selection, responsibilities, training and remuneration of field workers

The Department of Consumer Science at the University of Stellenbosch participated in the first pilot study and was responsible for selecting and appointing sixteen field workers in collaboration with the researcher. Twelve final year students from the Department of Consumer Science and four field workers who were regularly employed by the Department as research assistants were appointed to assist with the research. One of the pre-requisites for selecting these four field workers was that they were mothers. Their correct approach and attunement to handling small children was important. The twelve student fieldworkers attended only the first day of measuring while the four additional field workers attended all five measuring days. They were each allocated a specific task and were appointed as a dresser, measurer, scribe and photographer

Field workers were trained in all aspects of measuring according to the measuring guidelines of which each field worker received a copy (Appendixes 3, 3a, 3b & 3c). They underwent a two-hour orientation and training session on the first day of measuring. The function and responsibilities of each type of field worker was thoroughly explained and discussed. Children (one boy and one girl) were present during these training sessions for demonstration purposes and were also used as models for trial runs of measuring performed by each measurer.

Field workers received clear instructions on where the schools and measuring centres were. They were paid a standard hourly rate including a daily allowance for refreshments and transport. They were allowed to have a short tea break during the morning and afternoon sessions with a lunch break between the two measuring sessions.

3.2.4 Measuring methodology

In establishing a measuring methodology, draft documentation was developed to ensure consistency during the measuring process. This draft document was to be developed into a field worker manual to be used for managing all the measuring processes and activities. This includes the effective measuring of children as well as the development, selection and evaluation of equipment to test the correctness and ensure the accuracy of measuring, weighing and photographing each child.

3.2.4.1 Development of a measuring guide

The measuring guide developed for the first pilot study consisted of information regarding the planning of measuring activities, a guide for field workers, indemnity forms and measurement charts as well as instructions on how to measure the children. This document was called “Body measurement project: Children’s wear, ages 2 to 8 (boys and girls)”. It included guidelines and information on the child’s dress code, posture of the child during measuring, specific points of measuring, how to measure height, length, girth and width and how to weigh the children. The specific measurement selection was done in accordance with the recommendations regarding key measurements by Lohman *et al.* (1988:111-112) as listed in paragraph 2.10.4. The complete documentation of the first measuring guide was not included in this study, but a brief summary of the five sections was, however, included as Appendix 3. (Only the final measuring guide was included in this study as Appendix 5.) Each field worker received a copy of the full document. It was used in the training of the field workers to achieve accuracy and consistency during measuring and thus to contribute to the validity and reliability of the data.

3.2.4.2 Equipment

Each measuring centre and group of field workers received the necessary equipment as listed in the above-mentioned measuring guide that is included as Appendix 3c. The equipment was used to prepare, measure and photograph the children. Spare equipment was kept by the supervisor. Apart from the equipment listed, participating schools were also requested to make small tables available in each measuring centre.

3.2.5 Data gathering and management of the field activities

The management of the field activities included all aspects regarding the development of a project structure, including negotiations with schools and field workers, development, distribution and completion of indemnity forms and measurement charts as well as supervising the measuring process and data capturing.

3.2.5.1 Project structure

It was planned to complete the first pilot study over five days of measuring at the two selected nursery schools (paragraph 3.2.2.1) during five consecutive five-hour measuring days. A timetable was structured for measuring, which included lunch and two tea breaks.

Recruitment of field workers and schools started about four and six weeks respectively, ahead of measuring. The team of field workers was trained to perform the functions of dressing and measuring the children, recording the measurements, as well as photographing and weighing each child.

3.2.5.2 Indemnity forms and measurement charts

The indemnity form (Appendix 3a) was a summary and record of each child's personal information including age, which was specifically determined on the actual day of measuring. Indemnity forms were developed in Afrikaans and English and were issued according to the child's preference. A measurement chart (Appendix 3b) was printed on the back of the indemnity form. In this manner, the parents knew which measurements had been taken of their children. A contact person at each school was responsible for the distribution and collection of the completed indemnity forms (paragraph 3.2.2.2). This person was properly briefed on the requirements concerning these forms should any questions arise.

The sequence of measurements recorded on the measurement chart was based on those measurements specifically used in the South African children's wear industry in fit dummy assessment, pattern drafting and finished garment appraisal. The specific measurement selection was obtained by reference from industry experts and literature including O'Brien *et al*. (1941: 11-16 & 18), Kunick (1984:38-55), Taylor (1990:52), BSI (1990:17, 177-254) and Beazley (1997a:64-81). The measurement chart was developed according to a logical and easy flow of measurements and grouped according to the use of equipment. The focus of the development of the measurement chart was to reduce the waste of time between taking measurements and balancing all the different activities
in terms of estimated completion time.

3.2.5.3 Measuring

Guidelines on how to measure children were developed and standardised (paragraph 3.2.4.1). These were recorded as guidelines according to which field workers (the measurers) were trained for measuring children. They were also used as reference during the actual measuring to ensure consistency of measuring, accuracy of measurements and data capturing. All measurements were rounded to the first decimal. Length measurements were taken as straight measurements and girth measurements were taken flush to the body.

Timetables for measuring were drawn up according to the requirements of each participating school. At *Kinderland* the children were measured during the morning starting after 10h00 once the school activities had been completed. At *Kiddies Campus* the measuring team were allowed to measure the children only in the afternoons, because the children had activities during the morning and then had to have lunch, as well as an afternoon nap. Due to this arrangement, measuring centres had to be set up beforehand and dismantled after completion of measuring at the end of every measuring period on a daily basis.

A minimum of a hundred children had to be measured by the field workers during the measuring period of five working days, with an average of 20 children being measured during the five-hour measuring day. Measurements were taken according to the clear instructions as listed in the measuring guide, using the correct equipment and methodologies as prescribed. It was, however, a prerequisite that a liaison teacher from the school was, at all times, present in the measuring centre. Children had to be addressed in either English or Afrikaans and treated with respect and empathy.

3.2.5.4 Data capturing

Scribes were responsible for the recording of data on the measurement charts. They were also responsible for monitoring and directing the measurers on the correct flow of measurements.

Data capturing and statistical data analysis was not done, since this pilot study focussed on the importance of the actual measuring activities and not on the analysis of measurements. The quality and consistency of captured data were, however, assessed where possible, and the effective use and application of the measurement chart was reviewed. At this stage of the development it was not possible to ensure the validity and reliability of the captured data.

3.3 DEBRIEFING RESULTS AND RECOMMENDATIONS (FIRST PILOT STUDY)

To support the aim of this first pilot study, debriefing interviews were held with all parties involved in the execution of the process. The feedback was used to identify certain problem areas. In an effort to standardise all processes and procedures, this feedback was recorded. The two participating liaison teachers were asked daily to comment on the impact of the measuring process and activities. The four field workers were requested to comment on problems experienced while completing the measuring process. Feedback from field workers was received on a daily basis as well as during a formal feedback meeting held within a week after completion of the measuring process.

The outcome of this feedback was used as clear indicators for planning the next phase of the study. This had specific relevance to the general organisation and logistics of the total process. Comments were made about the distribution and completion of indemnity forms and the follow on effect of the use of measurement charts and the actual measuring of children. Shortcomings regarding dealings with children as well as the appointment and training of field workers were indicated. Table 3.2 gives a summary of the most important aspects identified as needing consideration when formalising the next phase of the study.

TABLE 3.2: SUMMARY OF DEBRIEFING AND RECOMMENDATIONS FOR THE SECOND PILOT STUDY

Debriefing
General organisation: schools, liaison teachers and children
* Schools did not always prepare the correct number of forms per age group and gender.
* Children were sometimes sick, busy with extramural activities or still asleep. These factors contributed to delays in measuring and resulted in too few children being measured.
* At one of the schools the liaison teacher did not stay in class during the measuring sessions. No initiative was taken to remunerate the teacher for her involvement during the measuring period.
Indemnity forms
* Parents were slow to complete and return the indemnity forms to the schools before the actual measuring dates.
* Parents did not always complete the forms properly, which caused delays on the days of measuring. Liaison teachers were also not disciplined enough to check these forms properly beforehand.
Children
* Some children cried and did not want to be measured, especially the smaller ones. This caused delays and also spilled over to the other children who then also did not want to be measured.
* Some children did not want to get undressed to be measured in their underwear.
* Some children did not wear underwear (panties or briefs) and could therefore not be measured.
* The age six, seven and eight girls were very self-conscious about only wearing a panty.
* Children younger than six years needed assistance with dressing.
* Some of the smaller children were afraid of the measuring equipment.
* Smaller children sometimes did not understand instructions, i.e. age two children did not understand how to kneel. Explanations were time consuming and "labour intensive".

Field workers and field worker training

* Training of field workers on the day of measuring is not considered effective. Too much information was given in a too short a time period. No time was allocated for practice runs and the demonstrations alone were not sufficient for fixing and understanding of all the measuring requirements.
* The function and responsibility of field workers were overlapping and caused an imbalance in their workload.

Measuring, weighing and photographing

* It was difficult to constantly keep the waist elastic in the correct position. When the children moved around in the measuring centre, the neck chain also did not stay in position.
* It was necessary to reset the scale from time to time.
* Some children found it difficult to keep the correct posture and stance during the measuring process. They were easily distracted by the measuring activities and looked down to the point of measuring. Children constantly had to be reminded of the correct posture and stance. This was obviously time consuming.

Photographs

* Photographing the smaller children was very difficult since they did not always understand the instructions.
* Children were sometimes confused with the required position of their feet for different angle photographs.
* Because children had to reposition their feet for photographs from different angles, they found the required postures difficult to hold.
* Photographs were taken at inconsistent distances and angles. There were also too many shadows on the photographs distorting the body contour.
* Photographs could not be used to do computerised analysis.

Logistics

* There were too many people in the measuring centre on the first day.
* More than twenty children can be measured during a measuring day of five hours, especially in the older age groups.
* There was an imbalance of time allocated to each of the measuring, weighing and photography activities. Field workers eventually split in two measuring teams of two each and shared the responsibility for all the activities between the measurer and scribe.
* Moving between two measuring centres during the same day was considered a waste of time.

Recommendations

General organisation: schools, liaison teachers and children

* The liaison teacher should be motivated to ensure the completion of the indemnity forms before the first day of measuring. This should be followed up on an ongoing basis. It is recommended to prepare 25% more forms per age group and gender before the day of measuring to avoid delays.
* The liaison teacher should be asked to assist in the proper scheduling and planning with regard to the availability of children at specific days and times for measuring.
* A teacher representing the school must be present during the day of measuring. If a full time staff member is not available, it is advised to remunerate a part-time staff member to perform this function. This is to verify that all activities are in accordance with the working agreement. Teachers should see that no damage is done to the facilities and to help the measuring team with questions and problems regarding children and facilities.

Indemnity forms

* To save time during the measuring days, parents should constantly be reminded to complete the indemnity forms in due time and to return the forms before the specific measuring days.
* Liaison teachers have to be motivated to thoroughly check these forms on return, to have all forms correctly completed and signed before the day of measuring.

Children

* No child should be forced to participate. They should receive a token of appreciation for their participation before they return to class.
* No child should be forced to undress and participate against their will. It is recommended to provide standardised outfits to the children to wear over their underwear during measuring.
* Children not wearing underwear (panties or briefs) cannot be measured.
* Whenever a girl is self conscious about wearing no top, they should be given one to wear as part of the measuring outfit.
* Preferably the liaison teacher or one of the field workers should be made available to help the smaller children with dressing.
* If a child is afraid of the measuring equipment, it is recommended that the teacher be asked to get involved to try and pacify the child. If needs be, the teacher may even take a measurement or two according to the measurer's instruction and supervision.
* The children should always be addressed in their mother tongue or home language such as Afrikaans, English or Xhosa. Teachers should also get involved if the child does not understand instructions. It is also recommended that at least the measurer or scribe should be able to communicate with the children in his/her mother tongue.

Field workers and field worker training

* Training of field workers should be done prior to the first day of measuring. The training should include practicing on children. Field worker activities and competencies should be properly assessed during these training sessions.
* A measuring team should consist of field workers with specific duties. The function and responsibility of each should be clarified and clearly defined. Each function should be assesses to ensure a balance of the workload between fieldworkers.

Measuring, weighing and photographing

* Waist elastics and neck chain positions should be marked on the body to ensure consistent measuring. It is recommended that one person does this marking on all children for consistency.
* The scale used for weighing should be properly calibrated. A digital scale is recommended.
* Teachers should help when photographing the children to ensure they understand instructions and to help them keep the correct posture and stance. It is recommended to have the children looking at a fixed point straight ahead during measuring.

Photographs

* It should be requested that the liaison teacher or one of the field workers help with positioning the child when photographing the smaller children.
* It is also recommended to have feet markers colour codes for different positions (front, back and side views) for the photographs. Different size feet markers have to be developed for different ages.
* A base for feet markers needs to be developed for children to stand in one position without moving for photographs from different angles.
* A photographer was contracted to help with the development of standards and procedures for all photographic activities.
* It was decided to take photographs with a digital still camera to be used for assessment during dummy development.

Logistics

* No more than five to ten children should be allowed in the measuring centre at one time.
* It is recommended to measure fifty children during a five-hour measuring day. It is expected that fewer children will be measured in the age group younger than four years, while more children can be measured if they are older than four years.
* Proper planning is needed in terms of the allocated time for each activity to ensure a more balanced flow during measuring.
* Measuring should take place in only one measuring centre per day.

Based on evaluations done during the actual measuring as well as comments made during the debriefing session and collation of the recommendations, further investigations seemed necessary to refine the development of standardised processes and equipment as well as the accuracy of measuring. All the aspects highlighted through debriefing interviews were implemented in the development of the second pilot study, and are discussed in the next part of this chapter.

3.4 SECOND PILOT STUDY

3.4.1 Motivation and objectives

A second pilot study was not initially anticipated but, considering the results and feedback after the first pilot study, it proved to be necessary. It became evident that a more encompassing survey needed to be done with expanded representation from more geographic areas. Expansion on the first pilot study therefore included further planning, testing and standardising of certain aspects. After careful consideration it was decided to focus on all the main activities developed for the first study. This was done because not all the processes, methods of measuring and data collection during the first pilot study were deemed scientifically sound. Therefore, it was important to refine and expand on each activity during a second pilot study.

In addition it was essential to ascertain whether measuring could be conducted scientifically soundly and reliably outside Cape Town by different measuring teams who would be managed and supervised by different supervisors, but according to instructions given by the researcher. Consistency, correct interpretation and application of processes and methods, as well as their accuracy, were a priority for testing. For the purposes of this second pilot study, more focus was placed on the quality of data captured, while less focus was placed on the statistical analysis of the captured data. Consequently, it was decided to finalise data analysis with the statistician at a later stage.

Based on the above motivation the broad objective of this second pilot study was to correct, improve and standardise the procedures, methods of measuring and data capturing to ensure the highest level of accuracy. The specific aims of the second pilot study were very closely linked to that of the first pilot study as recorded in paragraph 3.2.1. The following specific aims were finalised for the second pilot study:

- To standardise the measuring methodology.
- To standardise the data capturing format.
- To develop job descriptions, and training guidelines for the field workers as well as questionnaires for evaluating them.
- To finalise the measuring schedule, measurements and sequence of measuring.

This second pilot study was initiated for applications in the South African children's wear clothing industry and was performed during the second half of 1999. Since it had been decided to conduct the study in a centre outside Cape Town, the North West University was selected to participate for logistical reasons. (At the start of this project this university was known as The University of Potchefstroom for Christian Higher Education, but it has undergone a name change recently.) A research agreement already existed between the then Departments of Consumer Science at Stellenbosch University and North West University. Staff members from this department were selected as part of the research team, acting as supervisors. Students from the Department of Nutrition and Family Ecology were recruited and trained as field workers under the supervision of a senior lecturer from this department. The sample of children selected for participation will be described in the next section.

3.4.2 Sample selection and description

3.4.2.1 Selection of schools

In collaboration with the Department of Consumer Science at the North West University, two secondary schools in Potchefstroom representing different student profiles were selected to participate in this study. As in the first pilot study, schools were selected according to the black, non-black profile of the children at the schools (paragraph 3.2.2.1). *Boitirelo Combined School* and *Potchefstroom Secondary School* were selected to represent black and non-black children respectively. Schools were recruited about four weeks before the measuring was scheduled to start. On behalf of the researcher, the supervisor negotiated each school's participation with the principal. At *Boitirelo*

Combined School ten teachers participated in the study and assisted with all aspects of the study from managing the indemnity forms to the actual measuring activities, while six teachers participated at *Potchefstroom Secondary School*.

3.4.2.2 Indemnity

Parents and/or guardians were requested to complete the indemnity forms granting permission to the measuring team to measure their child(ren). Each child participating in the second pilot study was given an indemnity form (Appendix 4a & paragraph 3.4.5.2) for completion before measuring could take place. The supervisor, in collaboration with the liaison teachers, distributed indemnity forms to the children. The supervisor informed the liaison teachers thoroughly on the project to enable them to answer questions related to the project satisfactorily.

3.4.2.3 Selection of children

A convenience sample consisting of 144 children was selected to participate in this second pilot study. This number was selected according to age and gender restrictions within each of the participating classes. The possibility of absenteeism on the day of measuring and the overlapping of school activities and measuring times also influenced the numbers. Table 3.3 indicates how the selection was done to represent the study population, including the sector, age group and gender split, similar to the first pilot study. An equal number of children in each category were measured.

TABLE 3.3: FREQUENCY TABLE OF CHILDREN SELECTED FOR MEASURING (SECOND PILOT STUDY)

		STUDY POPULATION											
		SECTOR 1 (Black)						**SECTOR 2** (Non-Black)					
AGE (years)		9	10	11	12	13	14	9	10	11	12	13	14
GENDER	Boys	6	6	6	6	6	6	6	6	6	6	6	6
	Girls	6	6	6	6	6	6	6	6	6	6	6	6
Total (age/sector)		12	12	12	12	12	12	12	12	12	12	12	12
Total (per sector)		72						72					
Grand Total		144											

Children between the ages of 9 and 14 years were chosen for measuring. All the age categories of the South African children's wear consumers were covered and measured in the first and second pilot studies. As a result, all possible variations in standards of measuring or problems during measuring could be identified.

The age of the participating children was their actual age on the day of measuring and recorded as such on the measurement chart. An equal number of children (24 children) were measured per age group and an equal number of boys and girls were selected. Within each gender an equal number of both black and non-black boys and girls were included. A minimum of six children per category (sector, age and gender) was measured.

The supervisor and liaison teachers made every effort to ensure that the correct number of children had completed indemnity forms before measuring commenced. Therefore incomplete forms caused no delays on the days of measuring.

3.4.3 Field workers

3.4.3.1 Selection and responsibilities

The Department of Consumer Science at the Potchefstroom campus of the North West University that participated in the second pilot study was responsible for selecting and appointing the field workers. Two teams of field workers appointed were selected. One team was appointed to measure at *Boitirelo Combined School* while the other had to measure at *Potchefstroom Secondary School*.

Each team always measured at the school they were appointed to. The field workers in each team comprised four team members, these being a "preparer"/dresser, a measurer, a scribe and a photographer. All were from the participating communities. It was a prerequisite that all measurers and "preparers"/dressers should be mothers. Both the scribe and the photographer participated as a member of both teams. The scribe was a postgraduate student from the North West University. The field workers experienced no transport problems to and from the measuring centres, since most had children in the participating schools or lived very close to these schools.

The "preparer"/dresser helped the children with selecting the correct size swimwear, and dressing and undressing them. The measurer was responsible for taking all the measurements as listed in the measuring guide. The scribe was responsible for recording all the measurements as measured by the measurer and the photographer was responsible for taking the prescribed photographs of each child.

3.4.3.2 Training and remuneration

All field workers were trained in all aspects of measuring a week ahead of the scheduled date for measuring. Training was done according to the measuring guidelines (paragraph 3.4.4.1) and with further instruction by the researcher. Field workers scheduled to measure at *Boitirelo Combined School* were trained during two afternoon training sessions at the school. Field workers scheduled to measure at *Potchefstroom Secondary School* were trained at the University on a Saturday.

During training, field workers were accompanied by their own child to practice on. During the training sessions they also practiced on children other than their own. These practice runs enabled them to compare measurements and to test the accuracy of their measuring. Field workers were also trained in photographing the children.

Field workers were required to communicate clearly, treating children with respect and dignity and to be professional in their conduct. All field workers were tested at the end of the training period and completed the questionnaires (Appendix 4c) as included in the measuring guide. These completed questionnaires were assessed by the researcher and supervisor to ascertain whether the trainee field workers reached the required level of understanding and skill.

Field workers were paid a standard hourly rate and received treats during tea and lunch breaks. The two field worker teams alternated between the morning and afternoon measuring sessions. Field workers did not receive a travel allowance, since they all lived within walking distance of the measuring centres.

3.4.4 Measuring methodology

Important factors regarding the measuring methodology contributed to changes after careful considerations of the first pilot study results. The most important was the necessity of recruiting supervisors in different geographical areas, as measuring was planned in centres outside Cape Town. They had to be trained and appointed as supervisors and this led to the development of procedures and a guide for the training of supervisors. A measuring guide covering aspects of all the requirements for measuring, as well as the measuring activities important for the successful completion of this study under their supervision, was then compiled. The specific measurement selection was done in accordance with the recommendations made by Lohman *et al.* (1988:111-112**)** as listed in paragraph 2.10.4. Based on the feedback of the first pilot study, a revised and improved measurement chart was developed for the second pilot study (paragraph 3.4.5.2 and Appendix 4a).

3.4.4.1 Development of a measuring guide

In collaboration with an expert in developing such a guide, it was decided that the measuring guide should be user-friendly, including all activities and requirements of the measuring process. This document was called “Body sizing and measurement project, boys and girls: 9 to 14 years” (Appendix 4). It consisted of eight sections:

1. About this project
2. Participants to do
3. Supervisor
4. Field workers
5. Teachers, parents and children
6. Equipment
7. How to measure guide
8. Appendix

Each of these sections contained important information about the requirements to conduct the measuring process in a scientifically sound way, facilitating reliable data capturing. The complete measuring guide was not included in this study, but a brief summary of the documentation was included as Appendix 4. However, the final measuring guide, the Field *Worker Manual*, developed for the final study was included as Appendix 5.

3.4.4.2 Equipment

A complete list of the measuring equipment (adapted after the first pilot study) used is included in the above-mentioned measuring guide (Appendix 4d). It was the responsibility of the supervisor to prepare all equipment prior to the day and time of measuring. These included the photographic equipment and tables. Still photographs were taken with a digital video camera recorder. A regular bathroom scale was used for weighing. Tape measures, feet markers, marking pens and nametags as well as clipboards and stationary were also prepared separately for each measuring team. Based on experience gained during the first pilot study, swimwear (Speedos and bikinis) was used as standard measuring gear and worn over underwear. These suits had to be kept according to size and washed after each measuring day.

3.4.5 Data gathering and management of the field activities

Some of the field activities were adapted to achieve the specific aims of the second pilot study. This adaptation was done to accommodate the requirements for the measuring activities that were to take place in Potchefstroom, which had been adjusted, and was controlled by a supervisor on behalf of the researcher.

3.4.5.1 Project structure and supervisor responsibilities

The researcher, based in Cape Town, appointed a supervisor in Potchefstroom to be responsible for all aspects regarding measuring, field worker recruitment and training, negotiations with schools and data capturing during the second pilot study. A senior lecturer at the North West University Department of Consumer Science at the Potchefstroom campus was appointed. The researcher visited Potchefstroom once to train the supervisor in all aspects of the project field activities. These were recorded in detail in the measuring guide that was developed specifically for the second pilot study. This meeting took place at the end of March 1999.

During this meeting the supervisor had undergone orientation and thorough training regarding her responsibilities, which included the following:

- The requirements for communication between the researcher and the supervisor regarding administrative functions of all measuring activities.
- Selection, training and management of field workers.
- Selection of schools and negotiating a working agreement.
- All communications with schools and parents, i.e. letters, indemnity forms and gifts.
- Preparation and maintenance of equipment for and during measuring.
- Supervising and managing the measuring centre as well as all measuring activities.

The researcher and supervisor were in constant communication during completion of this phase of the study. The researcher were involved in decision making when necessary.

3.4.5.2 Indemnity forms and measurement charts

During the second pilot study each child's personal information had to be transferred to a separate measurement chart, since it was not printed on the same page as the indemnity form (Appendix 4a). It was therefore of the utmost importance for sufficient indemnity forms to be completed in due time to allow reasonable time for preparation of the measurement charts. The child's measurement chart was checked against the indemnity form. Each child's name and number had to be confirmed as corresponding with the number of the photograph board during photo sessions.

For the second pilot study, the indemnity forms and measurement charts were developed in the Formic format. This is a format in which data is captured for reading directly from the documents by using an optical reading device. This information is then automatically transferred to a computer for data analysis. A specialist in this field was involved in developing these forms and assisted in compiling guidelines on how to complete the forms correctly (Appendix 4b). It was of the utmost importance that these forms were copied and completed accurately to ensure effective reading of information as captured.

The forms were available in English and Afrikaans. Each child was given the form in the language the child was most comfortable with. The supervisor and liaison teachers had to ensure that enough indemnity forms were correctly completed and signed before measuring. Where forms were lacking, further distribution of forms was needed to ensure that enough were properly completed and returned before measuring commenced.

Measuring charts were not printed on the back of the indemnity forms used during the second pilot study. This was due to the restrictions of the format used for data capturing. Parents were, however, able to obtain information regarding measuring from the liaison teachers or the supervisor where they had questions.

3.4.5.3 Measuring

The guidelines on how to measure the children were expanded upon specifically to eliminate problems encountered during the first pilot study. With the retouching of the standards for measuring, specific focus was also placed on the anticipated needs for the specific age group being measured during the second pilot study. These included separate guidelines for the preparation, measuring, weighing and photographing of boys and girls. The supervisor and field worker training was based on these guidelines.

All measurements were recorded to the first decimal, and were rounded up or down as necessary. Length measurements were taken as straight measurements and girth measurements were taken flush to the body. Measuring teams received enough measurement charts with completed indemnity forms before measuring. They were therefore able to measure the prescribed number of children representing the study population in each category of age, gender and sector successfully.

Measuring was scheduled for completion within seven working days and 144 children were to be measured (Table 3.3). A minimum of six children of each category of age, gender and sector were to be measured. Schools were requested to inform children of the measuring timetable beforehand. The actual daily rate of measuring varied between 20 and 21 children during the five-hour measuring day. At *Boitirelo Combined School* measuring took place in the afternoons during a three and a half hour measuring period with an average daily rate of 13 children per session. At *Potchefstroom Secondary*

School an average of 20 children were measured during the school day, starting in the morning and continuing for about five hours. Measuring teams were moved between the two schools and had to set up the measuring centre for every session. Thus the measuring time was extended to about eight and a half hours per day.

During measuring, each child was addressed in their mother tongue and treated with respect and dignity. Where field workers were not able to communicate with a child in his/her mother tongue, teachers were requested to act as interpreters. Each participating child received a token of appreciation after measuring had been successfully completed. It was requested that the liaison teachers at each school should explain the measuring process to the children before the measuring days. It was also a prerequisite for a liaison teacher to be present during measuring.

3.4.5.4 Data capturing

The main focus of the second pilot study as regards data was the refining and finalising of the method of data collection to achieve correct and reliable data. As was the case with the first pilot study, this study focused on the data collection process only, the format of reading and recording captured data not being tested. It was essential that the data collection methods were rounded off and approved before any data analysis could be done.

The format chosen for capturing collected data had already proven to be successful as implemented by the University of Stellenbosch as a reliable method of data recording and it was therefore not tested. Although printed forms were the best for reading by an optical reader it was decided to photocopy all the forms for the purpose of this study since this was less costly. Instructions on how to photocopy the forms (Appendix 4b) were followed closely, since the quality and accuracy of the photocopied forms was very important to the successful reading and capturing of data with the optical reader. During data recording, it was important for the field workers not to make unnecessary marks, other than the required HB 5 pencil marks in the appropriate blocks. Where letters were recorded, they had to be written in upper case. Since the formic optical reader is very sensitive, it was of the utmost importance not to damage or scratch the forms in any way.

3.5 DEBRIEFING RESULTS AND RECOMMENDATIONS (SECOND PILOT STUDY)

To support the aims of the second pilot study, debriefing sessions were held with all the parties involved during the execution of all the processes. The supervisor and all field workers participating in the second pilot study met in Potchefstroom to discuss those processes and procedures which had been successful, and those which had not, or about which they had queries. This helped in the standardising of processes and procedures. The supervisor had telephonic debriefing discussions with the researcher, which were followed up by a written report. Table 3.4 is a summary of all the debriefing results and recommendations for the final study.

TABLE 3.4: SUMMARY OF DEBRIEFING AND RECOMMENDATIONS FOR THE FINAL STUDY

Debriefing
General organization: schools, liaison teachers and children * The facilities at both schools were insufficient. The rooms allocated for measuring were too small and crowded. The staff room was used at one school and the computer room was made available at the other school. * Principals sometimes did not priorities the administrative requirements, which caused delays with incomplete and insufficient indemnity forms. In some instances this impacted on the availability of the facilities, etc.. * When measuring was scheduled during school hours, some teachers could not be present at the measuring centre, because measuring took place whilst they were teaching. When measuring took place in the afternoons, some teachers had extramural activities and could not attend the full measuring sessions. * Assembly periods, tests and exams coincided with some of the measuring sessions. This impacted on the required daily rate of measuring, which was not achieved. * Poor attendance of children was a problem which affected the achievement of the required daily rate of measuring.
Equipment * The clothes of the children got mixed up or lost. * All measuring equipment had to be set up every day at each of the measuring centres. Equipment had to be moved in and out of the schools daily since nothing could be stored at either of the schools.
Logistics * Dressing rooms were far from the measuring centres and children were shy and uncomfortable walking this distance in their swimwear. * Measuring in two measuring centers on the same day was difficult. It was not possible to achieve the daily rate of measuring.

Measuring

* For religious reasons, some girls did not want to wear two-piece swimming costumes. This resulted in not all measurements being taken, since they were not allowed to expose some parts of their bodies.
* There were inconsistencies in measuring the children between the two measuring teams. These refer to marking of landmarks, points of measuring, handling of measuring equipment and actual measurement interpretation.
* The fact that field workers were mothers and could speak the same language as the children added to the success of the measuring process. This aspect should remain, for the next study. (Bigger boys were reluctant to participate, but because of the parents' involvement enough were measured.)
* The measuring guide was very clear to understand and easy to follow. It worked well as an operational guide.

Photographs

* For religious reasons all photographs could not be taken, as some children may not expose parts of their bodies.
* The lighting in both measuring centres was insufficient for taking photographs. Lighting was only from one side, creating a shadow which distorted the body outline against the grid.
* The quality of photographs taken with the still video camera is not sharp enough and they can therefore not be used.
* Landscape format photographs were taken. This photograph layout was wider than it was high and the images of the children were too small. The grid and child was too small a part of the photograph.
* The grid was skew on some photographs. Some photographs were also taken at different
* The distance from the grid differed between photographs.
* The stance of the some children was unbalanced.
* The board with the child's references was too big.
* The foot marker had to be repositioned for front and side view photographs. This was too time-consuming.
* Moving the foot marker sometimes caused inaccurate positioning in front of the grid. Some children's arms and hands were covering the front or back upper thigh when side view photographs were taken.

Recommendations

General organization: schools, liaison teachers and children

* Proper facilities should be negotiated ahead of time such as the school halls, etc. with changing room facilities close by.
* Principals should be requested to identify a teacher to liaise with the supervisor about all administrative aspects of the project if they are not able to do so themselves.
* Liaison teachers should be in attendance at the measuring activities at all times. This should be properly negotiated with the principals and measuring should be planned and scheduled at times when this is possible.
* Measuring should not be planned to coincide with test and exam timetables. Proper upfront planning and scheduling to be done with each participating school according to their specific time table.
* It is suggested to prepare at least a third more indemnity forms than necessary before measuring starts. This will ensure that when children are absent, enough children can still be measured that day. Poor attendance should not be holding up the measuring process.

Equipment

* Children's clothes should be kept in plastic bags to ensure that they do not get mixed up or lost.
* It is advised that schools should have storage facilities for measuring equipment so that field workers do not have to move equipment out of the building daily.

Logistics

* It is important to negotiate facilities with dressing rooms close to the measuring centres. These areas should preferably be away from the main school activities.
* Moving between measuring centres on the same day is not recommended. It is recommended that only one school be visited per day.

Measuring

* No child should be forced to participate in measuring for any reason. If parents did not complete the indemnity forms to grant permission, no child should be called to the measuring centre or be subject to any form of embarrassment.
* The same group of field workers should be measuring all children in different centres to ensure consistency in measuring. Each field worker should be measuring very specific measurements.
* Field workers must be able to address the children in their mother tongue.
* Each field worker must receive a copy of the measuring guide to study beforehand and to use as an operational guide.

Photographs

* Do not force any child to participate for any reason. If parents did not complete the indemnity forms to grant permission, no child should be called to the measuring centre or be caused any form of embarrassment.
* The part of the classroom with the best lighting should be used for photographs. Light should always be from right behind the photographer.
* Photographs should be properly focused. This is important to see the body contour clearly.
* Portrait format photographs should be taken. As little as possible background should be part of the photograph.
* The grid should be properly positioned in relation to the camera position. Marks should be identified to line up with the grid.
* The camera should be positioned at a constant and stable position and angle to the grid.
* Children should be properly lined up with the centre of the grid before photographs can be taken.
* The board with the child's reference numbers should be developed to be small and readable, without distorting the photographs.
* Foot markers should not be moved when taking photographs – improved equipment needs to be developed.
* When the child's hands, elbows or arms cover the outline of the thigh or the small of the back outlines, two photographs should be taken. One will be with the arms to the front and the other with the arms to the back.

Based on the debriefing results and the recommendations made during the second pilot study, further refining and standardising of processes and equipment, with greater accuracy of measuring and data collection, were possible. The aspects highlighted during debriefing were all implemented as a basis for the development of the final study. This study is discussed in the next part of the chapter.

3.6 FINAL EMPIRICAL STUDY

The information gained during the completion of the two pilot studies was implemented in planning, developing and conducting the final study.

3.6.1 Objectives

The final study was conducted at a national level starting in early 2000 and continuing until the middle of 2002 for specific application of the results in the South African clothing industry. Leading South African children's wear retailers were the main funders. The broad objective of this study was to investigate and determine the basic measurements and body shapes of the target market, the South African children's wear consumer.

In an effort to achieve this broad objective, the most important specific aim was to finalise the compilation of a measuring guide, in order to capture reliable and valid data. Once this had been achieved, further specific aims, based on those formulated in paragraph 1.3, were:

- To conduct a cross-sectional survey according to the required standards for measuring and in approved data-capturing format specified in the Field Worker Manual.
- To statistically analyse the collected data, to the requirements for fit dummy development.

Activities performed to achieve the abovementioned specific aims, included the following:

- Determining the size and the source of the sample for measuring.
- Scheduling of all measuring activities and dates.
- Negotiating agreements with the fieldworkers, including training sessions.
- Negotiating appropriate facilities for measuring with representatives from participating schools.

The implementation and execution of the final study were recorded in the following paragraphs to ensure that all the abovementioned aims and objectives were achieved.

3.6.2 Study population

It is, first of all, important to clarify whom the study population represented. This investigation focused on and was conducted for application in the South African children's wear clothing industry. The study population was therefore selected from an already existing and perceived consumer base, namely the typical South African children's wear consumer buying clothes from any of the leading children's wear retailers. The typical South African child was therefore not the main study population to be investigated for this survey. It was decided that, for the needs of the participating retailers only those children in the age bracket relevant for children's wear should be investigated. This selected group consisted of boys and girls between the ages of two and fourteen years.

On the one hand the study population was clearly defined. On the other hand, it was important to select the study population within the time frame, financial restrictions and the feasibility matching the purpose of this study. Because this decision can be influenced by variables such as age, gender, occupation, ethnicity or socio-economic group (Beazley, 1997a:261), these aspects as described in paragraph 2.10.2, had to be clearly defined. Furthermore, Taylor (1990:54) advised to spread the sample across the country and involve different communities because racial characteristics may influence the survey results. All these aspects as described in paragraphs 2.6, were implemented as basis for all decisions regarding and description of the specific study population selected for this survey.

It was therefore decided to select two different geographic areas in South Africa for measuring, namely the Western Cape (South) and Gauteng (North). These two areas were selected due to the concentration of the South African population in these regions. The population compilation of the Western Cape and Gauteng also differ. However, it was anticipated that, within the boundaries and restrictions of this study**,** provision had to be made for factors that may cause variation in the anthropometric dimensions of the children measured.

As in the first and second pilot studies (paragraphs 3.2.2.3 & 3.4.2.3), two sectors as categories of the study population were included (paragraph 1.5.5). When selecting schools in the Western Cape and Gauteng to partake in the study (paragraph 3.6.2), care was taken to include both urban and suburban areas. In the Western Cape schools in Cape Town metropole were selected as well as two schools in the rural areas in the near vicinity of Cape Town. In Gauteng schools in urban and suburban areas of Johannesburg were considered for inclusion.

The study population comprised the typical South African boy and girl who could be considered as consumers of children's wear. They were, consequently, in the age group two to fourteen years. The study population were living in the Western Cape (specifically in the Cape metropole and surrounding towns) and in Gauteng (specifically in Johannesburg urban and suburban areas). Children included in the study population were speaking black indigenous African languages (Sector 1) and other indigenous languages such as Afrikaans (Sector 2). These two categories of the study population were selected in accordance with the formulated aims for the study.

3.6.3 Sample selection and description

In consultation with the statistician, it was decided as with the first and second pilot studies, to select a convenience sample that adhered to the description of the study population (paragraph 3.6.2). It was also decided, as with the pilot studies, to use schools as the basis for the sample selection. According to the statisticians' recommendations, a minimum of a hundred children in each age group and sector had to be measured **(Table 3.5)**.

3.6.3.1 Selection of schools

Participating schools were carefully selected to adhere to the specifications regarding the profile of the specific study population (paragraph 3.6.2). Thirty seven (37) nursery, primary and secondary schools were selected (Table 3.5). Twenty two (22) of these were in the Western Cape and fifteen (15) in Gauteng. A total of 38 measuring centres were recorded on Table 3.5 because an extra measuring centre was set up at Edgardale. This was necessary at the end of the measuring period to achieve the required minimum children measured per category. Due to time restrictions and financial constraints, this centre was a cost effective alternative to achieve this goal.

In selecting the schools to participate the following practical issues were also considered:

- Measuring should preferably take place at one school on each day. Alternatively, the location of different schools to visit on the same day should be in close proximity in order to reduce the time wasted on travel and setting up measuring centres.
- Schools should have enough children representing the study population to enable the measuring team to measure at that school for at least a five hour measuring day, thereby achieving the minimum required rate of measuring.
- Since boys and girls should be measured separately, there should be enough children present to ensure few changes during the same measuring session. This should be done to reduce the time spent changing between measuring the groups.

Schools were recruited about a month before the measuring was scheduled to start. The field managers (paragraph 3.6.3.1) negotiated their participation with each school's principal. At each school a contact person (referred to as the liaison teacher) was appointed who helped with managing the indemnity forms, preparing the classroom for measuring, calling children from classes for measuring on the day of measuring, etc (Appendix 5, paragraph 3.6.5.1 & figure 3.1).

TABLE 3.5: ACTUAL SAMPLE MEASURED FROM STUDY POPULATION ACCORDING TO SECTOR, GENDER, AGE AND REGION

School (A-L) & Province	Sector		TOTAL	Profile of children measured																													
				Gender (by sector)				Ages																									
	B	NB		B		NB		2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	14
				M	F	M	F	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
Alfred Stempa Primary (WC)	341	0	341	172	169									10	2	23	16	15	10	18	20	18	21	14	29	21	26	24	19	21	14	8	12
	0	0				0	0																										
Aristae Primary (WC)	1	0	114	0	1																		1										
	0	113				44	69									4	7	1	7	9	11	9	16	10	15	6	11	5	2				
Bellpark Laerskool (WC)	0	0	122	0	0																												
	0	122				61	61											12	18	14	13	19	10	6	2	7	9	3	7		2		
Blair Athol (Ga)	97	0	97	57	40											1	1	8	6	8	7	7	5	7		4	9	9	5	7	3	6	4
	0	0				0	0																										
BonginKosi Edu-care Centre (WC)	179	0	179	90	89			9	12	21	22	22	21	31	23	7	11																
	0	0				0	0																										
Educare House (WC)	0	0	40	0	0																												
	0	40				19	21	2	3	2	3	3	4	9	8	3	3																
Franklin D. Rooseveldt (Ga)	35	0	67	16	19												1	1	2	3		1	4	6	8	2	1		1	2	2	1	
	0	32				23	9											3	2	3	3	2		5		2	2	4	1	3	1	1	
Hoërskool Goudini (WC)	0	0	96	0	0																												
	0	96				50	46									4	2	10	3	7	6	6	8	11	13	5	2	3	4	2	5	2	3
Hoërskool Linden (Ga)	0	0	41	0	0																												
	0	41				20	21																							2	7	18	14
Jeppe Boys High (Ga)	0	0	24	0	0																												
	0	24				24	0																							6		18	
Jeppe Girls High (Ga)	0	0	35	0	0																												
	0	35				0	35																								9		26
Khandubuhle Primary (Ga)	58	0	58	25	33											5		2			2		2					3	5	2	9	13	15
	0	0				0	0																										
Khanyile (Ga)	42	0	42	17	25			6	9	6	6	2	8			3	2																
	0	0				0	0																										
Khanyisa Crèche (WC)	89	0	89	44	45			7	11	13	10	13	11	11	11		1		1														
	0	0				0	0																										
Kiddies Campus (WC)	0	0	80	0	0																												
	0	80				41	39	5	3	6	11	15	11	14	13	1	1																
Kids College (WC)	0	0	9	0	0																												
	0	9				4	5		2		1	3	1	1	1																		
Kids Kingdom Pre-School (WC)	1	0	20	1	0					1																							
	0	19				5	14	1	2	2	3	1	3	1	4		2																
Kleinspan (WC)	0	0	26	0	0																												
	0	26				14	12				1	2	4	5	2	7	5																
La Rochelle Pre-Primary School (WC)	0	0	42	0	0																												
	0	42				18	24							4	6	14	18																
Laerskool Bellville-Noord (WC)	0	0	46	0	0																												
	0	46				27	19																					10	9	15	10	2	
Laerskool Louw Geldenhuys (Ga)	0	0	63	0	0																												
	0	63				33	30											11	8	7	6	4	2	5		3	2			1	11	2	1
Laerskool Simon van der Stel (WC)	0	0	135	0	0																												
	0	135				57	78							1	3	9	7	10	7	4	6	5	9	5	17	5	17	10	8	8	3		1

School (L-Z) & Province	Sector B	Sector NB	TOTAL	Gender (by sector) B M	B F	NB M	NB F	2 M	2 F	3 M	3 F	4 M	4 F	5 M	5 F	6 M	6 F	7 M	7 F	8 M	8 F	9 M	9 F	10 M	10 F	11 M	11 F	12 M	12 F	13 M	13 F	14 M	14 F
Linden Christian Nursary School (Ga)	0	0	5	0	0																												
	0	5				3	2		1	3	1																						
Linden Pre-Primary (Ga)	3	0	8	1	2				2	1																							
	0	5				1	4		2	1	2																						
Masigcinane Crèche (WC)	42	0	42	25	17			11	6	6	6	8	5																				
	0	0				0	0																										
Mickey Mouse (Ga)	46	0	46	15	31			3	2	4	8	3	6		6	5	9																
	0	0				0	0																										
NGK Kenridge Kleuterskool (WC)	0	0	17	0	0																												
	0	17				8	9		2	4	2	4	5																				
Noddyland (Ga)	2	0	20	1	1			1	1																								
	0	18				15	3	5	3	10																							
Norkem Park Primary (Ga)	59	0	76	29	30											1		3	5	3	8	5	4	5	8	9	4	1		2	1		
	0	17				15	2											2						1		7	1	1	1	4			
Paragon Nursary School (Ga)	0	0	16	0	0																												
	0	16				4	12	1	1	3	5		6																				
Permochio (Ga)	4	0	6	3	1			3	1																								
	0	2				0	2		1		1																						
Pikkie Paradys (WC)	0	0	72	0	0																												
	0	72				37	35				6	11	4	11	16	15	9																
Sakumlandela Primary (WC)	293	0	293	151	142							1	1	1	7	4	7	20	26	19	12	18	14	20	5	14	10	13	21	19	19	22	20
	0	0				0	0																										
Tikkel Tokkel (WC)	0	0	33	0	0																												
	0	33				18	15	7			5	6	5	5	5																		
Tiny Todds (WC)	4	0	32	3	1							1		2			1																
	0	28				13	15	1	2	3	2		2	4	6	5	3																
Uitsig Kleuterskool en Dagsorgsentrum (WC)	0	0	31	0	0																												
	0	31				14	17	1	1	5	6	7	10	1																			
Vredelust Laerskool (WC)	5	0	185	4	1																		1	2				1				1	
	0	180				87	93									9	10	7	12	12	18	13	15	16	18	18	13	11	6	1	1		
Edgardale (Ga)	3	0	29	0	3				3																								
	0	26				8	18	2	4	2	2	1					1									1	1		4	2	5		1
TOTAL	1304	1373	2677	654	650	663	710	67	76	96	106	107	111	116	118	126	123	112	114	115	120	116	121	123	125	115	119	110	105	110	115	108	111
	2677			2677				2885																									

Key:
B - Black
F - Female
Ga - Gauteng
M - Male
NB - Non-black
S1 - Sector 1 (Black)
S2 - Sector 2 (Non-Black)
WC - Western Cape

	2 M	2 F	3 M	3 F	4 M	4 F	5 M	5 F	6 M	6 F	7 M	7 F	8 M	8 F	9 M	9 F	10 M	10 F	11 M	11 F	12 M	12 F	13 M	13 F	14 M	14 F
WC (S1)	27	29	41	38	45	38	55	43	34	36	35	37	37	32	36	37	36	34	35	36	38	40	40	33	31	32
Ga (S1)	13	18	11	14	5	14	0	6	15	13	14	13	14	17	13	15	18	16	15	14	13	11	13	15	20	19
Total	**40**	**47**	**52**	**52**	**50**	**52**	**55**	**49**	**49**	**49**	**49**	**50**	**51**	**49**	**49**	**52**	**54**	**50**	**50**	**50**	**51**	**51**	**53**	**48**	**51**	**51**
	87		**104**		**102**		**104**		**98**		**99**		**100**		**101**		**104**		**100**		**102**		**101**		**102**	
WC (S2)	17	15	22	40	52	49	56	64	71	67	40	47	46	54	52	58	48	65	41	52	42	36	26	21	4	4
Ga (S2)	8	12	19	11	1	6	0	0	0	1	16	10	10	9	6	2	11	0	13	6	5	6	18	33	39	42
Total	**25**	**27**	**41**	**51**	**53**	**55**	**56**	**64**	**71**	**68**	**56**	**57**	**56**	**63**	**58**	**60**	**59**	**65**	**54**	**58**	**47**	**42**	**44**	**54**	**43**	**46**
	52		**92**		**108**		**120**		**139**		**113**		**119**		**118**		**124**		**112**		**89**		**98**		**89**	
2677 **TOTAL**	**65**	**74**	**93**	**103**	**103**	**107**	**111**	**113**	**120**	**117**	**105**	**107**	**107**	**112**	**107**	**112**	**113**	**115**	**104**	**108**	**98**	**93**	**97**	**102**	**94**	**97**

3.6.3.2 Indemnity

Each potential participant in this project received an indemnity for**m (Appendix 5b).** It was a requirement that each child's participation in this study carried the written consent and indemnity of a parent or legal guardian. These forms were printed in Afrikaans and English and were distributed depending on the language the child's parents preferred. Parents or legal guardians were requested to complete the forms granting the measuring team permission to measure their children.

A letter to the parents accompanied the indemnity form, explaining the purpose of the project, all aspects of the project and the measurements it was intended to take. Parents were also thanked for allowing their child(ren) to participate (Appendix 5). Measurement charts were not issued to parents for perusal, but they were encouraged to enquire at the school to have the field worker manual made available to them for further detail. The researcher's contact details were also printed on the letter to the parents, should any enquiries be made.

Generally, schools were very helpful in distributing the indemnity forms, but the collection and checking of the forms was a big task for the field managers. Some schools were very involved in the project and attached a cover letter to the parents. This was of great help and since they also actively participated in the collection of the forms, it helped the researcher to receive enough forms to prepare for measuring. At some schools the field managers had to motivate the liaison teachers regularly and sometimes additional forms had to be distributed.

3.6.3.3 Sample selection

In consultation with the statistician, it was decided to select a convenience sample representing the study population. Specific schools were, therefore, selected to participate in the study (paragraph 3.6.3.1). A sample of at least 2600 children was selected from these schools for participation in the final study. This sample size was selected, as recommended by the statistician, determined using a formula that included the two sectors (black and non-black) of boys and girls ranging over 13 age groups (between ages two and fourteen). When applying the formula by multiplying 2(sectors) X

13(ages) X 2(genders), the result equals 52, which is the number of strata. It was recommended that 50 children be selected from each stratum which, when multiplied by the above 52 strata, gives one a sample size of 2600 children. For practical reasons, such as financial and time constraints, the researcher, statistician and industry representatives considered this sample size as sufficient for the final study. A total sample of 2678 children was eventually measured (Table 3.5).

It was the responsibility of the researcher and field managers to select and prepare enough measurement charts to be able to measure the required quota of children. The field co-ordinator was, however, responsible for ensuring that the required quota was reached on a daily basis. The common practice at each school was to hand indemnity forms to all children in the required and qualifying age and gender groups. In organising and preparing an adequate number of forms for measuring, at least a third more forms than needed were completed at random. This allowed for absenteeism and unwillingness of a child to participate in the study.

Due to budgetary constraints, two thirds of the children were measured in the Western Cape while the remaining third was measured in Gauteng. An equal number of boys and girls representing each sector were measured. Table 3.6 summarises the number of children measured according to age, gender, sector and region. A minimum of 1820 boys and girls in the Western Cape and a minimum of 780 boys and girls in Gauteng had to be selected from the sample population for measuring. A total of at least 2600 children had to be measured including an equal number of boys and girls in each area from each age group and each sector.

TABLE 3.6: SAMPLE SELECTION AND MEASURING PLAN

WESTERN CAPE: May - September 2000 (n=1820)

SECTOR 1	Age	Boys	Girls	Total	SECTOR 2	Age	Boys	Girls	Total
(Black)	2	35	35	70	(Non-Black)	2	35	35	70
	3	35	35	70		3	35	35	70
	4	35	35	70		4	35	35	70
	5	35	35	70		5	35	35	70
	6	35	35	70		6	35	35	70
	7	35	35	70		7	35	35	70
	8	35	35	70		8	35	35	70
	9	35	35	70		9	35	35	70
	10	35	35	70		10	35	35	70
	11	35	35	70		11	35	35	70
	12	35	35	70		12	35	35	70
	13	35	35	70		13	35	35	70
	14	35	35	70		14	35	35	70
	Total	455	455	910		Total	455	455	910
	Days @50/day	9.1	9.1	18.2		Days @50/day	9.1	9.1	18.2

GAUTENG: October 2000 (n=780)

SECTOR 1	Age	Boys	Girls	Total	SECTOR 2	Age	Boys	Girls	Total
(Black)	2	15	15	30	(Non-Black)	2	15	15	30
	3	15	15	30		3	15	15	30
	4	15	15	30		4	15	15	30
	5	15	15	30		5	15	15	30
	6	15	15	30		6	15	15	30
	7	15	15	30		7	15	15	30
	8	15	15	30		8	15	15	30
	9	15	15	30		9	15	15	30
	10	15	15	30		10	15	15	30
	11	15	15	30		11	15	15	30
	12	15	15	30		12	15	15	30
	13	15	15	30		13	15	15	30
	14	15	15	30		14	15	15	30
	Total	195	195	390		Total	195	195	390
	Days @50/day	3.9	3.9	7.8		Days @50/day	3.9	3.9	7.8

TOTAL CHILDREN	650	650	1300	650	650	1300
TOTAL DAYS	13	13	26	13	13	26

Grand total children	2600
Grand total days	52

The selection of children on the day of measuring at the schools was at random. Initially all children in each class who were willing to participate were measured. Because daily counts were done, the researcher was able to give feedback on specific quota requirements to the field co-ordinator (Table 3.6). Progressing into the measuring period, the researcher had to give instructions on how many children still had to be measured from specific sectors, genders and ages. At this point in the measuring period, the liaison teacher at each school played a vital part in the random selection of children for measuring. Based on the information given to the field co-ordinator, teachers were requested to call children from specific sectors, genders and ages for measuring. In minor instances it did happen that not all children from a specific class were measured. If there were individuals, however, who insisted on participating, they were included although the quotas had been reached. Once the children had been called for measuring, all children present in the measuring centre and willing to participate were measured, regardless of the quotas. This practice was followed to ensure no embarrassment. There were a few incidents where children were called to the measuring centre and decided not to participate, in which case they were not forced but were replaced by other children in the required sector, gender or age groups. This procedure was followed in each geographical region.

Table 3.5 also includes a summary of the number of children measured at each measuring centre. The summary includes the total number of children measured per category of boys and girls measured per age and sector. It is important to report that each child's age was determined on the actual day of measuring by subtracting the child's birth date from the actual date on the day of measuring. This was done according to years, months and days. If a child's age was determined as for example five years, three months and four days, the child's age was recorded as that of a five-year-old child. If a child's birthday fell on the day of measuring, the child's age was recorded according to the actual or "new" age of the child. To summarise, the actual age of the child in a particular age group fell between the child's birthday and the day before the next birthday.

3.6.4 Field workers

3.6.4.1 Selection and responsibilities

The researcher was responsible for the recruitment and appointment of all the field workers participating in the final study (Appendix 5). To assist the researcher, an assistant from industry was appointed. She had almost twenty years' experience in pattern making and clothing manufacture. She also had experience at retail level with the setting of standards for sizing and fitting of garments. She was involved with gathering information regarding the types of measurements required for fit dummy development. She also helped with the training and assessment of field workers, sorting out problems at the measuring centres and certain administrative functions.

The researcher appointed field workers according to the structure depicted in Figure 3.1 (paragraph 3.6.6). All the field workers were females. The measurers had to be mothers. Two field managers were appointed for operating in the Western Cape and one in Gauteng. Their function was purely of an administrative nature. These field managers had to be bilingual and able to communicate clearly, as well as having strong administrative and organisational skills.

A field co-ordinator (supervisor) was appointed to be responsible for all measuring activities in the Western Cape and Gauteng. She had to be from Cape Town and had to be able to travel with and be responsible for the measuring team in both areas. She had to be bilingual and have a sympathetic way of dealing with children. She had to have an understanding of sewing and pattern making, and some experience in operating cameras. She had undergone extensive training in all operational aspects of the project.

Following the field co-ordinator's appointment, a photographer was recruited. She had to be from Cape Town and had to be able to travel with the measuring team. She had to be bilingual and had to be able to communicate clearly and work sympathetically with children. She had to have a sound knowledge of operating cameras. In addition, a professional photographer was commissioned to train this field worker to achieve the required standards of photographing.

Further to the appointments mentioned above three measurers were appointed. These measurers were each responsible for the execution of specific tasks (Appendix 5) and were considered as three separate teams (Figure 3.1). These field workers were recruited in Cape Town and had to be able to travel to Johannesburg. It was a pre-requisite for the measurers to be mothers and a requirement for all three appointees to be able to participate during the entire measuring period. These ladies had to be sympathetic in their dealings with children. They also had to have understanding of sewing and basic pattern making. They had to be available to undergo extensive training in how to measure children accurately according to the standards set for the final study.

The same team of measurers were measuring children in both areas. Individual field workers were responsible for taking specific measurements on the day and thereafter during the survey (Simmons & Istook, 2001: 98). This extremely important aspect regarding consistency of the measuring process was implemented to ensure the reliability and validity of data (paragraph 3.6.6.4.2).

Another appointment was that of the scribes, namely seven from the Western Cape and fourteen from Gauteng. The scribes had to be bilingual and able to communicate clearly in Afrikaans or English and / or an indigenous language, depending on the mother tongue of the children being measured. They had to be able to understand written instructions, write clearly and work in an empathetic manner with children. They also had to be available for training beforehand. The scribes were, however, selected to work at specific schools according to the language the children spoke. For example, scribes able to speak Xhosa were chosen to participate at schools where Xhosa was predominantly spoken. The other scribes were chosen to participate at schools where English or Afrikaans was predominantly spoken.

Investing in the proper training of field workers as well as the thorough assessments during practice sessions, were underlying to the success rate of the data capturing. Special care was therefore taken in thorough training and assessment of field workers, as discussed in the next section.

3.6.4.2 Training

As mentioned in the previous paragraph, the researcher and her assistant were responsible for the training and assessment of field workers prior to the actual measuring of children. The main focus of this training was to thoroughly train and assess fieldworkers to achieve and conform to the standards of accuracy and consistency set for this study (Simmons & Istook, 2001: 98). The training and evaluation of field workers before and during the final study were done in accordance with the recommendations by Lohman *et al.* (1988:109) in paragraph 2.10.3.3. All field workers received thorough training in all aspects of the measuring process according to the instruction in the measuring guide, the “Children’s Dummy Development: Field Worker Manual” (Appendix 5). Each field worker received a copy of this manual and was requested to study it before the training sessions. It was to be used as a reference guide during the measuring period to ensure accurate and consistent measuring.

Prior to the training of field workers, the field co-ordinator was briefed on her function and responsibilities. She was also introduced to the requirements of the measuring process in total. Thereafter the field workers (photographer, measurers and scribes) underwent an intensive training period of five days. The first four days consisted of two, two-hour sessions. During these sessions field workers were exposed to the equipment, and in depth discussions of the measuring process. They witnessed and took part in demonstrations on children. They were given ample time for questions and discussions of possible problems and inconsistencies during measuring and data capturing.

A simulated measuring centre was set up each day and field workers were given the opportunity to practice measuring on children. Children rotated between the different groups of field workers. This was done in order to assess and compare the accuracy of measuring and data recording of each group. Each day measurers received feedback on their progress with the procedures, their accuracy of measuring and their general understanding of all the measuring activities. Scribes were assessed on their writing abilities, as well as the quality and accuracy of the information they recorded, as stipulated by Beazley (1997a:59) in paragraph 2.11.3.6. Their interaction with the children and assistance to the measurers were also evaluated and developed. In order to standardise the assessment of field worker efficiency and skills, a checklist was developed and used along with the measurement chart during the training sessions (Appendix 5: section 5.2). Apart from this training session, every time a new team of scribes started working at different the various schools, this was preceded by a follow-up training session. This was done because the time span between working sessions for team members could be weeks, depending on the language spoken at different schools. Brief orientation discussions took place regarding the function of the scribes, the types of measurements taken and the sequence of the measurement chart took place. Dry runs were always done to thrash out all problem areas and to ensure that the quality of standards was upheld.

On the fifth day of training, measurers and scribes were assessed and certified to participate in the final study as field workers. Each field worker was appointed on a fixed term contract basis. All field workers were allocated a specific function for the duration of the project, as listed in the measuring guide (Appendix 5). All field workers were expected to comply with all rules and procedures relating to health, safety, hygiene, security and discipline of the project as listed in the Field Work Manual.

3.6.4.3 Remuneration and contractual agreements

All field workers were enrolled for a probationary period. This was subject to the successful completion of the prescribed training period. Once the field workers had been certified as having met the required standards and level of competency, they were appointed on a fixed term contract. A copy of this contract is included as Appendix 5c. Field workers were employed for a set number of days and were required to work for at least five hours daily, or successfully measure a minimum of 50 children each day. Measuring centres needed to be set up before and dismantled after the prescribed measuring hours.

Apart from receiving a fixed daily rate of pay, field workers also received an additional daily allowance for meals. While measuring in Cape Town, field workers received no remuneration on public holidays, Saturdays and Sundays. No measuring activities were scheduled on these days, since schools were closed. All the paid field workers hailed from Cape Town and they all accepted the contract conditions stipulating no payments on days other than working week days while measuring in the Western Cape. Field workers did, however, receive payment on public holidays, Saturdays and Sundays while measuring in Gauteng. No measuring activities were scheduled on these days.

All travel expenditures such as airfare, accommodation and transport of all field workers were covered when measuring in Gauteng. While working in Cape Town, field workers had to cover the travel expenses themselves and arrange lift clubs when travelling together.

It was agreed that either party, on written notice, might terminate the fixed term contract. If the field worker had been employed for sixteen days or less, the requirement of one working day’s written notice stood. If the field worker had been employed for more than sixteen days, five working day’s written notice was required. If the field worker, however, wanted to terminate the working agreement while measuring in Gauteng, the individual were personally responsible for paying back the full travel and accommodation costs incurred on her behalf.

3.6.5 Measuring methodology

3.6.5.1 Field Worker Manual

The Field Worker Manual is the final document of the measuring guides and was developed based on the feedback of the pilot studies. The focus of the Field Worker Manual for the final study was to be a clear description of all the requirements of the measuring process as discussed in paragraphs 2.10 and 2.11. Its function was to be a user-friendly guide and reference to all field workers and other parties involved. It also served as record of the survey procedures. It was called “Children’s Dummy Development: Field Worker Manual” (Appendix 5). This manual consists of 10 different chapters. Each chapter covers vital information about the minimum requirements necessary for successful completion of the measuring process:

Chapter 1: An introduction to the project gives insight into what the project is about as well as by whom it is being managed and financed. It has guidelines on how to use the manual.

Chapter 2: Participants in this project are identified and the profile of each participant described while the responsibilities of each is clearly listed. Apart from the project manager (the researcher), the participants in this project were the field manager, different field workers, teachers, parents and children. The field workers were the field co-ordinator, the photographer, measurers and scribes.

Chapter 3: All letters and forms used to communicate with schools and parents as well as the indemnity forms are included.

Chapter 4: All the equipment needed to successfully measure the children is described. There is a list of equipment to be provided by each participating school and lists of equipment needed for preparation and photographs. The required maintenance of equipment is outlined and a full checklist of all equipment and the purpose for which it is used is included.

Chapter 5: The information on all the landmarks and measuring positions on the body is described. A checklist of these is included, along with the bone drawings included as illustrations for clarity of instructions.

Chapter 6: All aspects of the preparation of the children for measuring are discussed. The equipment needed for preparation, how to prepare the child and the points of marking on the body are thoroughly described.

Chapter 7: Clear instructions on how to photograph the children are included. Firstly, all the equipment needed is listed and described. Secondly, instructions on how to set up the photographic equipment is included. Thirdly, the correct standards and requirements for photographing the children are listed.

Chapters 8, 9 and 10 are the instructive chapters on how to measure the children. Each chapter deals with the requirements of the measuring teams separately. The selection of specific measurements suitable for the final study was done according to guidelines discussed in paragraph 2.10.4 as well as the key measurements listed in Table 2.3 and the selection of measurements for manual measuring in Table 2.4. The specific measuring requirements implemented in the final study are based on the recommendations by Beazley (1997a:59) (paragraph 2.10.5). The equipment needed to measure the children with and instructions on how to measure are all listed and thoroughly explained. The information listed in each chapter is according to the required flow of the measurements on the measurement chart (Appendix 5b). An index has been included for quick reference.

Chapter 8: The instructions to the first measuring team for measuring the girth of the base of the neck, the armhole and the elbow by using a measuring chain and metal ruler are outlined. The centre vertical post of the anthropometer is used to measure the height, nape to floor and crutch to floor measurements of the child. The side vertical post of the anthropometer is used to measure the child's scye depth as well as the waist, hip, knee and ankle to floor measurements on the left side of the body. The last three measurements are measured with a 75 cm measuring tape. These are the nape to waist, nape to shoulder and stern to waist measurements.

Chapter 9: Instructions to the second measuring team measuring with tape measures of two lengths, 75 cm and 150 cm respectively, are specified. The measurements taken are the head girth, head arc, cervical brow, neck girth, bust or chest girth, under bust girth, nape to bust point, nape to under bust point, inter-nipple position, across front, shoulder circumference, shoulder breadth, across back, waist and hip girth.

Chapter 10: Instructions to measuring team three are listed, measuring with a 75 cm long tape measure. The measurements taken are the shoulder to elbow (straight and bent) length, the shoulder to wrist (straight and bent) length, the biceps girth, the elbow (straight), the wrist, thigh, knee (straight), calf, ankle and instep and heel girth measurements. A pair of callipers is used to take the back neck width and hand width measurements. A two-meter long tape measure is used to take the crutch length as well as the vertical trunk length measurements.

3.6.5.2 Equipment

In Chapter 4 of the Field Worker Manual (Appendix 5), all aspects pertaining to the necessary equipment for measuring children are listed. In selecting and developing equipment for photographing, weighing and measuring the children, the safety and comfort of the participating children and field workers are the priority. Proper and safe housekeeping was also instilled during field worker training. The following procedures were implemented to facilitate such safety measures:

- Each child was measured wearing a clean measuring outfit. For hygienic considerations, the gusset inner of the bottoms was lined with a protective strip which was changed for every child.
- Measuring outfits were laundered at the end of each measuring day. Detergent was supplied to the field co-ordinator.
- Each measurer wore protective surgical gloves during the measuring of children.
- Hand lotion was supplied for use of the field workers.

- Disinfectant was used to clean hairclips and measuring equipment. Hairclips were cleaned after use by each child. Measuring equipment was cleaned at least twice a day, or alternatively, at the discretion of the measurers or field co-ordinator.
- Air freshener was used as and when necessary.
- *"Wet ones"* were supplied for use by field workers.
- Black bags were to be used for the dirty laundry and in the dustbins supplied by the schools for all rubbish.

Further to this, each participating school was requested to make a few pieces of furniture, which were important for measuring, available in the measuring centre. This included a school desk, chairs, mirrors, tables and fitting booth screens (only where no changing room facilities were available nearby the measuring centre). The assistance of schools in this regard was very helpful, since the field workers were measuring in different centres whether in the Western Cape or the Gauteng and were unable to travel with the abovementioned equipment. All the equipment needed in the execution of all the actual measuring activities was supplied to the teams by the researcher.

Photographic equipment was purchased as listed in Appendix 5. Photographs were taken with a digital camera and other equipment was specifically developed for photographing the children. To facilitate standardised photographs which could be used in analysing the body silhouette, shape and stance of children, a special foot stand and detachable grid was developed. The square foot stand was designed with a rotating disc at the centre of the stand. Feet position markers are attached to the centre of this rotating disc. These indicate the correct positions of the children's feet during the process of photographing them. The foot position markers are in different sizes to accommodate the foot sizes of the children of different ages. These are placed with the centre of the body in the centre of the rotating disc. This centre point is lined up with the centred line on the detachable grid fixed to the foot stand. On the centre line of the grid, the focus point for the camera is fixed and indicated by two triangles.

To facilitate the effective measuring of vertical measurements, an anthropometer was developed. This anthropometer consists of a base with two measuring poles. Affixed to each pole, are tape measures and horizontal measuring devices. One pole has been developed to take measurements along the centre vertical post such as height, nape (cervical) height and crotch height. The second pole has deen developed to take measurements on the left vertical post such as scye depth, waist, hip, knee and ankle height. An additional horizontal measuring device is affixed at the bottom of both poles to measure the crotch and ankle heights of smaller children accurately. All the measurements taken with the anthropometer are taken from the floor level up.

Four carry bags containing equipment were given to the group of field workers. Field workers were in teams, each responsible for a bag. They had to make sure that all equipment was maintained properly through regular maintenance checks. A checklist, listing all the equipment required to successfully complete the measuring, was developed for reference to the field co-ordinator. The first bag contained all the small pieces of the measuring equipment. The second bag contained all the gifts for the children, the third all the measuring outfits and the fourth all the stationery, the scale, etc.. For the weighing of children, a digital bathroom scale was used. Custom made travelling bags were specifically designed for the photographic equipment, such as the grid and stand. The anthropometric measuring device was also transported in these bags.

3.6.6 Conducting the empirical study

3.6.6.1 Structure and responsibilities of collaborating parties

As recorded in the Field Worker Manual, (Appendix 5) a number of people were involved in this study. A diagram of all parties involved with the execution of the final study is given in Figure 3.1 below. For the purpose of this final phase of the study, the researcher (also referred to as the project manager) and an assistant from industry, whose role and function, is discussed in paragraph 3.6.4.1 was appointed.

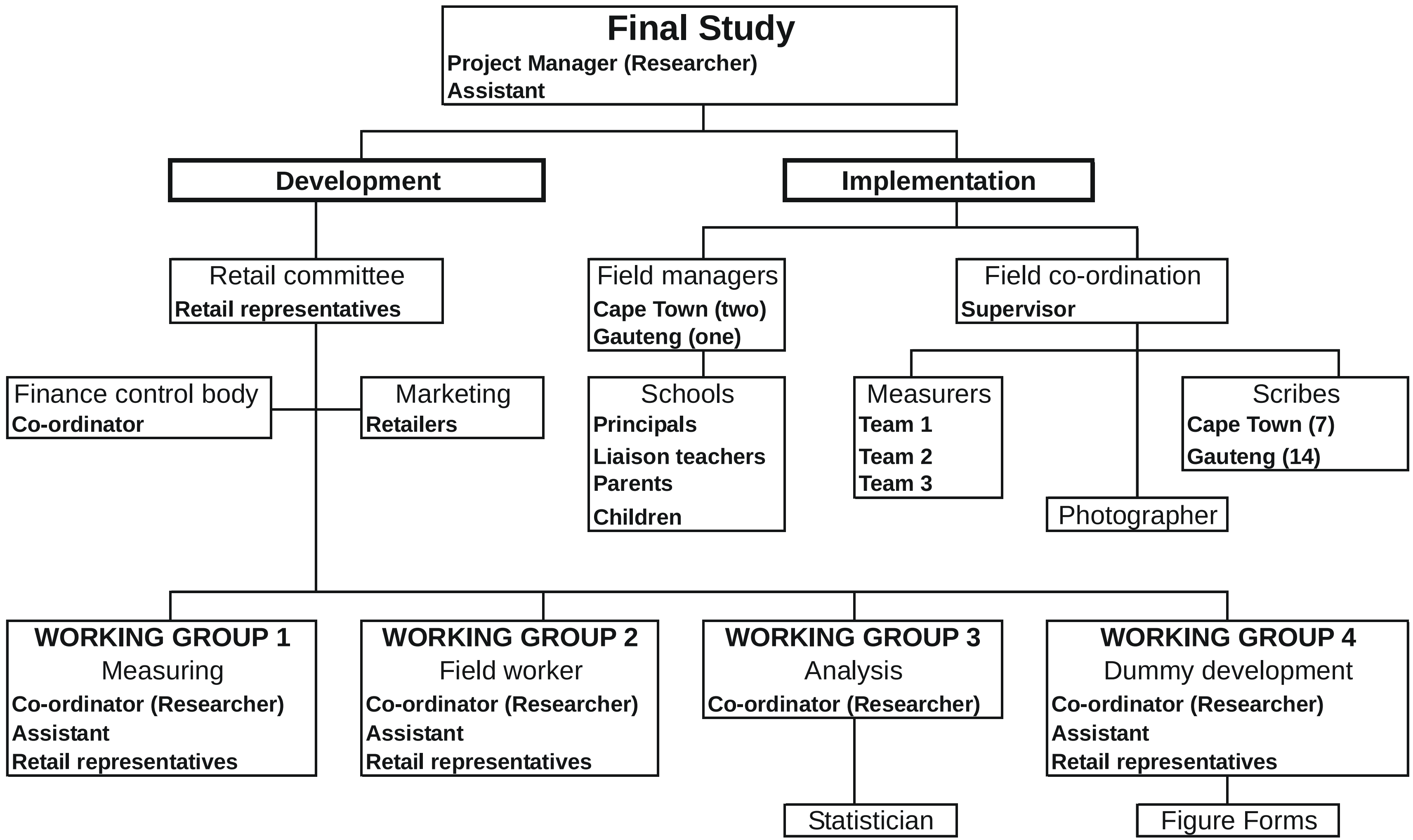


FIGURE 3.1: PARTIES INVOLVED IN THE EXECUTION OF THE FINAL STUDY

The researcher and her assistant took responsibility for all the administrative activities required to implement and successfully complete the empirical study. The development and implementation of the final study was conducted under the researcher's supervision and management. She took full responsibility for the total execution of the final study and was a leading member of each working group. The researcher appointed individuals to operate as field managers, a field-co-ordinator, measurers, scribes and a photographer, Appendix 5 and paragraph 3.4.3.

Figure 3.1 describes the various stages of development and implementation of the empirical study. The members of the Retail committee are all representatives of the contributing children's wear clothing retailers and *Figure Forms*, the company which developed the fit dummies prototypes. This committee acted as the liaison body for the final study, to ensure that the needs of industry were met. The committee seconded representatives from each collaborating retail company to form working groups, and the committee met once every four months.

The Finance control body was responsible for controlling all the funds on behalf of all the contributors. In collaboration with the researcher, the financial manager co-ordinated all the payments by contributors to the project as well as payments made to various service providers. This body presented the financial statements at the quarterly committee meetings. Marketing of the implementation of the research results was done by the contributing companies individually according to their own marketing needs.

Each contributing retailer had representation in the working groups that were formed. *Working group 1 (Measuring)* was responsible for the development of the measuring methodologies and standards collated in the Field Worker Manual (Appendix 5) and for selecting, standardising and obtaining all the measuring equipment and techniques for the empirical study. All decisions regarding the standardised methodologies (how) and what to measure were their responsibility. In collaboration with the researcher, the *Working group* 2 (Field workers) was responsible for recruiting, training and appointment of all field workers. On behalf of this working group, the researcher closed contracts (Appendix 5c) with each field worker for the duration of the measuring period. The *Working group 3 (Analysis)* was responsible for the structuring and statistical outcomes of the study. The researcher in collaboration with a statistician assumed responsibility for this working group and all aspects implemented. His tasks included setting up of the analysis structure, finalising the format of data recording and capturing. The *Working group 4 (Dummy development)* was, in collaboration with *Figure Forms*, responsible for the fit dummy development process, which involved standardising the measuring and photographing of children to facilitate fit dummy development.

3.6.6.2 Managing the field activities

The researcher supervised the three *Field managers*, two of whom were operating in the Western Cape and another in Gauteng. They were thoroughly briefed on their function prior to the commencement of measuring and had specific responsibilities as described in. Also reporting to the researcher was the *Field co-ordinator*, who acted as the supervisor during the entire measuring process, which had to be conducted as prescribed in. Her responsibilities varied from all aspects associated with the indemnity forms to the general housekeeping of the measuring centre. She had to familiarise herself with all aspects of measuring, had to understand the function of the scribes and had to brief and train the scribes in Gauteng (Appendix 5).

Three types of *Field workers* were involved in the measuring process. The responsibilities of the measurers, scribes and photographer were pointed out in paragraph 3.6.4.1. A *Liaison teacher* was the vital link between the school and field manager and field co-ordinator (or supervisor). Her responsibilities was discussed in paragraph 3.6.3.1. *Parents and guardians* were responsible for the completion of the indemnity forms and were invited to attend the measuring session of their child. *Children* between the ages of two and fourteen of both genders qualified to be measured during the final study (Appendix 5).

3.6.6.3 Letters and forms

Both English and Afrikaans letters were developed for use in all communications with schools and parents. These are letters to the principals of schools as well as parents (Appendix 5) to give the background of the project and to request permission from parents to allow their children to participate in this research. Letters of thanks to schools were not included in the manual, but were written individually (Appendix 5a).

Indemnity forms and a measurement chart (Appendix 5b) with which to capture data were added to the Field Worker Manual. Indemnity forms were developed in both English and Afrikaans, but the measurement chart was only done in English. The field workers and researcher, who were all fluent in English, used only this form.

A coded measurement chart was developed in collaboration with the statistician and this was used for the recording of data. In total, 47 direct measurements were recorded on the measurement chart (Appendix 5b). The statistician used this information to derive an additional eight measurements for analysis (Table 2.4). The measurements were captured according to the flow chart developed for measuring. The indemnity form contained personal information on the child, such as name, date of birth, home language and gender. This was captured onto the measurement chart along with the actual date of measuring. The child's weight, photograph numbers and all measurements were also recorded on the measurement chart. The section, *for office use only*, contained information on the child's actual age, the sector and the measuring form number. These were recorded according to the field co-ordinator's discretion and confirmed by the researcher.

3.6.6.4 Measuring

3.6.6.4.1 Schedule for measuring

Out of a possible 107 measuring days, measuring had to be completed during a fixed period of 59 five-hour working days. A total of 44 working days was spent in the Western Cape and 15 in Gauteng. A minimum of 2600 children had to be measured relating, which meant a minimum average of 50 children per day. The actual measuring rate was, however, influenced by the ages of the children measured. Field workers were able to measure more children daily in the older age groups and fewer in the age group younger than five years.

Measuring took place during May, July, August, September and October 2000. June 2000 was excluded due to tests, exams and school holidays falling in this month. See Table 3.6 for the actual days of measuring. Specific days were negotiated with schools, anticipating the best dates for maximum attendance of children. Measuring was never scheduled during public or school holidays and during test series or exams. At nursery schools specific day programmes sometimes restricted measuring times.

TABLE 3.7: MEASURING CALENDAR

2000 WESTERN CAPE

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
May	**1**	2	3	4	5	6	7
	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24	25	26	27	28
	29	30	31				
July						1	2
	3	4	5	6	7	8	9
	10	11	12	13	14	15	16
	17	18	19	20	21	22	23
	24	25	26	27	28	29	30
August		1	2	3	4	5	6
	7	8	9	10	11	12	13
	14	15	16	17	18	19	20
	21	22	23	24	25	26	27
September	28	29	30	31	1	2	3
	4	5	6	7	8	9	10
	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	

2000 GAUTENG

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
October							1
	2	3	4	5	6	7	8
	9	10	11	12	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
	30	31					

Key: Public and school holidays

Measuring was scheduled first in the Western Cape. This allowed the researcher to sort out all problems, delays or uncertainties in the measuring process before measuring in Gauteng commenced. Provision was therefore made for extra measuring days in the Western Cape, should they be needed. Two thirds of the children were measured in the Western Cape and the remaining one third in Gauteng (paragraph 3.6.3.3).

Measuring took place mostly during the normal school hours and schools were responsible for informing parents and children of the measuring timetables beforehand. At some schools the field workers were, however, allowed to measure during the after care hours as well. At nursery schools measuring was restricted to the times in the daily schedule when children did not eat or sleep. At primary and secondary schools, the measuring activities were dictated by the schools' timetables and extramural activities. Periods such as assembly were excluded from the measuring schedule, while break times were included. As far as possible, measuring was scheduled to take place at one school only on any particular day. In some instances this was not possible, since there were insufficient children qualifying to be measured at a school. In these instances, more than one school in close proximity was scheduled for measuring on one day.

3.6.6.4.2 Reliability and validity of measuring

Reliability refers to the application of a valid measuring instrument to different groups under different sets of circumstances that lead to the same measurements or observations (Mouton & Marais, 1990:79). In order to secure reliable data collection, certain measures were implemented during the execution of the empirical study. In this regard the prerequisites was accuracy and consistency when measuring subjects manually, as described paragraphs 2.9.4 and 2.10.3. It was stipulated that the same measurer should take the same measurements of each child, using the same procedures and equipment, measuring all children under the same conditions. Therefore all children had to be prepared for measuring by the same person, applying the same standards according to the requirements for this survey (Appendix 5). To facilitate this, children were given standardised measuring outfits to wear over their own underwear during measuring. The sizes of the measuring outfits were carefully selected according to each child's gender, size and age group. Care was taken to ensure the elastic bands used for determining the landmarks did not cut into the bodies to distort the body contour and thus the measurements. By implementing these procedures as standard, it was possible to achieve a high level of consistency with regard to preparing the children throughout the execution of the empirical study.

Furthermore, accuracy of measuring was one of the most important factors relating to the success of the empirical study. The selection of body surface landmarks easily palpable in both lean and obese children (Lohman *et al.*, 1988:28) as discussed in paragraph 2.11.1 is essential and the inclusion of direct and proportional measurements, as recommended by Beazley (1997a:58) and discussed in paragraph 2.10.5, was a prerequisite for accurately measuring a subject manually. To achieve consistency and accuracy of measuring, field workers were trained intensively and assessed on their results after taking measurements of the same child repeatedly. Once this had been done, field workers were requested to cross-measure the same children, and eventually these results were compared to the measurements taken by the researcher. These assessments were done during training as well as at different stages during the execution of the empirical study.

To achieve accuracy during measuring the children were measured as stipulated in the Field Worker Manual (Appendix 5) in accordance with the recommendations by Simmons and Istook (2001:98) (paragraph 2.9.4). The measuring standards recorded in the manual were based on studies by O'Brien *et al.* (1941), Kunick (1984), BSI (1990) and Beazley (1997a&b) and were developed in accordance with the requirements for conducting anthropometric surveys as described in paragraph 2.10. The measuring standards refer both to the instructions on how to measure as well as how the specified measuring instruments should be used. The measuring instruments were another aspect of securing the validity and reliability of measurements. The same instruments were used constantly during the measuring period. It was important to check and verify the constancy of measuring throughout the measuring period. The anthropometer had secured measuring tapes attached, measuring tapes for manual measuring were all reinforced, while the callipers and scale were calibrated. During the entire empirical study, tests were done at random to ensure no deviation in the condition and calibration of the measuring instruments.

The requirement was that the same results had to be produced in terms of the application of measuring standards and procedures. Furthermore, all measurements were recorded according to the actual measurement, taken to the first decimal place. These were then rounded up or down to the nearest 0.5 cm. Length measurements were taken as straight measurements and girth measurements were taken flush to the body. Measurements were taken down the centre of the body, across and horizontally and on the left side of the body. The field co-ordinator ensured that all activities were in line with the guidelines and reported back to the researcher on a daily basis.

The researcher visited measuring centres regularly to assess the progress, accuracy and consistency of the measuring teams' activities. This was done in accordance with the recommendations by Lohman *et al.* (1988:1) as described in paragraph 2.10.3.3. To further ensure continuous accuracy of the measuring process, continuous assessment of field worker activities was done at random by comparing measurement charts with the standards set for measuring and measurement recording. The commencement of work by a new team of scribes was always preceded by thorough training and assessment sessions. The same standards and procedures were followed as stipulated and described in paragraphs 3.6.4.1 and paragraph 3.6.4.2. Apart from orientation regarding the function of the scribes, they were also briefed on the types and methods of measurements taken and the sequence of the measurement chart. The following section deals with the data capturing and the statistical analysis of the captured data.

3.6.6.5 Data capturing

The scribes used the coded measurement chart (Appendix 5b) that was developed in collaboration with the statistician for data collection. The personal information on the child such as name, date of birth, home language, gender and date of measuring was verified by the field co-ordinator before the child could be measured. The child's weight, photograph numbers and all measurements which had been recorded on this form were confirmed correct and signed by the field co-ordinator on completion of each measurement chart. The *For office use only* section which contained information on the child's actual age on the day of measuring, as well as the sector and measuring form number, was confirmed by both the field co-ordinator and the researcher before the data was made available for capturing by the statistician.

Since the measurements were recorded according to the flow chart developed for measuring, it was essential that the scribe and measurer were well acquainted with the prescribed sequence of measuring. Measurements were recorded with an HB-pencil and taken to the nearest decimal. The measurement chart consisted of frames for each letter or digit, which was recorded. For numbers, enough frames were allowed for the biggest measurement anticipated. The last frame was reserved for the first decimal digit. If a measurement occupied fewer than the allowed number of frames, a zero had to be written in front of the actual measurement. This means that if the measurement was, for example, 97.4 cm and four frames had been allowed, the scribes had to write $\boxed{0}\boxed{9}\boxed{7}\boxed{,4}$ in the appropriate frames. (The decimal comma was already printed on the measurement chart to avoid misunderstandings.) Note that the number of frames allocated for the recording of each individual measurement was according to the maximum number of digits anticipated. Three frames were allocated in most instances, and four only as an exception.

It was also the responsibility of each scribe to double check the column filled in by the previous team before her team could continue with measuring. Although the next scribe could not verify the accuracy of measurements, she had to check that what was written down was easy to read and whether the column was completed in full, as prescribed. If any areas of concern were identified, the measurement chart had to be returned to the previous team for corrections. Only if the scribe was satisfied with the previous team's data recording was the measurer allowed to commence with taking the next set of measurements. It was the responsibility of the field co-ordinator to sign each form off as properly and correctly completed before it was filed with the rest of the forms for safekeeping. The field co-ordinator returned these completed measurement charts to the researcher at the end of each day's measuring.

3.7 STATISTICAL ANALYSIS

The statistical analysis of the captured data was done in accordance with the Centre for Statistical Consultation at the University of Stellenbosch. This process consisted of three stages. During the *first stage*, the focus was on the data itself. The reliability of the measurements were tested by verifying the accuracy of classification and measuring the subjects. The captured data was then edited and cleaned up for analysis after which the data characteristics were visually displayed on a scatter plot.

The *second stage* of the statistical analysis focussed on the process of analysis. Key measurements were selected based on the strength of the relationships between measurements depending on the value of the correlation coefficients. Consequently based on this selection, it was possible to develop sizing and size designation systems. This development was based on the clustering of data by means of the *k*-means analysis.

The sizing system consisted of different clusters that were classified into different sizes. Interpreting the differences between the sizes of the size designation system, the increments between them were calculate. To be able to implement this analysed data for fit dummy development, the minimum and maximum values of each measurement size were calculated.

The data analysis ended with the *third stage* during which body measurement tables were developed for implementation in fit dummy development. From these, it was possible to extract specific growth patterns and to identify the age of gender split of the sample population. The *third stage* was concluded with the development of fit dummies for the South African children's wear market sector.

3.8 CONCLUDING SUMMARY

The aims and objectives set for this study were the basis and starting point for the planning and implementation of the survey. The literature study in Chapter 2 was primarily the basis on which decisions were during the development and implementation stages of the empirical study. The study were conducted in three phases. The *First pilot study* aimed at identifying and developing scientifically sound measuring methodologies, standardised measuring instruments and proper guidelines for data collection.

Based on the information gathered, the *Second pilot study* were planned and implemented. Specific methodologies were refined and standardised to ensure the collection of scientifically sound, valid and reliable data collection. Based on this, further refining was done in planning a further study in two geographical areas (Western Cape and Gauteng). An encompassing Field Worker Manual (Appendix 5) was developed and tested during the *Final study* to guarantee scientifically sound methodologies in the collection of valid and reliable data for analysis. The collected data was statistically analysed after which the results were discussed in the Chapter 5.

CHAPTER 4

RESULTS AND DISCUSSION OF THE EMPIRICAL STUDY

4.1 INTRODUCTION

Chapter 4 is a discussion of the results of the final empirical study (paragraph 3.6) and the statistical analysis of anthropometric data, which in this study was based on the body measurements of children between the ages of two and 14 years. The key objectives set for this study were to develop sizing systems for the South African children's wear market sector, including both boys and girls, and to establish body measurement tables for the development of fit dummy prototypes. To achieve these objectives, the discussion of results will be presented according to the structure outlined in Figure 4.1. This flow diagram represents a summary of the important stages during which the anthropometric data was captured, analysed and implemented. Reporting entails a brief description (the main focus) of each stage, followed by a practical application according to the key aspects below.

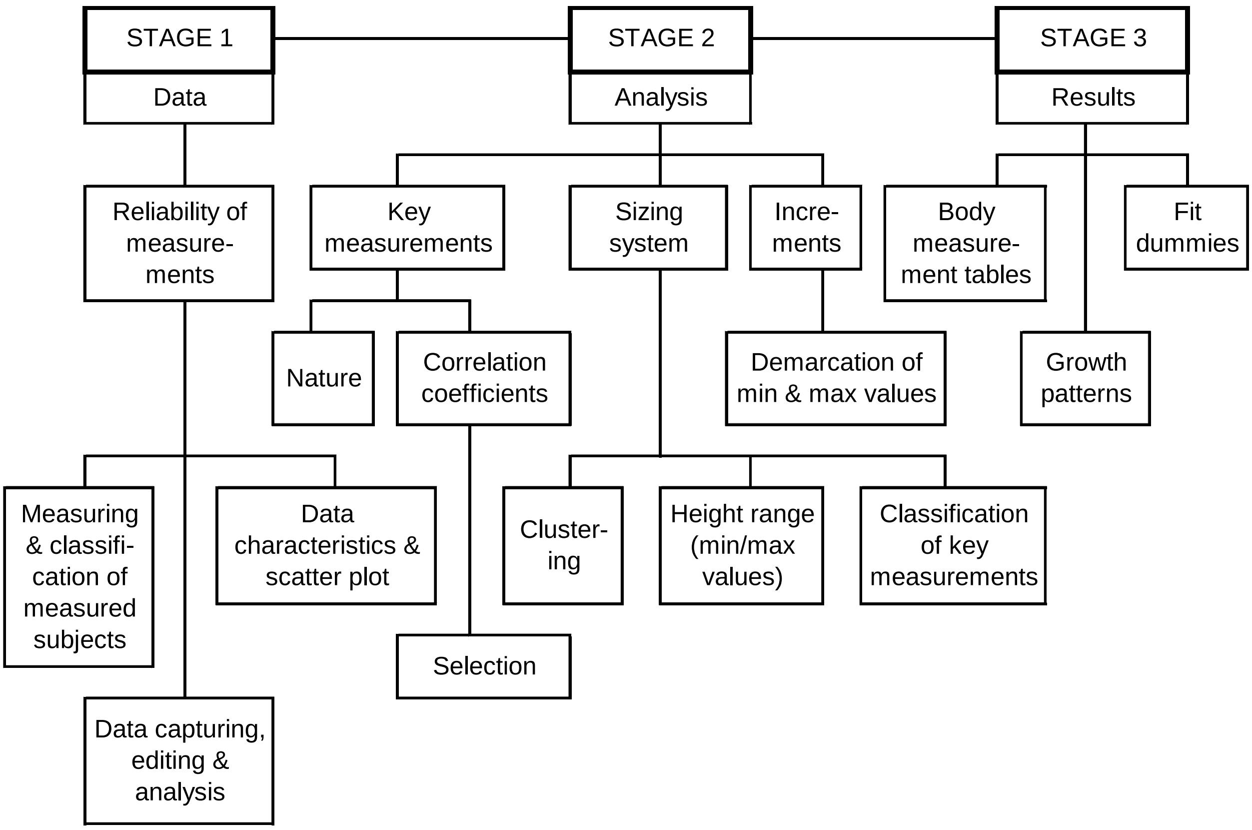


FIGURE 4.1: FLOW DIAGRAM OF THE STAGES IN THE ANALYSIS OF THE ANTHROPOMETRIC DATA

Focusing on the reliability of data, the process starts with the identification of the most important measurements and measurement practices pertaining to the purposes of this study. The aim was to ensure the reliability and accuracy of the raw data. These aspects have been discussed in depth in paragraphs 2.10.3.4 and 3.6.6.4.2. Following the raw data collection, all data was transferred to an Excel spreadsheet. The Statistica version 7 computer package of Statsoft Inc. was used by the Centre for Statistical Consultation at Stellenbosch University to analyse the anthropometric data recorded. The data set was cleaned up by correcting all obvious inconsistencies. Errors were identified and corrected, after which measurements were classified. All captured data was finally presented in the form of a scatter plot with the heights plotted against age (paragraph 4.2.3).

The second stage in the analysis of the anthropometric data was to identify key measurements by establishing the strengths of the relationships between measurements through correlation coefficients. To measure the strengths of the relationships between the different body measurements, a scale for correlations was developed and implemented as described in paragraph 4.2.3. A first screening was executed to identify important measurements that were good predictors of measurements of other parts of the body, as well as measurements important in fit dummy development, pattern drafting and garment development. A second screening was performed to select a shortlist of seven key measurements that are good predictors of size and represent the entire body.

In the third and final stage, the key measurements were categorised in order to develop the body measurement tables for fit dummy prototype development. It is important to note that the final body measurement tables for size chart development could only be confirmed on completion of the fit dummies. According to Otieno and Fairhurst (2000b: 161) the procedures used in size chart development from raw data are very important, and this process should be meticulously done, step-by-step, to prevent error and to support the validity and reliability of the results. In the execution of the final stage of the statistical analysis, mean values and standard deviations were used to develop body measurement tables and size charts. This information was applied in the development of new sizing systems for children’s wear in South Africa. Further analysis was done to finalise body measurement tables suitable for fit dummy prototype development. For the purposes of this study, the actual fit dummy prototype development was a continuation and application of the results to illustrate how proposed sizing systems and body measurement tables compiled during the study can be successfully implemented.

4.2 RELIABILITY OF MEASUREMENTS

4.2.1 Measuring and classification of subjects measured

The measuring methodology was discussed in depth in Chapter 3. All aspects of measuring and data collection, as described in the Field Worker Manual (Appendix 5) were followed consistently throughout the execution of the final empirical study. Reliability and accuracy of measurements were monitored during the entire measuring period and all measurements were taken with a measurement error of no more than 0.5 cm on the length, width and breadth measurements (paragraph 3.6.6.4.2). Forty-seven (47) direct measurements of each subject (including weight) were taken manually and a further eight were derived from these during analyses as recommended in Table 2.4.

Healthy South African boys and girls between the ages of two and 14 years were measured. These children were categorised according to gender (male or female), age (2-14 years) and sector (Black or Non-Black). Measurement charts of male (recorded as gender 1) and female (recorded as gender 2) children were separated from the start. The child's actual age on the day of measuring was recorded on measurement charts and each child's measurements fell within one of 13 age groups. They were, consequently, classified according to age. Children speaking a black indigenous African language as mother tongue were categorised as Black (sector 1, recorded as S1) while all others were categorised as Non-Black (sector 2, recorded as S2) (paragraph 3.6.2 & Table 3.5). This classification was confirmed on location on the day of measuring by the supervisor. All statistical analyses were done based on this specific classification of the subjects.

4.2.2 Editing of data during capturing and for analysis

A total of 2679 body measurement data sheets were completed during measuring and manual data gathering. The editing of these recorded body measurement data sheets took place in three phases. *Initially*, the supervisor edited the personal data of each child before the child was measured to confirm gender, age and population affiliation. Age was recorded as that on the actual day of measuring, while population affiliation was confirmed according to the child's home language. The *second phase* was to edit the recorded body measurements daily on site. Scribes verified the consistency of measurements of the previous scribe, identifying obvious faults. (This aspect of verification was discussed, practiced and confirmed as part of the training and orientation of the fieldworkers.) The supervisor signed each sheet off as correct and fully complete only once all field workers confirmed it. The *last phase* was the daily spot checks which the researcher had done to confirm that no obvious mistakes were made. Where problems were identified, they were addressed and corrected by speaking to the measuring team before the next day's measuring started. By implementing quality control measures throughout the phases described above in paragraph 2.10.3.3, it was possible to identify significant sources of variance during measuring.

Once the measuring and raw data collection had been completed in the field, all manually recorded and hand written measurement charts were handed to a statistician for electronic capturing in an Excel document. During the first screening the captured data was cleaned up from possible data capture errors. Fifty nine (59) cases were queried and compared against the original data sheets. Thereafter, during a second screening of the captured data, a 10% sample of cases was randomly selected and checked against the original written data sheets for errors and omissions (UniSearch, 2000:4). Fifteen (15) such cases were identified. It was, however, possible to correct the measurements after communications with the field workers involved. Inconsistencies of the recorded body measurements were classified as either omissions or errors. Omissions occurred, for example, when disabled children had been measured to prevent embarrassment on the day of measurement. There was one such case. Another case of omission was on a data sheet where more than two thirds of the measurements had not been filled in and the error could not be resolved through correspondence with the field workers. Errors were recorded when the recorded measurements seemed to be incorrect, such as when the hip height was greater than the waist height or measurements were too big or too small in comparison with those of the peers.

A total of 2677 measurement data sheets were finally used for electronic data capturing. At this stage, a final screening was conducted to perform further checks to clean up the data. Auto filters were set on all columns to identify the minimum and maximum values of the data. Where a zero had been captured, it was treated as a data capturing error and changed to an empty cell, depending on the type of measurement. If not applicable to the specific measurement, it was excluded from the data set. Doing spot checks also assessed the other measurements and contributed to identifying measurements as being unrealistic for the specific measurement recorded. If irrelevant, the data was either corrected or excluded. A further check was done to identify typical female measurements, such as under bust and nape to under bust, under the data captured for boys. Where these occurred they were either corrected or removed from the data set. The final number of measurement data sheets recorded was 2675 (1313 boys and 1364 girls), since the data sets of two forms was excluded for the reasons mentioned above.

4.2.3 Characteristics and scatter plot of the data

The data consisted of non-parametric, ordinal continuous data and was based on the 55 measurements of which 47 (including weight) were direct measurements (Appendix 5b). The remaining eight measurements were calculated, being derived from the direct measurements. Three independent variables were used in the data set, with age (13 categories varying from ages two to 14 years) as an interval variable and gender (male and female) and population affiliation (black and non-black) as two different normal variables. All analyses were based on these 13 categories, representing the 13 age groups that will be analysed separately for boys and girls.

The first form of data analysis was done by means of a scatter plot of data. This visual display of the data sets was done with height measurements plotted against age in a scatter diagram for critical investigation. Figures 4.2 and 4.3 display the individual data points that are represented in a two-dimensional space, where the height measurements (on the vertical or Y-axis) of boys and girls are plotted separately against the thirteen ages measured (on the horizontal or X-axis). The X and Y co-ordinates determine the location of each point corresponding to its specific values of the two variables age and height. The mean heights of the age groups were connected. The more densely filled area indicates that more children of a particular age have similar measurements. The extremes in each age group will be furthest above and below the line.

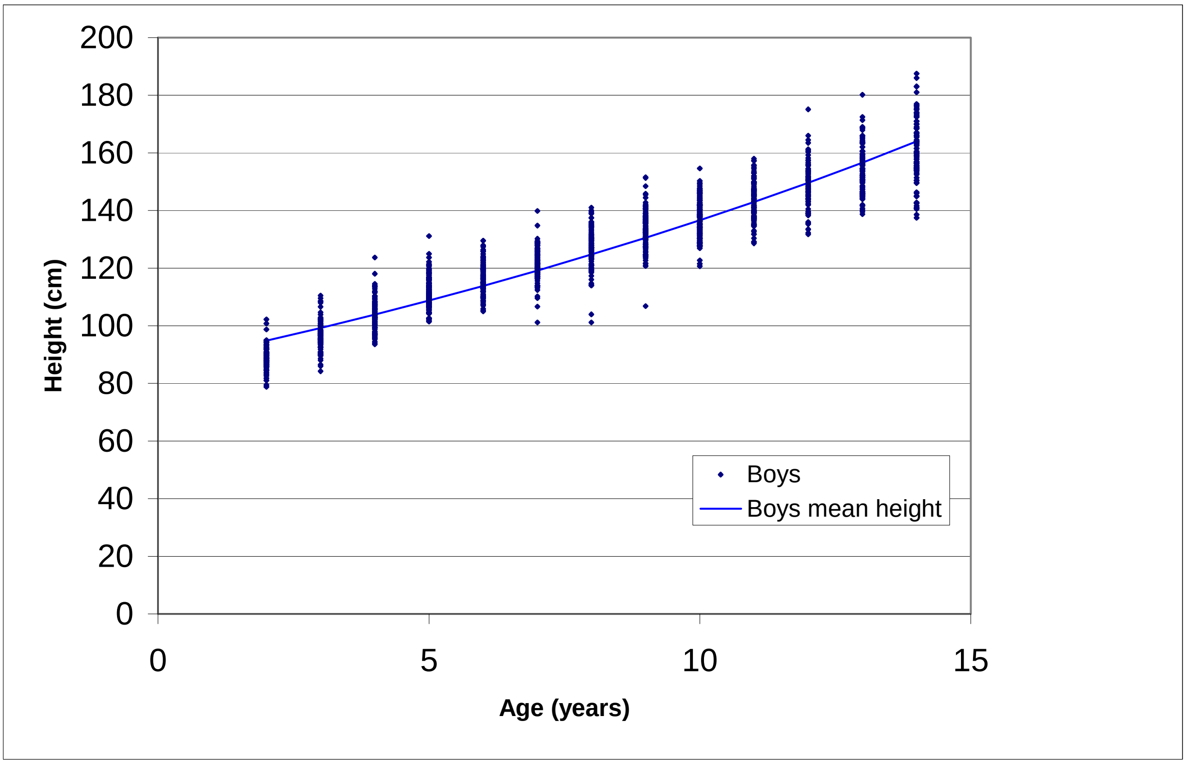


FIGURE 4.2: INCREASE IN MEAN HEIGHT FOR BOYS WITH HEIGHT MEASUREMENTS SCATTERED AND DISTRIBUTED AT INDIVIDUAL AGES

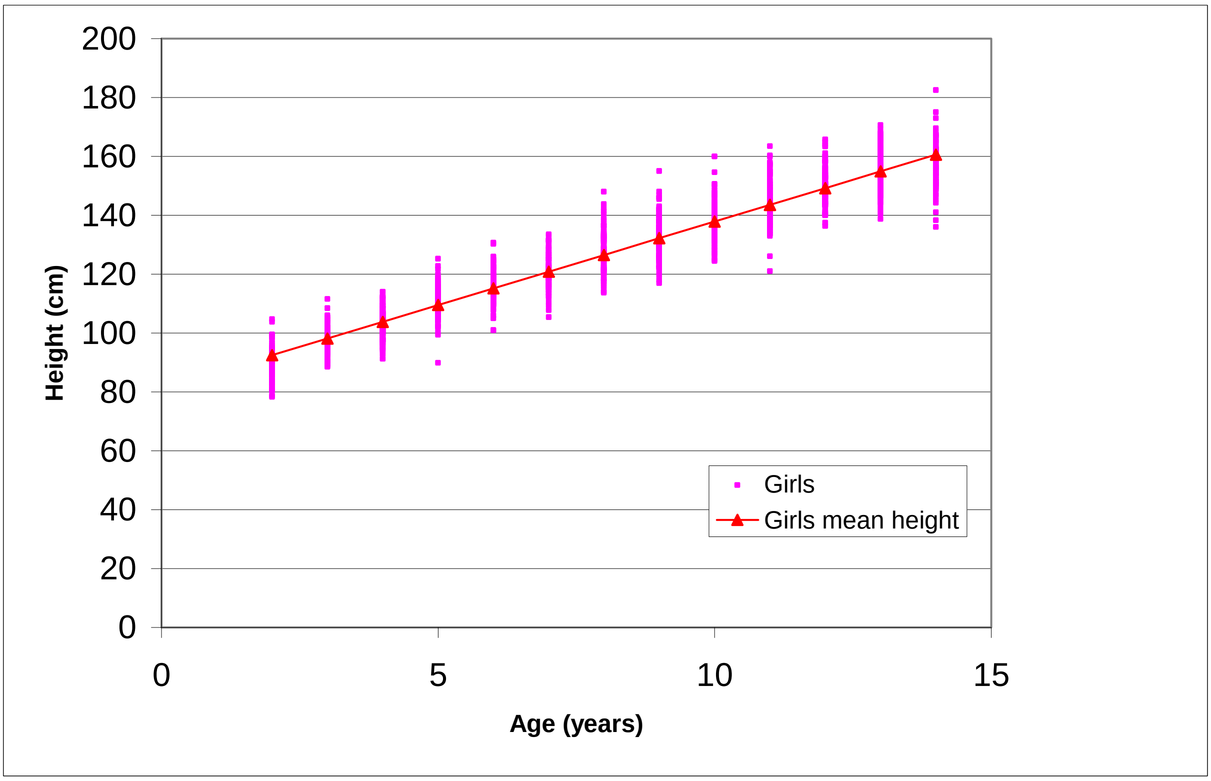


FIGURE 4.3: INCREASE IN MEAN HEIGHT FOR GIRLS WITH HEIGHT MEASUREMENTS SCATTERED AND DISTRIBUTED AT INDIVIDUAL AGES

The variation and scatter of the height measurements at each age for both boys and girls are displayed in Figure 4.4. There appears to be a bigger variation between the minimum and maximum values of the height measurements of girls than that of boys at most ages. This indicates smaller height variation and measurement distribution for boys at any given age in comparison with that of girls, but it is evident that the biggest variance is at age 14 for both boys and girls.

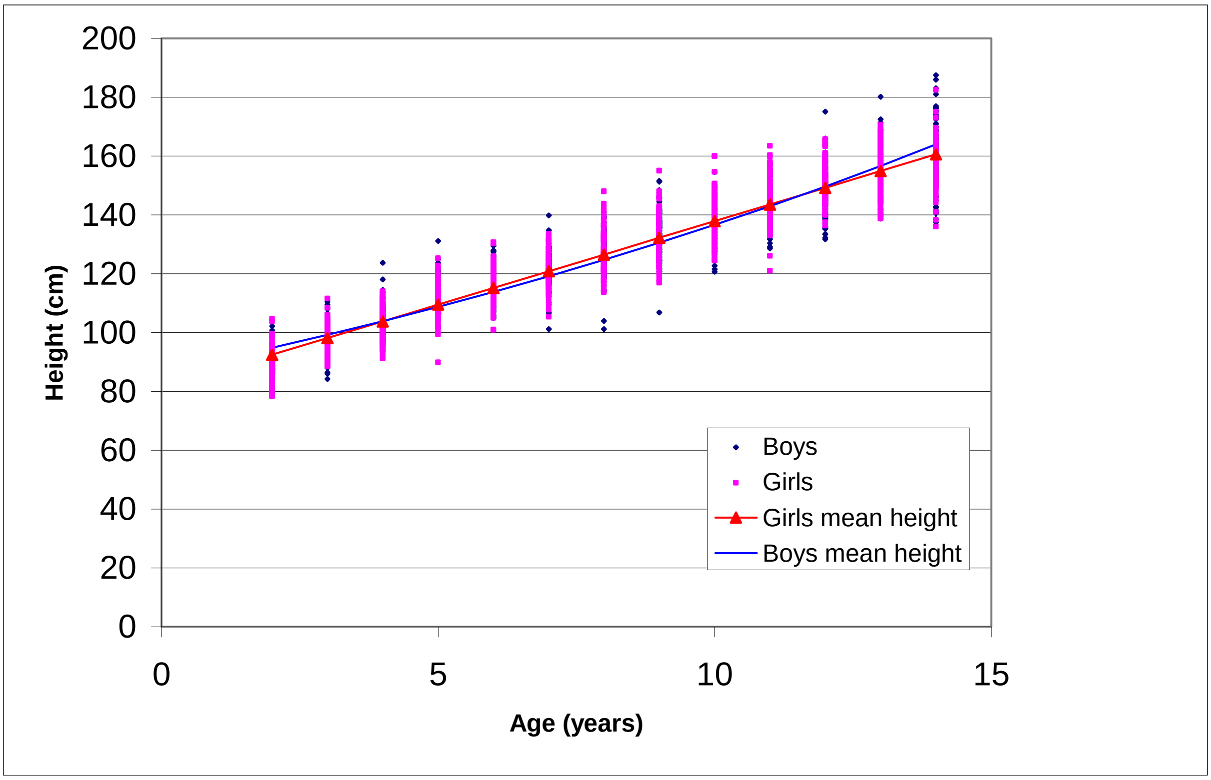


FIGURE 4.4: INCREASE IN MEAN HEIGHT FOR BOTH BOYS AND GIRLS WITH HEIGHT MEASUREMENTS SCATTERED AND DISTRIBUTED AT INDIVIDUAL AGES

Furthermore, there appears to be an extensive overlap in height measurements between the different age groups of the two genders. This visual display of the extent of the overlap does indicate that age is not necessarily suitable as a size indicator and a basis for a sizing system for children, when a height measurement is plotted on the y-axis. However, to start with the development of a sizing system, it is important to first find key measurements or combination of measurements upon which a classification can be formulated (O'Brien *et al.*, 1941:29). The next section deals with these aspects in terms of the South African context, with the analysis focusing on the development of a sizing system.

4.3 KEY MEASUREMENTS

4.3.1 Nature

Through the years various researchers have established different theories regarding the importance of key measurements and application thereof. As reported by Otieno and Fairhurst (2000a: 147) key measurements should be balanced between the upper and lower torsos. A key measurement should also be a body measurement with strong relationships with most other body dimensions important to the garment, which by implication indicate that key measurements are important in the development of sizing systems and finally the development of fit dummy prototypes. It is further reported by Otieno and Fairhurst, that according to Yoon and Jasper (1996), key measurements can be good predictors of the size of other parts of the body. Key measurements should be easy to measure. The criteria for key measurements vary and there are various methods to be established in this regard. By using correlation coefficients it could be possible to identify key measurements to use for the development of sizing systems, as well as body measurement tables and size charts. Correlation coefficient values indicate the strength of linear relationships between variables (Otieno & Fairhurst, 2000a: 146) and were, as such, implemented in this study. The variables (represented by measurements) under study refer to body measurements, including age and weight.

4.3.2 Selection based on correlation coefficients

The Pearson correlation coefficient (r) is a measure of the strength of the linear relationship between two random variables. Correlation coefficients are independent of the specific measurement units used, which means that the correlation, for example between age, height and weight can be compared regardless of the applicable measurement units. Correlation coefficients range from -1.00 to +1.00. The value of –1.00 represents a perfect negative correlation (indicating a perfect negative linear relationship between variables) and a value of +1.00 represents a perfect positive correlation (indicating a perfect positive linear relationship between variables). A value of 0.00 reflects no correlation (no linear relationship) between the respective variables.

To identify the most significant correlations in this study, the correlation coefficient (r) of each variable with every other variable was calculated. Since in this study all variables are positively correlated with all others, the value of the correlation is the determining indicator of the strength of the positive linear relationship between pairs of variables. The following arbitrary scale for correlations was implemented to indicate the strength of the relationship between variables:

1. $0 \leq r \leq 0.4$ indicated a weak, but positive relationship,
2. $0.5 \leq r \leq 0.74$ indicated a medium strong positive relationship,
3. $0.75 \leq r \leq 0.84$ indicated a strong positive relationship, and
4. $0.85 \leq r < 1$ indicated a very strong positive relationship.

Once the correlation coefficients had been calculated, and since all are positive, the variables could be ranked in a descending order of the mean of the correlations with all other variables as illustrated in Table 4.1. In this study variables have been referred to as body measurements, including age. These “variables” or “measurements” should not be confused with the term measurements on a particular variable. The terms “variable” and “measurement” are synonymous in this study and both terms will be used where appropriate.

Out of the 56 variables (measurements), nine indicated a very strong positive relationship ($0.85 \leq r < 1$) with all others, while 35 indicated a strong positive relationship ($0.75 \leq r \leq 0.84$). Of the remainder, 10 indicated a medium strong positive relationship ($0.5 \leq r \leq 0.74$) with all others. In descending order, these variables or measurements were all good indicators of size due to the strength of the relationships with all the other variables. The remaining two variables, namely *nape to under bust point* and *under bust circumference* measurements indicated a weak, but positive relationship ($r < 0.5$). These variables could be ignored, since they were only measured on girls.

Fifty-six (56) variables are too many to be considered as key measurements, therefore, by means of elimination and based on the strength of the correlation coefficients; a shortlist of 27 measurements was compiled as key measurements.

TABLE 4.1: RANKING OF MEAN CORRELATION COEFFICIENTS OF EACH VARIABLE (MEASUREMENT) WITH ALL OTHER VARIABLES (MEASUREMENTS)

RANKING	VARIABLE	STRENGTH OF RELATIONSHIP
1	Vertical trunk	Very strong ($0.85 \leq r < 1$)
2	Height	
3	Nape to floor	
4	Waist to floor	
5	Scye depth	
6	Shoulder to elbow (straight)	
7	Hip to floor	
8	Weight	
9	Shoulder to wrist (straight)	
10	Shoulder to wrist (bent)	Strong ($0.75 \leq r \leq 0.84$)
11	Hip circumference	
12	Crutch to floor	
13	Shoulder to elbow (bent)	
14	Knee (bent) circumference	
15	Knee to floor	
16	Shoulder circumference	
17	Knee (straight) circumference	
18	Crutch length	
19	Elbow (bent) circumference	
20	Calf length	
21	Mid calf position	
22	Calf circumference	
23	Bust / Chest circumference	
24	Ankle circumference	
25	Shoulder breadth	
26	Thigh length	
27	Mid thigh position	
28	Elbow (straight) circumference	
29	Age	
30	Hand width	
31	Nape to shoulder	
32	Thigh circumference	
33	Armhole circumference	
34	Neck base circumference	
35	Nape to waist	
36	Nape to bust point	
37	Instep & heel circumference	
38	Stern to waist	
39	Shoulder length	
40	Across back	
41	Crutch depth	
42	Head arc	
43	Ankle to floor	
44	Waist circumference	
45	Inter-nipple position	Medium strong ($0.5 \leq r \leq 0.74$)
46	Neck circumference	
47	Biceps circumference	
48	Across front	
49	Wrist circumference	
50	Waist to hip	
51	Cervical brow	
52	Head height	
53	Head circumference	
54	Back neck width	
55	Nape to under bust girls	Weak ($r < 0.5$)
56	Under bust girls	

The 27 key measurements were selected because they were representative of the total body, and primarily based on the strength of their relationships with all other variables, that varied from very strong to medium strong. The stronger the relationships, the more important the measurements were in determining the size of children. These were also good predictors of the size of other parts of the body and therefore became a good choice as key measurements. Most of these key measurements selected were easy to measure and important in fit dummy development, in pattern drafting as well as in garment development. In the final selection of key measurements, more upper torso measurements were selected since they appeared to have stronger relationships with all others in comparison with the lower torso.

An almost even number of vertical (11) and horizontal (10) measurements were included in the selection based on the value of the correlation coefficients and the strength of their relationships with other measurements. The most important vertical measurements were of the vertical trunk and height, nape to floor and waist to floor while horizontal measurements, such as hip, shoulder and chest/bust circumferences were selected. In addition to the 11 vertical and length measurements as well as 10 horizontal measurements, three width (across front, shoulder breadth and across back) and three additional measurements (age, weight and vertical trunk) were selected.

Weight, vertical trunk, height, nape to floor, scye depth, waist to floor, knee to floor and shoulder to wrist (measured straight) were selected because they had very strong positive relationships ($0.85 \leq r < 1$) with all other measurements. This means that these measurements were good predictors of size, and with landmarks correctly located, these measurements can easily and accurately be measured. All of these, except for weight, are important in fit dummy development, pattern drafting and garment development. Of the selection of eight body measurements, excluding weight, six are upper torso measurements while one is a lower torso measurement. Age, neck base circumference, armhole circumference, shoulder circumference, chest circumference, waist circumference, hip circumference, thigh circumference, crutch to floor, knee to floor, nape to waist, nape to bust point, across front, shoulder breadth and across back all had strong positive relationships ($0.75 \leq r \leq 0.84$) with all other measurements. Although these measurements were more difficult to measure, with landmarks being more difficult to locate, they were also good predictors of size. Except for age, all were important measurements in fit dummy development, pattern drafting and garment development. Of the selection of 15 measurements, excluding age, 11 were upper torso measurements while three were lower torso measurements. Head circumference, biceps circumference, wrist circumference and waist to hip had all medium strong positive relationships will all other measurements. Although relatively easy to measure accurately, the selection of these measurements was based on their importance in the development of fit dummy prototypes, pattern drafting and garment development. All four measurements were upper torso measurements. The correlation coefficients of the sets of measurements on which the selection was based as described above are included as Table 4.2 for boys and Table 4.3 for girls, respectively. All the correlation coefficients indicating very strong relationships with other measurements were highlighted in bold type.

For boys, height (mean $r = 0.89$), vertical trunk (mean $r = 0.89$) and nape to floor (mean $r = 0.88$) measurements, in descending order, had the highest correlation coefficients indicating the strongest relationships with all other measurements. Height had a very strong relationship ($0.85 \leq r < 1$) with 20 of the selected key measurements, vertical trunk measurement had a very strong relationship with 21 of the key measurements, while nape to floor had a very strong relationship with 20 key measurements. For girls, however, vertical trunk (mean $r = 0.88$), nape to floor (mean $r = 0.87$) and height (mean $r = 0.87$) measurements, in descending order, had the highest correlation coefficients. Vertical trunk measurements had a very strong relationship ($0.85 \leq r < 1$) with 21 of the selected key measurements. The nape to floor measurement had a very strong relationship with 19 of the key measurements while height also had a very strong relationship with 19 of the selected key measurements. For both genders, hip (boys: mean $r = 0.87$ and girls: mean $r = 0.86$) size was the horizontal measurement with the highest correlation coefficient, indicating a very strong relationship with all other measurements, yet the relationship was not as strong as that of the abovementioned vertical measurements. The hip measurement of both boys and girls had a very strong relationship ($0.85 \leq r < 1$) with 22 of the selected key measurements. These measurements have been highlighted in Table 4.2 for boys, and Table 4.3 for girls, respectively.

TABLE 4.2: CORRELATIONS OF 27 MEASUREMENTS ON A SAMPLE OF 1313 BOYS (2-14 years old)

BOYS (2-14 years)

		Age	Weight	Vertical trunk	Head circumference	Neck base circumference	Armhole circumference	Shoulder circumference	Chest circumference	Waist circumference	Hip circumference	Biceps circumference	Wrist circumference	Thigh circumference	Height	Nape to floor	Crutch to floor	Scye depth	Waist to floor	Hip to floor	Knee to floor	Nape to waist	Waist to hip	Nape to bust point	Shoulder to wrist (straight)	Across front	Shoulder breadth	Across back
1	Age		**0.85**	**0.90**	0.67	0.83	0.78	0.83	0.82	0.71	**0.85**	0.64	0.63	0.80	**0.94**	**0.95**	**0.95**	**0.94**	**0.95**	**0.95**	**0.94**	**0.87**	0.67	0.81	**0.92**	0.76	**0.86**	0.80
2	Weight	**0.85**		**0.96**	0.74	**0.91**	**0.91**	**0.94**	**0.94**	**0.90**	**0.97**	0.84	0.77	**0.93**	**0.93**	**0.93**	**0.89**	**0.91**	**0.92**	**0.91**	**0.90**	**0.86**	0.72	**0.90**	**0.91**	0.83	**0.90**	**0.87**
3	Vertical trunk	**0.90**	**0.96**		0.75	**0.90**	**0.91**	**0.93**	**0.93**	**0.85**	**0.95**	0.78	0.75	**0.90**	**0.97**	**0.97**	**0.94**	**0.95**	**0.96**	**0.95**	**0.93**	**0.92**	0.73	**0.90**	**0.95**	0.81	**0.92**	**0.87**
4	Head circumference	0.67	0.74	0.75		0.69	0.69	0.71	0.73	0.69	0.75	0.61	0.56	0.72	0.74	0.73	0.72	0.72	0.73	0.72	0.72	0.67	0.55	0.68	0.72	0.66	0.70	0.65
5	Neck base circumference	0.83	**0.91**	**0.90**	0.69		**0.85**	**0.88**	**0.87**	0.81	**0.88**	0.73	0.71	0.84	**0.89**	**0.89**	**0.86**	**0.88**	**0.89**	**0.87**	**0.87**	0.82	0.68	**0.87**	**0.87**	0.77	**0.87**	0.84
6	Armhole circumference	0.78	**0.91**	**0.91**	0.69	**0.85**		**0.90**	**0.91**	**0.87**	**0.91**	0.82	0.75	**0.88**	**0.87**	**0.87**	0.82	0.84	**0.86**	**0.85**	0.83	0.83	0.64	**0.87**	**0.87**	0.73	**0.85**	0.84
7	Shoulder circumference	0.83	**0.94**	**0.93**	0.71	**0.88**	**0.90**		**0.93**	**0.88**	**0.94**	0.82	0.75	**0.90**	**0.90**	**0.90**	**0.86**	**0.88**	**0.89**	**0.88**	**0.87**	0.84	0.69	**0.88**	**0.89**	0.79	**0.90**	**0.87**
8	Chest circumference	0.82	**0.94**	**0.93**	0.73	**0.87**	**0.91**	**0.93**		**0.90**	**0.94**	0.82	0.75	**0.90**	**0.89**	**0.89**	**0.86**	**0.87**	**0.88**	**0.87**	**0.86**	0.84	0.67	**0.89**	**0.89**	0.79	**0.88**	**0.86**
9	Waist circumference	0.71	**0.90**	**0.85**	0.69	0.81	**0.87**	**0.88**	**0.90**		**0.91**	0.83	0.72	**0.89**	0.79	0.79	0.75	0.77	0.79	0.77	0.76	0.73	0.62	0.83	0.79	0.73	0.80	0.79
10	Hip circumference	**0.85**	**0.97**	**0.95**	0.75	**0.88**	**0.91**	**0.94**	**0.94**	**0.91**		**0.85**	0.76	**0.96**	**0.92**	**0.92**	**0.89**	**0.90**	**0.92**	**0.90**	**0.89**	**0.85**	0.71	**0.90**	**0.91**	0.82	**0.89**	**0.86**
11	Biceps circumference	0.64	0.84	0.78	0.61	0.73	0.82	0.82	0.82	0.83	**0.85**		0.72	0.80	0.71	0.71	0.67	0.69	0.71	0.70	0.68	0.66	0.57	0.77	0.70	0.67	0.73	0.73
12	Wrist circumference	0.63	0.77	0.75	0.56	0.71	0.75	0.75	0.75	0.72	0.76	0.72		0.70	0.71	0.71	0.67	0.70	0.70	0.69	0.68	0.68	0.55	0.72	0.70	0.62	0.72	0.69
13	Thigh circumference	0.80	**0.93**	**0.90**	0.72	0.84	**0.88**	**0.90**	**0.90**	**0.89**	**0.96**	0.80	0.70		**0.86**	**0.86**	0.83	0.84	**0.85**	0.84	0.83	0.78	0.66	**0.85**	**0.85**	0.79	0.84	0.81
14	Height	**0.94**	**0.93**	**0.97**	0.74	**0.89**	**0.87**	**0.90**	**0.89**	0.79	**0.92**	0.71	0.71	**0.86**		**1.00**	**0.99**	**0.99**	**0.99**	**0.99**	**0.98**	**0.93**	0.72	**0.88**	**0.98**	0.80	**0.93**	**0.87**
15	Nape to floor	**0.95**	**0.93**	**0.97**	0.73	**0.89**	**0.87**	**0.90**	**0.89**	0.79	**0.92**	0.71	0.71	**0.86**	**1.00**		**0.99**	**0.99**	**0.99**	**0.99**	**0.98**	**0.93**	0.72	**0.88**	**0.98**	0.80	**0.92**	**0.86**
16	Crutch to floor	**0.95**	**0.89**	**0.94**	0.72	**0.86**	0.82	**0.86**	**0.86**	0.75	**0.89**	0.67	0.67	0.83	**0.99**	**0.99**		**0.98**	**0.99**	**0.99**	**0.98**	**0.90**	0.70	0.84	**0.97**	0.79	**0.90**	0.83
17	Scye depth	**0.94**	**0.91**	**0.95**	0.72	**0.88**	0.84	**0.88**	**0.87**	0.77	**0.90**	0.69	0.70	0.84	**0.99**	**0.99**	**0.98**		**0.99**	**0.98**	**0.97**	**0.91**	0.72	**0.86**	**0.97**	0.80	**0.91**	**0.85**
18	Waist to floor	**0.95**	**0.92**	**0.96**	0.73	**0.89**	**0.86**	**0.89**	**0.88**	0.79	**0.92**	0.71	0.70	**0.85**	**0.99**	**0.99**	**0.99**	**0.99**		**0.99**	**0.98**	**0.91**	0.75	**0.87**	**0.97**	0.80	**0.91**	**0.86**
19	Hip to floor	**0.95**	**0.91**	**0.95**	0.72	**0.87**	**0.85**	**0.88**	**0.87**	0.77	**0.90**	0.70	0.69	0.84	**0.99**	**0.99**	**0.99**	**0.98**	**0.99**		**0.98**	**0.90**	0.65	**0.86**	**0.97**	0.79	**0.90**	0.84
20	Knee to floor	**0.94**	**0.90**	**0.93**	0.72	**0.87**	0.83	**0.87**	**0.86**	0.76	**0.89**	0.68	0.68	0.83	**0.98**	**0.98**	**0.98**	**0.97**	**0.98**	**0.98**		**0.89**	0.70	**0.85**	**0.96**	0.79	**0.89**	0.83
21	Nape to waist	**0.87**	**0.86**	**0.92**	0.67	0.82	0.83	0.84	0.84	0.73	**0.85**	0.66	0.68	0.78	**0.93**	**0.93**	**0.90**	**0.91**	**0.91**	**0.90**	**0.89**		0.66	0.82	**0.90**	0.70	**0.89**	0.83
22	Waist to hip	0.67	0.72	0.73	0.55	0.68	0.64	0.69	0.67	0.62	0.71	0.57	0.55	0.66	0.72	0.72	0.70	0.72	0.75	0.65	0.70	0.66		0.67	0.69	0.64	0.69	0.66
23	Nape to bust point	0.81	**0.90**	**0.90**	0.68	**0.87**	**0.87**	**0.88**	**0.89**	0.83	**0.90**	0.77	0.72	**0.85**	**0.88**	**0.88**	0.84	**0.86**	**0.87**	**0.86**	**0.85**	0.82	0.67		**0.87**	0.74	**0.87**	0.84
24	Shoulder to wrist (straight)	**0.92**	**0.91**	**0.95**	0.72	**0.87**	**0.87**	**0.89**	**0.89**	0.79	**0.91**	0.70	0.70	**0.85**	**0.98**	**0.98**	**0.97**	**0.97**	**0.97**	**0.97**	**0.96**	**0.90**	0.69	**0.87**		0.79	**0.90**	**0.85**
25	Across front	0.76	0.83	0.81	0.66	0.77	0.73	0.79	0.79	0.73	0.82	0.67	0.62	0.79	0.80	0.80	0.79	0.80	0.80	0.79	0.79	0.70	0.64	0.74	0.79		0.72	0.64
26	Shoulder breadth	**0.86**	**0.90**	**0.92**	0.70	**0.87**	**0.85**	**0.90**	**0.88**	0.80	**0.89**	0.73	0.72	0.84	**0.93**	**0.92**	**0.90**	**0.91**	**0.91**	**0.90**	**0.89**	**0.89**	0.69	**0.87**	**0.90**	0.72		**0.92**
27	Across back	0.80	**0.87**	**0.87**	0.65	0.84	0.84	**0.87**	**0.86**	0.79	**0.86**	0.73	0.69	0.81	**0.87**	**0.86**	0.83	**0.85**	**0.86**	0.84	0.83	0.83	0.66	0.84	**0.85**	0.64	**0.92**	

TABLE 4.3: CORRELATIONS OF 27 MEASUREMENTS ON A SAMPLE OF 1364 GIRLS (2-14 years old)

	GIRLS (2-14 years)	Age	Weight	Vertical trunk	Head circumference	Neck base circumference	Armhole circumference	Shoulder circumference	Bust circumference	Waist circumference	Hip circumference	Biceps circumference	Wrist circumference	Thigh circumference	Height	Nape to floor	Crutch to floor	Scye depth	Waist to floor	Hip to floor	Knee to floor	Nape to waist	Waist to hip	Nape to bust point	Shoulder to wrist (straight)	Across front	Shoulder breadth	Across back
1	Age		**0.86**	**0.92**	0.58	0.83	0.78	**0.86**	0.84	0.69	**0.87**	0.70	0.75	0.82	**0.94**	**0.94**	**0.95**	**0.95**	**0.94**	**0.94**	**0.93**	**0.87**	0.66	0.82	**0.93**	0.76	**0.87**	0.80
2	Weight	**0.86**		**0.96**	0.62	**0.88**	**0.88**	**0.96**	**0.95**	**0.90**	**0.98**	**0.91**	**0.85**	**0.96**	**0.90**	**0.90**	**0.88**	**0.89**	**0.90**	**0.89**	**0.88**	0.83	0.69	**0.90**	**0.90**	0.84	**0.88**	**0.86**
3	Vertical trunk	**0.92**	**0.96**		0.62	**0.88**	**0.89**	**0.95**	**0.93**	0.84	**0.96**	**0.86**	**0.85**	**0.93**	**0.95**	**0.96**	**0.93**	**0.95**	**0.95**	**0.93**	**0.92**	**0.90**	0.72	**0.90**	**0.95**	0.83	**0.91**	**0.87**
4	Head circumference	0.58	0.62	0.62		0.57	0.55	0.60	0.63	0.54	0.61	0.54	0.53	0.60	0.61	0.61	0.60	0.61	0.61	0.61	0.61	0.56	0.44	0.51	0.61	0.55	0.58	0.53
5	Neck base circumference	0.83	**0.88**	**0.88**	0.57		**0.85**	**0.87**	**0.86**	0.76	**0.86**	0.78	0.78	0.83	**0.90**	**0.89**	**0.87**	**0.89**	**0.89**	**0.88**	**0.87**	0.82	0.67	**0.85**	**0.85**	0.76	0.84	0.82
6	Armhole circumference	0.78	**0.88**	**0.89**	0.55	**0.85**		**0.91**	**0.88**	0.83	**0.88**	**0.87**	0.83	**0.87**	**0.86**	**0.86**	0.83	0.84	**0.86**	0.84	0.83	0.82	0.64	0.84	0.84	0.74	0.83	0.81
7	Shoulder circumference	**0.86**	**0.96**	**0.95**	0.60	**0.87**	**0.91**		**0.96**	**0.90**	**0.96**	**0.92**	**0.86**	**0.95**	**0.89**	**0.90**	**0.87**	**0.88**	**0.90**	**0.88**	**0.87**	0.83	0.67	**0.90**	**0.90**	0.83	**0.91**	**0.89**
8	Bust circumference	0.84	**0.95**	**0.93**	0.63	**0.86**	**0.88**	**0.96**		**0.89**	**0.94**	**0.89**	0.84	**0.92**	**0.87**	**0.87**	**0.85**	**0.86**	**0.87**	**0.86**	0.84	0.82	0.65	**0.88**	**0.88**	0.82	**0.87**	**0.86**
9	Waist circumference	0.69	**0.90**	0.84	0.54	0.76	0.83	**0.90**	**0.89**		**0.90**	**0.92**	0.77	**0.91**	0.73	0.74	0.71	0.72	0.74	0.72	0.72	0.66	0.58	0.81	0.76	0.77	0.77	0.79
10	Hip circumference	**0.87**	**0.98**	**0.96**	0.61	**0.86**	**0.88**	**0.96**	**0.94**	**0.90**		**0.92**	**0.85**	**0.98**	**0.90**	**0.90**	**0.88**	**0.89**	**0.90**	**0.89**	**0.88**	0.83	0.69	**0.90**	**0.91**	0.84	**0.88**	**0.86**
11	Biceps circumference	0.70	**0.91**	**0.86**	0.54	0.78	**0.87**	**0.92**	**0.89**	**0.92**	**0.92**		0.83	**0.94**	0.75	0.76	0.72	0.74	0.76	0.74	0.73	0.70	0.60	0.82	0.77	0.77	0.78	0.79
12	Wrist circumference	0.75	**0.85**	**0.85**	0.53	0.78	0.83	**0.86**	0.84	0.77	**0.85**	0.83		0.82	0.80	0.80	0.78	0.79	0.80	0.79	0.78	0.77	0.59	0.79	0.80	0.72	0.80	0.77
13	Thigh circumference	0.82	**0.96**	**0.93**	0.60	0.83	**0.87**	**0.95**	**0.92**	**0.91**	**0.98**	**0.94**	0.82		**0.85**	**0.86**	0.84	**0.85**	**0.86**	**0.85**	0.83	0.77	0.66	**0.87**	**0.87**	0.83	**0.85**	0.83
14	Height	**0.94**	**0.90**	**0.95**	0.61	**0.90**	**0.86**	**0.89**	**0.87**	0.73	**0.90**	0.75	0.80	**0.85**		**1.00**	**0.99**	**0.99**	**0.99**	**0.98**	**0.98**	**0.93**	0.72	**0.86**	**0.96**	0.78	**0.90**	0.84
15	Nape to floor	**0.94**	**0.90**	**0.96**	0.61	**0.89**	**0.86**	**0.90**	**0.87**	0.74	**0.90**	0.76	0.80	**0.86**	**1.00**		**0.99**	**0.99**	**0.99**	**0.99**	**0.98**	**0.93**	0.72	**0.86**	**0.96**	0.78	**0.91**	0.84
16	Crutch to floor	**0.95**	**0.88**	**0.93**	0.60	**0.87**	0.83	**0.87**	**0.85**	0.71	**0.88**	0.72	0.78	0.84	**0.99**	**0.99**		**0.99**	**0.99**	**0.99**	**0.98**	**0.90**	0.70	0.83	**0.96**	0.77	**0.89**	0.82
17	Scye depth	**0.95**	**0.89**	**0.95**	0.61	**0.89**	0.84	**0.88**	**0.86**	0.72	**0.89**	0.74	0.79	**0.85**	**0.99**	**0.99**	**0.99**		**0.99**	**0.99**	**0.98**	**0.92**	0.72	**0.85**	**0.96**	0.78	**0.89**	0.82
18	Waist to floor	**0.94**	**0.90**	**0.95**	0.61	**0.89**	**0.86**	**0.90**	**0.87**	0.74	**0.90**	0.76	0.80	**0.86**	**0.99**	**0.99**	**0.99**	**0.99**		**0.99**	**0.98**	**0.90**	0.73	**0.85**	**0.96**	0.79	**0.90**	0.84
19	Hip to floor	**0.94**	**0.89**	**0.93**	0.61	**0.88**	0.84	**0.88**	**0.86**	0.72	**0.89**	0.74	0.79	**0.85**	**0.98**	**0.99**	**0.99**	**0.99**	**0.99**		**0.98**	**0.90**	0.63	0.84	**0.96**	0.78	**0.89**	0.82
20	Knee to floor	**0.93**	**0.88**	**0.92**	0.61	**0.87**	0.83	**0.87**	0.84	0.72	**0.88**	0.73	0.78	0.83	**0.98**	**0.98**	**0.98**	**0.98**	**0.98**	**0.98**		**0.89**	0.69	0.83	**0.95**	0.77	**0.88**	0.81
21	Nape to waist	**0.87**	0.83	**0.90**	0.56	0.82	0.82	0.83	0.82	0.66	0.83	0.70	0.77	0.77	**0.93**	**0.93**	**0.90**	**0.92**	**0.90**	**0.90**	**0.89**		0.66	0.80	**0.88**	0.68	**0.87**	0.81
22	Waist to hip	0.66	0.69	0.72	0.44	0.67	0.64	0.67	0.65	0.58	0.69	0.60	0.59	0.66	0.72	0.72	0.70	0.72	0.73	0.63	0.69	0.66		0.66	0.68	0.61	0.66	0.63
23	Nape to bust point	0.82	**0.90**	**0.90**	0.51	**0.85**	0.84	**0.90**	**0.88**	0.81	**0.90**	0.82	0.79	**0.87**	**0.86**	**0.86**	0.83	**0.85**	**0.85**	0.84	0.83	0.80	0.66		**0.86**	0.76	**0.85**	0.83
24	Shoulder to wrist (straight)	**0.93**	**0.90**	**0.95**	0.61	**0.85**	0.84	**0.90**	**0.88**	0.76	**0.91**	0.77	0.80	**0.87**	**0.96**	**0.96**	**0.96**	**0.96**	**0.96**	**0.96**	**0.95**	**0.88**	0.68	**0.86**		0.80	**0.89**	0.84
25	Across front	0.76	0.84	0.83	0.55	0.76	0.74	0.83	0.82	0.77	0.84	0.77	0.72	0.83	0.78	0.78	0.77	0.78	0.79	0.78	0.77	0.68	0.61	0.76	0.80		0.71	0.66
26	Shoulder breadth	**0.87**	**0.88**	**0.91**	0.58	0.84	0.83	**0.91**	**0.87**	0.77	**0.88**	0.78	0.80	**0.85**	**0.90**	**0.91**	**0.89**	**0.89**	**0.90**	**0.89**	**0.88**	**0.87**	0.66	**0.85**	**0.89**	0.71		**0.92**
27	Across back	0.80	**0.86**	**0.87**	0.53	0.82	0.81	**0.89**	**0.86**	0.79	**0.86**	0.79	0.77	0.83	0.84	0.84	0.82	0.82	0.84	0.82	0.81	0.81	0.63	0.83	0.84	0.66	**0.92**	

Vertical measurements generally had stronger relationships with all other measurements than horizontal measurements. Eight of the nine highest ranking measurements with very strong relationships ($0.85 \leq r < 1$) with all other measurements were vertical measurements as depicted in Table 4.1. This indicated vertical measurements as the best size indicators and best predictors of other measurements when measuring growing children. Weight was ranked eighth with a very strong relationship with all other measurements. Age was less correlated with all those measurements which had a strong relationship ($0.75 \leq r \leq 0.84$) with each other. Since weight is not a measurement that is applicable for fit dummy development, pattern drafting or garment development, these values were ignored, as predictors of size. Age, on the other hand, was included for practical reasons and because it is internationally the best known, and traditionally the most used, indicator of size when buying children's clothes.

In the study by O'Brien *et al.* (1941: 36) eight variables (measurements) were selected as the most important key measurements. With similarities in the analysis and following the selection procedures in this study, age (boys and girls mean r = 0.83) and seven key measurements were identified from the twenty-seven important measurements. The only difference between the results of the two studies was that weight, which was included in the 1941 study, was replaced by shoulder circumference in this particular study. The seven selected key measurements were: vertical trunk (boys mean r = 0.89 and girls mean r = 0.88), height (boys mean r = 0.89 and girls mean r = 0.87), waist to floor (boys mean r = 0.88 and girls mean r = 0.87), shoulder to wrist measured straight (boys mean r = 0.87 and girls mean r = 0.86), hip circumference (boys mean r = 0.87 and girls mean r = 0.86), chest circumference (boys mean r = 0.85) or bust circumference (girls mean r = 0.84) and shoulder circumference (boys mean r = 0.85 and girls mean r = 0.86). Age is the least correlated with all measurements, and is therefore not a good predictor of size. The other seven measurements all adhered to all the abovementioned criteria and were generally good predictors of size whilst representing the total body. Vertical trunk is the size indicator of the upper torso length, but is a very difficult measurement to measure consistently and accurately, due to the lack of and difficult location of landmarks. Height is a measurement that could easily be measured consistently and accurately with ease and success, while waist to floor indicates the length of the lower torso. Hip circumference has a very strong relationship with all other measurements and can be measured more accurately than bust/chest circumference, because it is measured at a consistent bony point of the body.

On the other hand bust/chest circumference and shoulder circumference are upper torso measurements, which can be measured with relative ease and accuracy.

Following the selection of the key measurements came the categorisation of measurements to develop body measurement tables. Vertical trunk had the strongest relationship with all other measurements, but could be considered a difficult measurement to take with accuracy on a child, due to its dependence on the correctness of the relevant landmarks, such as the mid shoulder point and crutch (particularly for boys). Measuring over or around the bust and measuring on the body contour or straight from shoulder to crutch would also affect the accuracy of this particular measurement. Depending on the child, it can also be a very intimidating measurement to be subjected to and in some cultures (e.g. Indian), this measurement would not even be allowed, as was experienced during the second pilot study. Height was the vertical measurement, with the second highest correlation coefficients for both boys and girls and it ranked second with very strong relationships with all other measurements. This vertical measurement is considered to be the easiest to measure on a child under most conditions and in most locations by anyone. In addition, parents are also more likely, apart from age, to know their child's height than any other body measurement when selecting garments. Height was therefore selected as the most important variable and the key measurement on which to base the development of the sizing system for the purposes of this study.

Internationally, age has traditionally been used as the only indicator of body size among children. The correlation coefficient of age and the strength of its relationship ($0.75 \leq r \leq 0.84$) with all other measurements as identified in this study (Table 4.1), make it a less likely choice. However, it is believed that age could be very successfully used in conjunction with height, especially since height is very highly correlated with all other measurements. It is a very easy measurement to measure accurately, as already discussed. After studying Tables 4.2 and 4.3, it could be deduced from these tables that, for both genders, vertical measurements have stronger relationships with age than horizontal measurements have. Therefore, if an increase in a particular length measurement, such as height, nape to floor, waist to floor or shoulder to wrist is evident, that is a better indicator of the child's age than any horizontal measurement would be. In conclusion, height was selected as the most important variable and as the key measurement. Consequently, height as key measurement was then implemented as the basis for the development of a range of children’s body sizes, which could then be used for the development of body measurement tables and size charts, as well as a sizing system for the South African children’s wear market. This confirms the hypothesis for this study, stating that a sizing system for application in the South African children’s wear market should be based on specific height ranges as size criteria for the development of a range of fit dummies to facilitate the product development in this market sector. The practical application of this combination is discussed in the next section.

4.4 DEVELOPING A SIZING SYSTEM

4.4.1 Introduction

Key measurements are the best indicators for deciding on size designations and various criteria, such as height, weight, age, hip, or combinations of vertical and girth measurements, can be used as a basis for the development of a sizing system. In this study, height was identified, as the size criterion, which was advantageous, since it was found that a child’s height is highly correlated with other body measurements as discussed in the previous section. It can also be measured easily. Although weight is often used for infants and age is not the most reliable criterion, it is generally known and often useful. It is generally recognised that age is not a good indicator for children’s sizing, because children frequently vary in the rate of their development, making sizing by age unreliable. Two children of average build and nominally in the same age group can show a significant difference in their heights (as indicated in Figures 4.2 and 4.3), more so when there is a wide time span within their contemporary year. Children also do not maintain a consistent rate of growth. These are all sound reasons for designating children’s sizing by stature in preference to age. According to Kunick (1984:153), this is not to say that age should be ignored in the sizing system. It is a useful code number and acts as a starting point for selecting the right size. It is therefore considered to be more practical to use age in conjunction with another indicator to sort data.

As described in the precious section, a key measurement was selected as basis for the development of a size range for South African children’s body sizes. Dividing this data into artificial divisions created categories into which the data could be classified. In this study, height was chosen as the preferred constant variable and key dimension. However, the classification of key dimensions was performed in different stages. Initially, an analysis of the height measurements was done to identify different groups or clusters of height measurements. These height clusters were linked to age categories to obtain an initial size criterion. Further analysis of the anthropometric data was done to develop ranges of different sizes based on these selected height and age ranges. Once this selection had been done, the values of the key measurements were recorded. All the analyses were performed separately on the data of boys and girls and all were recorded in centimetres and years.

4.4.2 Clustering

The StatSoft Statistica 7 computer package was used to analyse the data by implementing the *k*- means clustering technique. This technique is generally applied to classify a great deal of information into manageable and meaningful piles. The *k*-means analysis was chosen to divide the results into 13 clusters for the children measured between the ages of two and 14 years. The motivation for 13 clusters was based on the current practice of most South Africa children's wear retailers to sell garments between these ages as either single or duel size designations. Fewer clusters might result in the "height grades" between the mean values of clusters being too big and impractical, especially when developing trousers. In this instance, duel size designations would be difficult and impractical. On the other hand if more than 13 clusters had been identified, this would call for the grouping of clusters, resulting in the same impact as too few clusters, where the "height grades" become too widely spaced and impractical in product development.

The objective of the *k*-means algorithm is to find the optimum "partition" for dividing a number of objects into *k* clusters (StatSoft, 2004:1). This procedure will move objects around from cluster to cluster, the purpose being to minimize the within-cluster variance and maximise the between-cluster variance. By conducting the *k*-means analysis, it was possible to identify the mean height of each of the clusters. Minimum and maximum height measurements were calculated and the data was sorted and grouped according to these values. Tables 4.4 and 4.5 depict the 13 clusters based on the height measurements. Also indicated in these tables was the number of children included in each cluster. Using the mean height values for each cluster, the differences between these clusters were calculated and were recorded as the "height grade" values. All the values were rounded to the first decimal for practical reasons. The minimum and maximum height for each cluster was calculated as follows:

Minimum height = Mean height – ½ height grade

Maximum height = Mean height + ½ height grade

In studying the summary of height clusters for boys in Table 4.4**,** column one indicates the number of clusters, while the second column indicates the number of boys grouped into cluster. The number of boys in each cluster vary between a minimum of 13 boys (in cluster 13) to a maximum of 151 boys (in cluster 4). The mean height values (in cm) for each of the 13 clusters are recorded in column three. This mean height was calculated by averaging the minimum and maximum values, indicating the within-cluster variance. These values varied between a minimum of 87.9 cm (in cluster one) to a maximum value of 179.3 cm (in cluster 13). The fourth column indicates the results of the between-cluster variance, based on the mean values of each cluster in column three. The minimum and maximum height measurements were calculated according to the formulas mentioned above and recorded in columns five and six respectively. Examples of the calculations for boys are:

Minimum height (e.g. cluster 2): = 96.7 - 4.4 (Mean height – ½ height grade)
= 92.3 cm

Maximum height (e.g. cluster 2): = 96.7 + 4.4 (Mean height + ½ height grade)
= 101.1 cm

TABLE 4.4: SUMMARY OF HEIGHT CLUSTERS WITH THE NUMBER OF BOYS INCLUDED IN EACH CLUSTER

Cluster numbers	Number of boys per cluster	Mean height (cm)	Height grade between means (cm)	Minimum height (cm)	Maximum height (cm)
1	66	87.9			92.3
2	106	96.7	8.9	92.3	101.1
3	121	105.5	8.8	101.1	109.3
4	151	113.1	7.6	109.3	116.8
5	144	120.5	7.3	116.8	124.1
6	146	127.7	7.2	124.1	130.9
7	111	134.1	6.5	130.9	136.9
8	133	139.7	5.6	136.9	142.8
9	116	145.9	6.2	142.8	149.4
10	112	152.9	7.0	149.4	156.7
11	62	160.5	7.6	156.7	164.8
12	32	169.0	8.6	164.8	174.2
13	13	179.3	10.3	174.2	

In Table 4.5, the summary of height clusters for girls, each of the six columns indicated was calculated in the same manner as for Table 4.4. Thirteen clusters were also identified in column one, while the number of girls grouped into each of the 13 clusters is indicated in column two. It can be deducted from this that the variation in the number of girls per cluster was bigger than that of the boys, since the minimum number of girls in cluster 13 was 3 girls, while the maximum number of girls per cluster was 156 girls in cluster 5. The mean height values (in cm) for each of the 13 clusters are also recorded in column three. This mean height was also calculated by averaging the minimum and maximum values indicating the within-cluster variance. For girls, these values varied between a minimum of 87.0 cm (in cluster one) to a maximum value of 176.8 cm (in cluster 13). The fourth column also indicates the results of the between-cluster variance based on the mean values of each cluster in column three, while the formulas, as mentioned above, were used to calculate minimum (in column five) and maximum (in column six) height measurements. Examples of the calculations for girls are:

Minimum height (cluster 2): = 96 - 4.5 (Mean height – ½ height grade)

= 91.5 cm

Maximum height (cluster 2): = 96 + 4.5 (Mean height + ½ height grade)

= 100.5 cm

In this example there is a difference between the maximum height value calculated and the actual value recorded in Table 4.5. The maximum value calculated was 100.5 and the maximum value of 99.8 was recorded. This was done because it had to correspond to the minimum value of the adjacent third cluster. In this "cleaning up" process, some minor manipulations were done to record the most "practical" value. This process was repeated on all the measurements of adjacent clusters where either no overlap or some small degree of overlap was evident between the maximum and minimum values of adjacent clusters.

TABLE 4.5: SUMMARY OF HEIGHT CLUSTERS WITH THE NUMBER OF GIRLS INCLUDED IN EACH CLUSTER

Cluster numbers	Number of girls per cluster	Mean height (cm)	Height grade between means (cm)	Minimum height (cm)	Maximum height (cm)
1	57	87.0			91.5
2	114	96.0	9.0	91.5	99.8
3	130	103.6	7.6	99.8	107.5
4	135	111.3	7.8	107.5	114.6
5	156	117.9	6.6	114.6	121.6
6	144	125.3	7.3	121.6	129.3
7	141	133.4	8.1	129.3	137.0
8	127	140.6	7.2	137.0	144.2
9	143	147.9	7.3	144.2	151.1
10	95	154.3	6.4	151.1	157.2
11	77	160.1	5.8	157.2	163.0
12	40	166.0	5.8	163.0	171.4
13	3	176.8	10.9	171.4	

Once the height clusters had been calculated, it was possible to calculate the minimum and maximum values of the height ranges as a basis for the development of the sizing systems for both boys and girls. This aspect is discussed in the next section.

4.4.3 Calculating minimum and maximum values of the height ranges

To continue, the minimum and maximum values of each of the thirteen clusters were determined by using the height measurement means and standard deviations. According to Steyn, Smit, DuToit and Strasheim (1994:137), the standard deviation is a measure of variation of all the individual values from the arithmetic mean. The greater the standard deviation (s) is, the further, on average, the values were from the arithmetic mean. For a reasonable symmetrical bell-shaped distribution, approximately 68% of the values fall within one standard deviation (s) from the mean. On the other hand, approximately 95% of all the values within two standard deviations (2s) from the mean while 99% values fall within tree standard deviations (3s) from the mean. The mean minus 2s and mean plus 2s were considered applicable for the sample under study as a prediction interval that includes 95% of the measured children in each cluster in the target population. The overlap between the clusters was considered a positive indication that the remaining 5% of the children are included in bordering clusters. Tables 4.6 and 4.7 illustrate the height values per cluster and the mean minus 2s and mean plus 2s values for boys and girls separately. The specific height range minimum (column 4) and maximum (column 5) values indicate the height measurement ranges per cluster (column one) as proposed in this study. The following formulas were implemented to calculate these values:

Minimum value of proposed height range (e.g. cluster 2) =
½ ((mean height + 2s of cluster 1) – (mean height – 2s of cluster 2)) + (mean height - 2s of cluster 2)

Maximum value of proposed height range (e.g. cluster 2) =
- ½ ((mean height + 2s of cluster 2) – (mean height – 2s of cluster 3)) + (mean height + 2s for cluster 2)

Examples of these calculations for boys and girls separately follow in each of the tables below. Slight differences in the values recorded are due to rounding of measurements to the first decimal.

TABLE 4.6: SUMMARY OF HEIGHT VALUES PER CLUSTER AND NUMBER OF BOYS WITH MEAN HEIGHT MINUS TWO STANDARD DEVIATIONS AND MEAN HEIGHT PLUS TWO STANDARD DEVIATIONS

Cluster numbers	Mean height minus two standard deviations (cm)	Mean height plus two standard deviations (cm)	Proposed height range minimum (cm)	Proposed height range maximum (cm)
1	81.9	93.6		92.7
2	91.8	101.3	92.7	100.9
3	100.5	109.9	100.9	109.2
4	108.4	117.5	109.2	117.1
5	116.6	124.3	117.1	123.9
6	123.6	131.6	123.9	131.1
7	130.7	137.4	131.1	136.9
8	136.4	143.0	136.9	142.9
9	142.8	148.8	142.9	148.5
10	148.3	157.2	148.5	156.4
11	155.7	165.3	156.4	164.4
12	163.5	174.6	164.4	172.5
13	170.5	188.2	172.5	

An example of the specific application in the boys proposed height range based on the information in Table 4.6 is:

Minimum value of proposed height range (e.g. cluster 2 boys)

$$= \tfrac{1}{2}(93.6 - 91.8) + 91.8$$
$$= \tfrac{1}{2}(1.8) + 91.8$$
$$= 92.7 \text{ cm}$$

Maximum value of proposed height range (e.g. cluster 2 boys)

$$= -\tfrac{1}{2}(101.3 - 100.5) + 101.3$$
$$= -\tfrac{1}{2}(0.8) + 101.3$$
$$= 100.9 \text{ cm}$$

TABLE 4.7: SUMMARY OF HEIGHT VALUES PER CLUSTER AND NUMBER OF GIRLS WITH MEAN HEIGHT MINUS TWO STANDARD DEVIATIONS AND MEAN HEIGHT PLUS TWO STANDARD DEVIATIONS

Cluster numbers	Mean height minus two standard deviations (cm)	Mean height plus two standard deviations (cm)	Proposed height range minimum (cm)	Proposed height range maximum (cm)
1	79.7	93.4		92.2
2	90.9	100.6	92.2	99.9
3	99.2	108.4	99.9	108.0
4	107.6	115.6	108.0	114.9
5	114.2	122.2	114.9	121.7
6	121.2	130.3	121.7	130.0
7	129.7	137.7	130.0	137.0
8	136.3	144.7	137.0	144.1
9	143.6	151.9	144.1	151.3
10	150.7	157.3	151.3	156.9
11	156.4	163.3	156.9	162.8
12	162.2	169.7	162.8	168.2
13	166.8	186.8	168.2	

An example of the specific application in the girls proposed height range based on the information in Table 4.7 is:

Minimum value of proposed height range (e.g. cluster 2 girls)

= ½ (93.4 – 90.9) + 90.9

= ½ (2.5) + 90.9

= 92.2 cm (rounded to the first decimal)

Maximum value of proposed height range (e.g. cluster 2 girls)

= - ½ (100.6 – 99.2) + (100.6)

= - ½ (1.4) + 100.6

= 99.9 cm

Implementing the information extracted form Tables 4.6 and 4.7, all key measurements were classified to be able to develop sizing systems for both boys and girls separately. This aspect is discussed in the following paragraphs.

4.4.4 Classification of key measurements

To achieve the objective of developing a sizing system, the next step in the data analysis was to analyse the anthropometric data to be able to designate the data into different sizes as a starting point for the body measurement tables. It was possible to calculate the actual ranges of height measurements as a criterion for the development of size designations from the information in the previous paragraphs. Tables 4.8 and 4.9 are summaries of the values of the height ranges for boys and girls separately. The size code indicator (row one) has been recorded for practical reasons as numbers, but how it is implemented will depend on the specific system used by the company implementing these particular size designations. The height ranges (row two) are based on the information extracted from Tables 4.6 and 4.7. Both these height ranges were implemented as the basis and starting point for the development of the sizing system proposed in this study. The age ranges (row three), however, referred to the approximate ages allocated to each size code and height range. In calculating these actual age ranges, the mean age value was determined for each of the clusters as starting point before allocation was done. Although age is not a good indicator of size (or height measurement) it was still important to link age ranges with the height ranges. This classification of key measurements was done in accordance with recommendations in paragraph 2.10.4. In this study age was added merely as a size code or size indicator, which can be used in conjunction with the height ranges, to facilitate the selection of garment sizes.

TABLE 4.8: SIZE DESIGNATIONS FOR BOYS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

Size code	1	2	3	4	5	6	7	8	9	10	11	12	13
Height range (cm)	86-92	93-100	101-109	110-117	118-124	125-131	132-136	137-142	143-148	149-156	157-164	165-172	173-179
Age range (years)	1-<2	2-<3	3-<4	4-<5	5-<6	6-<7	7-<8	8-<9	9-<10	10-<11	11-<12	12-<13	13-<14

TABLE 4.9: SIZE DESIGNATIONS FOR GIRLS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

Size code	1	2	3	4	5	6	7	8	9	10	11	12	13
Height range (cm)	86-92	93-99	100-108	109-114	115-121	122-130	131-137	138-144	145-151	152-156	157-162	163-168	169-175
Age range (years)	1-<2	2-<3	3-<4	4-<5	5-<6	6-<7	7-<8	8-<9	9-<10	10-<11	11-<12	12-<13	13-<14

In both Tables 4.8 and 4.9, the age ranges were recorded as an age equal to or bigger than the smaller number, but smaller than the bigger number, e.g. 3-4^{-} and indicates the set of ages x such as $3 \leq x < 4$. In this example it should be interpreted as the age of a child of three years old but younger than four years. For a child who is, however, four years old, the applicable age range is recorded as 4-5^{-}. With this understanding and interpretation of the age ranges, all forthcoming tables recorded the age ranges as follows for practical reasons and simplification:

Age range (years)	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14

This information can now be implemented and recorded in various combinations and size designations. Height or age can, alternatively, be used as size designations. Furthermore, the combination of both, or a simple reference to size, can be used. The specific criterion selected for implementation will depend on the requirements of the company implementing the sizing system.

In this study, the sizing system proposed for implementation was based on the height ranges developed and recorded in Tables 4.8 and 4.9. To proceed with the analysis and based on the height clusters, the mean values of the seven key dimensions were calculated using the raw data. From these values preliminary body measurement tables were developed, depicting the mean values of the key measurements. The key measurements as identified in paragraph 4.3.2 were height, vertical trunk, waist to floor, shoulder to wrist, shoulder circumference, bust/chest circumference and hip circumference. The mean value of each of these measurements is recorded in the following tables as the actual mean value before rounding off. Tables 4.10 and 4.11 represent the sizing system (based on height ranges) and preliminary body measurement of the seven key measurements calculated as separate tables for boys and girls.

TABLE 4.10: SIZE DESIGNATIONS AND PRELIMINARY BODY MEASUREMENTS OF KEY MEASUREMENTS FOR BOYS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

Size code	1	2	3	4	5	6	7	8	9	10	11	12	13
Height range (cm)	86-92	93-100	101-109	110-117	118-124	125-131	132-136	137-142	143-148	149-156	157-164	165-172	173-179
Age range (years)	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14
Mean values:													
Height	87.7	96.6	105.2	113.0	120.4	127.6	134.0	139.7	145.8	152.7	160.5	169.0	179.3
Vertical trunk	87.6	92.5	98.6	103.2	108.8	114.1	118.5	123.4	128.4	134.4	142.3	149.6	155.2
Waist to floor	50.3	56.4	63.0	68.6	73.9	79.3	84.0	88.4	92.8	97.6	103.2	109.2	114.5
Shoulder to wrist	27.2	30.4	33.6	36.4	39.1	41.6	43.5	46.2	48.0	50.6	53.4	55.8	59.3
Shoulder circumference	60.9	63.2	66.7	70.3	73.5	76.9	80.0	83.5	87.1	91.5	96.1	101.2	106.8
Chest circumference	50.4	51.9	54.9	56.5	59.2	61.9	63.6	67.3	69.4	72.9	75.8	79.4	83.0
Hip circumference	51.2	54.0	57.2	60.1	62.8	66.6	69.1	73.5	76.3	80.2	83.6	87.8	90.0

TABLE 4.11: SIZE DESIGNATIONS AND PRELIMINARY BODY MEASUREMENTS OF KEY MEASUREMENTS FOR GIRLS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

Size code	1	2	3	4	5	6	7	8	9	10	11	12	13
Height range (cm)	86-92	93-99	100-108	109-114	115-121	122-130	131-137	138-144	145-151	152-156	157-162	163-168	169-175
Age range (years)	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14
Mean values:													
Height	86.5	95.8	103.8	111.6	118.2	125.7	133.7	140.5	147.7	154.0	159.9	166.0	176.8
Vertical trunk	85.6	91.6	97.2	103.0	106.6	112.1	118.9	124.9	131.8	137.0	143.7	147.0	160.3
Waist to floor	50.0	56.8	62.5	68.0	73.0	78.4	84.5	89.6	94.7	98.7	102.8	106.1	114.0
Shoulder to wrist	27.1	30.2	32.8	35.6	38.0	41.1	43.7	45.9	48.8	51.1	53.0	54.4	58.0
Shoulder circumference	60.1	62.6	66.6	70.4	72.1	76.4	80.3	85.0	88.6	91.9	97.1	98.3	102.5
Bust circumference	49.0	50.7	53.6	55.5	58.1	60.8	64.6	68.6	72.8	75.2	81.3	81.1	85.5
Hip circumference	51.5	54.5	57.9	61.6	63.8	67.4	72.0	76.6	81.3	85.1	90.5	90.1	96.8

Tables 4.10 and 4.11 represent the first step in the development of mean body measurements tables, which form part of the objective of this study. These preliminary tables need to be “cleaned up” by rounding the mean values of the measurements to the first decimal for application in the development of the fit dummies. Tables 4.12 and 4.13 indicate the rounded mean values of the seven key measurements separately, for boys and girls respectively.

TABLE 4.12: ROUNDED BODY MEASUREMENT TABLE OF THE KEY MEASUREMENTS FOR BOYS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

Size code	1	2	3	4	5	6	7	8	9	10	11	12	13
Height range (cm)	86-92	93-100	101-109	110-117	118-124	125-131	132-136	137-142	143-148	149-156	157-164	165-172	173-179
Age range (years)	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14
Mean values:													
Height	87.5	96.5	105	113	120.5	127.5	134	139.5	146	152.5	160.5	169	179.5
Vertical trunk	87.5	92.5	98.5	103	109	114	118.5	123.5	128.5	134.5	142.5	149.6	155
Waist to floor	50.5	56.5	63	68.5	74	79.5	84	88.5	93	97.5	103	109	114.5
Shoulder to wrist	27	30.5	33.5	36.5	39	41.5	43.5	46	48	50.5	53.5	56	59.5
Shoulder circumference	61	63	66.5	70.5	73.5	77	80	83.5	87	91.5	96	101	107
Chest circumference	50.5	52	55	56.5	59	62	63.5	67.5	69.5	73	75.5	79.5	83
Hip circumference	52	54	57	61	63	66.5	69	73.5	76.5	80	83.5	88	90

TABLE 4.13: ROUNDED BODY MEASUREMENT TABLE OF THE KEY MEASUREMENTS FOR GIRLS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

Size code	1	2	3	4	5	6	7	8	9	10	11	12	13
Height range (cm)	86-92	93-99	100-108	109-114	115-121	122-130	131-137	138-144	145-151	152-156	157-162	163-168	169-175
Age range (years)	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14
Mean values:													
Height	86.5	96	104	111.5	118	125.5	133.5	140.5	147.5	154	160	166	177
Vertical trunk	85.5	91.5	97	103	106.5	112	119	125	132	137	143.5	147	160.5
Waist to floor	50	57	62.5	68	73	78.5	84.5	89.5	94.5	98.5	103	106	114
Shoulder to wrist	27	30	33	35.5	38	41	43.5	46	49	51	53	54.5	58
Shoulder circumference	60	62.5	66.5	70.5	72	76.5	80	85	88.5	92	97	98.5	102.5
Bust circumference	49	50.5	53.5	55.5	58	61	64.5	68.5	73	75	81	81	85.5
Hip circumference	51.5	54.5	58	61.5	63.5	67.4	72	76.5	81.5	85	90.5	90	97

With the development of these rounded body measurement tables as listed in Tables 4.12 and 4.13, it will be possible to plan and select the different sizes for product assortments. Although the mean values of these key measurements cannot yet be used in garment development, the information can be implemented as described in paragraph 4.6 as value ranges for the purpose of fit dummy prototype development. However, final body measurement tables can only be developed once the actual fit dummy ranges have been completed. The rounded body measurements of the seven key measurements for both boys and girls will, however, be expanded to the selection of all 27 key measurements as recorded in paragraph 4.3.2 to be implemented as illustrated in Tables 4.18 and 4.19. At this stage, the summary of the seven rounded body measurements makes it possible to determine increments between different sizes, and this will be discussed in depth in the following section.

4.5 INCREMENTS

4.5.1 Developing increments

The next step in the compilation of the body measurement tables was to establish the increments between the mean values of the different sizes of the key body measurements. The reason for establishing increments was to indicate the difference between the various measurements of different size fit dummies and primarily based on the recommendations in paragraph 2.3.3 for the development of size charts. (Since the development of size charts are pre-empted by the development of the body measurement tables for fit dummy prototype development, these recommendations were relevant.) These increments could, in the final phase, be used as a basis for grade rule developments and indicators for ease and over body tolerance allowances. Whether developing initial increments for practical application in development of a three dimensional fit dummy prototype, or the subsequent grade rules for pattern drafting and garment development, the initial (“raw”) mean values of measurements have to be rounded to the nearest 0.5 cm. It is evident that the result of this initial rounding off can be irregular or uneven increments.

Since the application of increments should be easy to understand and implement, it requires in most instances only a slight adjustment to some measurements to facilitate this requirement. The goal, however, remains that, where possible, the increments should be as regular as possible to ensure easy implementation when grading measurements during either fit dummy development or pattern grading (paragraph 2.3.3). Once the key measurements had been rounded off, the increments between sizes were calculated by determining the difference between the mean values of each size. Tables 4.14 and 4.15 are summaries of the rounded key measurements (in Tables 4.12 and 4.13) and all the increments between the mean values of each of the seven key measurements. The increments for boys and girls were calculated separately.

4.5.2 Demarcation of minimum and maximum values of key measurements

The next phase in the development of the body measurement tables was to demarcate minimum and maximum values of the seven key measurements based on the height ranges as size criterion. The height ranges were recorded as 13 single sizes, whereafter the minimum and maximum values for each of the key measurements were demarcated to indicate the specific boundaries per size. No overlap existed between the different sizes. These minimum and maximum values were demarcated because of their importance in three-dimensional fit dummy prototype development, since more detailed size ranges are imperative.

Demarcation of the minimum and maximum values for each of the key measurements was done in the same way as described in paragraph 4.4.3 and is illustrated in Tables 4.6 and 4.7. For each of the seven key measurements, the mean minus two standard deviations and mean plus two standard deviations were used as minimum and maximum values respectively. The demarcations of the minimum and maximum values of the seven key measurements are listed in Tables 4.16 and 4.17 separately for boys and girls respectively.

For the purposes of this study it was decided to use only the seven key measurements (as point of departure) to develop body measurement tables for the development of fit dummies. However, the process described above could be repeated for as many measurements as are considered essential for fit dummy development and, eventually, for garment development when more detailed or wider ranges of body measurement tables are compiled.

TABLE 4.14: INCREMENTS OF KEY MEASUREMENTS OF BOYS BASED ON MEAN VALUES PER SIZE WITH THE HEIGHT RANGES AS SIZE CRITERION

Size code	1		2		3		4		5		6		7		8		9		10		11		12		13
Height range (cm)	86-92		93-100		101-109		110-117		118-124		125-131		132-136		137-142		143-148		149-156		157-164		165-172		173-179
Age range (years)	1~2		2~3		3~4		4~5		5~6		6~7		7~8		8~9		9~10		10~11		11~12		12~13		13~14
Mean values (cm):																									
Height	87.5	9.0	96.5	8.5	105	8.0	113	7.5	120.5	7.0	127.5	6.5	134	5.5	139.5	6.5	146	6.5	152.5	8.0	160.5	8.5	169	10.5	179.5
Vertical trunk	87.5	5.0	92.5	6.0	98.5	4.5	103	6.0	109	5.0	114	4.5	118.5	5.0	123.5	5.0	128.5	6.0	134.5	8.0	142.5	7.1	149.6	5.4	155
Waist to floor	50.5	6.0	56.5	6.5	63	5.5	68.5	5.5	74	5.5	79.5	4.5	84	4.5	88.5	4.5	93	4.5	97.5	5.5	103	6.0	109	5.5	114.5
Shoulder to wrist	27	3.5	30.5	3.0	33.5	3.0	36.5	2.5	39	2.5	41.5	2.0	43.5	2.5	46	2.0	48	2.5	50.5	3.0	53.5	2.5	56	3.5	59.5
Shoulder circumference	61	2.0	63	3.5	66.5	4.0	70.5	3.0	73.5	3.5	77	3.0	80	3.5	83.5	3.5	87	4.5	91.5	4.5	96	5.0	101	6.0	107
Chest circumference	50.5	1.5	52	3.0	55	1.5	56.5	2.5	59	3.0	62	1.5	63.5	4.0	67.5	2.0	69.5	3.5	73	2.5	75.5	4.0	79.5	3.5	83
Hip circumference	52	2.0	54	3.0	57	4.0	61	2.0	63	3.5	66.5	2.5	69	4.5	73.5	3.0	76.5	3.5	80	3.5	83.5	4.5	88	2.0	90

Key: Actual measurement Increment

TABLE 4.15: INCREMENTS OF KEY MEASUREMENTS OF GIRLS BASED ON MEAN VALUES PER SIZE WITH THE HEIGHT RANGES AS SIZE CRITERION

Size code	1		2		3		4		5		6		7		8		9		10		11		12		13
Height range (cm)	86-92		93-99		100-108		109-114		115-121		122-130		131-137		138-144		145-151		152-156		157-162		163-168		169-175
Age range (range)	1~2		2~3		3~4		4~5		5~6		6~7		7~8		8~9		9~10		10~11		11~12		12~13		13~14
Mean values (cm):																									
Height	86.5	9.5	96	8.0	104	7.5	111.5	6.5	118	7.5	125.5	8.0	133.5	7.0	140.5	7.0	147.5	6.5	154	6.0	160	6.0	166	11.0	177
Vertical trunk	85.5	6.0	91.5	5.5	97	6.0	103	3.5	106.5	5.5	112	7.0	119	6.0	125	7.0	132	5.0	137	6.5	143.5	3.5	147	13.5	160.5
Waist to floor	50	7.0	57	5.5	62.5	5.5	68	5.0	73	5.5	78.5	6.0	84.5	5.0	89.5	5.0	94.5	4.0	98.5	4.5	103	3.0	106	8.0	114
Shoulder to wrist	27	3.0	30	3.0	33	2.5	35.5	2.5	38	3.0	41	2.5	43.5	2.5	46	3.0	49	2.0	51	2.0	53	1.5	54.5	3.5	58
Shoulder circumference	60	2.5	62.5	4.0	66.5	4.0	70.5	1.5	72	4.5	76.5	3.5	80	5.0	85	3.5	88.5	3.5	92	5.0	97	1.5	98.5	4.0	102.5
Bust circumference	49	1.5	50.5	3.0	53.5	2.0	55.5	2.5	58	3.0	61	3.5	64.5	4.0	68.5	4.5	73	2.0	75	6.0	81	0.0	81	4.5	85.5
Hip circumference	51.5	3.0	54.5	3.5	58	3.5	61.5	2.0	63.5	3.9	67.4	4.6	72	4.5	76.5	5.0	81.5	3.5	85	5.5	90.5	-0.5	90	7.0	97

Key: Actual measurement Increment

TABLE 4.16: DEMARCATION OF THE MINIMUM AND MAXIMUM VALUES OF THE SEVEN KEY MEASUREMENTS FOR BOYS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

SIZE DESIGNATION			KEY MEASUREMENT SIZE RANGES																				
Size code	Height range (cm)	Age range (years)	HEIGHT			VERTICAL TRUNK			WAIST TO FLOOR			SHOULDER TO WRIST			SHOULDER CIRCUMFERENCE			CHEST CIRCUMFERENCE			HIP CIRCUMFERENCE		
			MEAN -2*SD	Means	MEAN +2*SD	MEAN -2*SD	Means	MEAN +2*SD	MEAN -2*SD	Means	MEAN +2*SD	MEAN -2*SD	Means	MEAN +2*SD	MEAN -2*SD	Means	MEAN -2*SD	MEAN -2*SD	Means	MEAN +2*SD	MEAN -2*SD	Means	MEAN +2*SD
1	86-92	1~2	81.9	87.7	93.6	80.1	87.6	95.0	45.5	50.3	55.1	22.5	27.2	31.9	55.8	60.9	66.0	46.2	50.4	54.5	45.4	51.2	56.9
2	93-100	2~3	91.8	96.6	101.3	83.9	92.5	101.1	52.1	56.4	60.7	27.3	30.4	33.5	58.1	63.2	68.3	44.3	51.9	59.5	48.8	54.0	59.2
3	101-109	3~4	100.5	105.2	109.9	91.7	98.6	105.5	56.0	63.0	70.0	30.7	33.6	36.5	55.5	66.7	77.9	50.2	54.9	59.6	51.2	57.2	63.1
4	110-117	4~5	108.4	113.0	117.5	95.3	103.2	111.1	64.5	68.6	72.7	33.6	36.4	39.2	64.3	70.3	76.4	45.8	56.5	67.1	54.1	60.1	66.0
5	118-124	5~6	116.6	120.4	124.3	101.8	108.8	115.8	69.7	73.9	78.2	36.4	39.1	41.8	66.7	73.5	80.2	53.8	59.2	64.5	55.9	62.8	69.6
6	125-131	6~7	123.6	127.6	131.6	106.0	114.1	122.3	74.8	79.3	83.8	38.9	41.6	44.4	65.6	76.9	88.2	55.5	61.9	68.4	58.9	66.6	74.3
7	132-136	7~8	130.7	134.0	137.4	110.8	118.5	126.2	79.6	84.0	88.4	36.2	43.5	50.7	72.2	80.0	87.8	57.0	63.6	70.3	61.0	69.1	77.3
8	137-142	8~9	136.4	139.7	143.0	113.5	123.4	133.3	84.4	88.4	92.4	43.2	46.2	49.2	65.5	83.5	101.6	58.1	67.3	76.5	62.4	73.5	84.6
9	143-148	9~10	142.8	145.8	148.8	120.7	128.4	136.0	88.8	92.8	96.8	44.7	48.0	51.3	75.9	87.1	98.3	60.7	69.4	78.1	66.7	76.3	86.0
10	149-156	10~11	148.3	152.7	157.2	122.4	134.4	146.4	93.1	97.6	102.1	47.0	50.6	54.2	79.7	91.5	103.3	62.7	72.9	83.1	68.2	80.2	92.2
11	157-164	11~12	155.7	160.5	165.3	129.3	142.3	155.2	98.3	103.2	108.2	50.4	53.4	56.5	83.7	96.1	108.4	65.8	75.8	85.7	73.9	83.6	93.4
12	165-172	12~13	163.5	169.0	174.6	139.6	149.6	159.6	103.3	109.2	115.2	52.6	55.8	59.0	88.9	101.2	113.6	69.5	79.4	89.4	75.4	87.8	100.2
13	173-179	13~14	170.5	179.3	188.2	145.5	155.2	164.9	107.1	114.5	121.8	54.0	59.3	64.7	96.7	106.8	116.8	70.5	83.0	95.5	73.1	90.0	106.9

TABLE 4.17: DEMARCATION OF THE MINIMUM AND MAXIMUM VALUES OF THE SEVEN KEY MEASUREMENTS FOR GIRLS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

SIZE DESIGNATION			KEY MEASUREMENT SIZE RANGES																				
Size code	Height range (cm)	Age range (years)	HEIGHT			VERTICAL TRUNK			WAIST TO FLOOR			SHOULDER TO WRIST			SHOULDER CIRCUMFERENCE			BUST CIRCUMFERENCE			HIP CIRCUMFERENCE		
			MEAN -2*SD	Means	MEAN +2*SD	MEAN -2*SD	Means	MEAN +2*SD	MEAN -2*SD	Means	MEAN +2*SD	MEAN -2*SD	Means	MEAN +2*SD	MEAN -2*SD	Means	MEAN -2*SD	MEAN -2*SD	Means	MEAN +2*SD	MEAN -2*SD	Means	MEAN +2*SD
1	86-92	1~2	79.7	86.5	93.4	76.9	85.6	94.2	43.9	50.0	56.1	23.8	27.1	30.4	53.7	60.1	66.4	44.3	49.0	53.7	44.3	51.5	58.8
2	93-99	2~3	90.9	95.8	100.6	83.1	91.6	100.1	52.4	56.8	61.2	23.9	30.2	36.6	57.4	62.6	67.8	42.9	50.7	58.5	48.8	54.5	60.3
3	100-108	3~4	99.2	103.8	108.4	89.9	97.2	104.5	57.3	62.5	67.7	29.8	32.8	35.8	59.7	66.6	73.5	48.0	53.6	59.2	50.5	57.9	65.3
4	109-114	4~5	107.6	111.6	115.6	95.2	103.0	110.8	63.3	68.0	72.7	33.1	35.6	38.2	63.0	70.4	77.7	44.4	55.5	66.6	54.1	61.6	69.1
5	115-121	5~6	114.2	118.2	122.2	99.1	106.6	114.1	69.1	73.0	77.0	35.2	38.0	40.7	63.3	72.1	80.9	50.2	58.1	66.1	55.6	63.8	71.9
6	122-130	6~7	121.2	125.7	130.3	103.9	112.1	120.3	74.1	78.4	82.8	38.1	41.1	44.0	66.9	76.4	85.9	53.5	60.8	68.1	58.5	67.4	76.2
7	131-137	7~8	129.7	133.7	137.7	110.0	118.9	127.8	80.8	84.5	88.1	40.6	43.7	46.9	70.2	80.3	90.4	56.2	64.6	72.9	61.4	72.0	82.6
8	138-144	8~9	136.3	140.5	144.7	114.4	124.9	135.3	85.6	89.6	93.6	41.6	45.9	50.3	73.5	85.0	96.5	57.1	68.6	80.2	66.0	76.6	87.2
9	145-151	9~10	143.6	147.7	151.9	121.2	131.8	142.4	90.3	94.7	99.1	42.9	48.8	54.7	73.7	88.6	103.4	61.0	72.8	84.6	68.3	81.3	94.4
10	152-156	10~11	150.7	154.0	157.3	123.9	137.0	150.1	94.8	98.7	102.7	47.6	51.1	54.5	80.7	91.9	103.2	62.9	75.2	87.6	73.2	85.1	97.0
11	157-162	11~12	156.4	159.9	163.3	131.1	143.7	156.3	97.7	102.8	107.9	49.1	53.0	56.8	83.6	97.1	110.5	66.6	81.3	96.0	75.6	90.5	105.3
12	163-168	12~13	162.2	166.0	169.7	136.0	147.0	158.0	99.9	106.1	112.3	49.1	54.4	59.7	87.1	98.3	109.4	69.5	81.1	92.8	77.7	90.1	102.5
13	169-175	13~14	166.8	176.8	186.8	154.2	160.3	166.4	104.8	114.0	123.2	54.0	58.0	62.0	97.9	102.5	107.1	80.9	85.5	90.1	88.7	96.8	105.0

4.6 DEVELOPING BODY MEASUREMENT TABLES

Body measurement tables serve as a basis for the development of three-dimensional fit dummies. In this study and for this purpose, the development of body measurement tables has been based on mean values for single measurements and standard deviations to determine the minimum and maximum values of the measurement ranges. Tables 4.18 and 4.19 are examples of body measurement tables that could be used for the development of fit dummies in particular, using the mean values. It is, however, necessary that these initial body measurements are subject to some adjustment during the development of the three dimensional fit dummy prototypes, during which the standard deviations are applied as the minimum and maximum values for the measurement ranges. This aspect will be discussed later in this section.

As listed in Tables 4.18 and 4.19, the seven key measurements (as recorded in Tables 4.12 and 4.13) have been extended to the full range of 27 key measurements as identified in Tables 4.1, 4.2 and 4.3. The sequence in which the measurements were recorded corresponds with that of Tables 4.2 and 4.3. Because age was recorded as a possible size criterion, and because it is not a “measurement” which can be used in the three-dimensional fit dummy development, it was excluded from the list as one of the key measurements. Therefore the final lists of key measurements as recorded in Tables 4.18 and 4.19 consisted of only 26 key measurements.

TABLE 4.18: BODY MEASUREMENT TABLE FOR BOYS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

SIZE DESIGNATION

Size code	1	2	3	4	5	6	7	8	9	10	11	12	13
Height range (cm)	86-92	93-100	101-109	110-117	118-124	125-131	132-136	137-142	143-148	149-156	157-164	165-172	173-179
Age range (years)	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14

BODY MEASUREMENTS (cm): Boys

1 Weight	13.2	15.2	17.9	20.5	23.1	26.9	29.7	34.7	38.0	44.2	50.7	57.8	64.5
2 Vertical trunk	87.6	92.5	98.6	103.2	108.8	114.1	118.5	123.4	128.4	134.4	142.3	149.6	155.2
3 Head circumference	49.9	51.0	51.8	52.2	52.6	53.3	53.6	54.2	54.5	55.0	55.5	56.2	56.3
4 Neck base circumference	28.2	29.2	30.4	31.4	32.3	33.5	34.2	35.4	36.6	38.1	39.9	42.6	45.2
5 Armhole circumference	21.3	22.5	24.4	25.4	26.3	27.8	28.7	30.6	31.6	33.3	35.0	36.9	39.6
6 Shoulder circumference	60.9	63.2	66.7	70.3	73.5	76.9	80.0	83.5	87.1	91.5	96.1	101.2	106.8
7 Chest circumference	50.4	51.9	54.9	56.5	59.2	61.9	63.6	67.3	69.4	72.9	75.8	79.4	83.0
8 Waist circumference	49.0	50.0	51.6	53.0	54.4	56.9	57.8	60.9	62.2	65.3	66.7	70.1	71.8
9 Hip circumference	51.2	54.0	57.2	60.1	62.8	66.6	69.1	73.5	76.3	80.2	83.6	87.8	90.0
10 Biceps circumference	15.5	15.7	16.4	17.0	17.5	18.3	19.1	20.3	21.0	21.9	23.4	24.4	24.7
11 Wrist circumference	11.6	11.5	11.7	12.3	12.5	12.9	13.3	13.8	14.2	14.9	15.6	16.3	16.8
12 Thigh circumference	29.4	30.7	32.5	34.0	35.7	38.0	39.5	42.6	44.5	46.4	47.6	50.8	52.6
13 Height	87.7	96.6	105.2	113.0	120.4	127.6	134.0	139.7	145.8	152.7	160.5	169.0	179.3
14 Nape to floor	70.3	78.3	86.3	93.1	100.0	106.5	112.4	118.0	123.6	130.0	137.3	144.2	151.3
15 Crutch to floor	35.0	39.7	44.9	49.7	54.3	59.0	62.8	66.3	69.7	73.2	77.5	81.2	85.2
16 Scye depth	61.1	68.4	75.5	81.6	88.1	94.0	98.6	103.7	108.9	114.8	121.0	127.2	136.5
17 Waist to floor	50.3	56.4	63.0	68.6	73.9	79.3	84.0	88.4	92.8	97.6	103.2	109.2	114.5
18 Hip to floor	39.6	44.6	50.5	55.5	60.2	65.0	69.4	73.1	77.0	80.7	84.8	89.9	94.0
19 Knee to floor	22.4	25.7	28.8	31.0	33.6	36.0	38.3	40.4	42.2	44.6	46.4	49.0	51.3
20 Nape to waist	19.9	21.9	23.8	25.0	26.7	27.9	29.0	30.2	31.7	33.6	35.5	37.2	39.3
21 Waist to hip	10.8	11.8	12.5	13.1	13.7	14.3	14.6	15.3	15.8	16.9	18.4	19.3	20.5
22 Nape to bust point	19.1	19.8	21.3	22.1	23.2	24.2	25.3	26.3	27.3	28.6	30.4	32.2	34.6
23 Shoulder wrist (straight)	27.2	30.4	33.6	36.4	39.1	41.6	43.5	46.2	48.0	50.6	53.4	55.8	59.3
24 Across front	21.6	22.0	23.1	23.8	24.8	25.7	26.5	27.4	28.3	29.5	31.2	32.7	33.8
25 Shoulder breadth	22.2	24.1	26.2	28.2	29.7	30.8	32.2	33.7	34.8	36.6	38.8	40.4	43.6
26 Across back	20.9	22.5	24.8	26.2	27.4	28.6	29.4	31.0	32.3	33.7	35.4	36.9	39.9

TABLE 4.19: BODY MEASUREMENT TABLE FOR GIRLS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

SIZE DESIGNATION

Size code	1	2	3	4	5	6	7	8	9	10	11	12	13
Height range (cm)	86-92	93-99	100-108	109-114	115-121	122-130	131-137	138-144	145-151	152-156	157-162	163-168	169-175
Age range (years)	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14

BODY MEASUREMENTS (cm): Girls

1 Weight	12.8	14.8	17.5	20.4	22.4	25.7	30.6	35.6	41.4	46.5	53.5	54.5	64.3
2 Vertical trunk	85.6	91.6	97.2	103.0	106.6	112.1	118.9	124.9	131.8	137.0	143.7	147.0	160.3
3 Head circumference	48.0	50.1	50.9	51.4	52.1	52.6	53.1	54.1	54.8	55.2	55.4	55.7	56.5
4 Neck base circumference	27.7	28.8	29.8	30.8	31.3	32.5	33.6	34.7	36.6	38.0	39.4	40.1	42.1
5 Armhole circumference	21.0	22.0	23.6	25.2	25.8	27.6	29.2	30.7	32.0	33.1	34.8	35.6	37.7
6 Shoulder circumference	60.1	62.6	66.6	70.4	72.1	76.4	80.3	85.0	88.6	91.9	97.1	98.3	102.5
7 Bust circumference	49.0	50.7	53.6	55.5	58.1	60.8	64.6	68.6	72.8	75.2	81.3	81.1	85.5
8 Waist circumference	48.2	49.4	50.9	52.7	53.4	55.3	57.8	60.2	62.5	64.1	67.1	66.2	68.8
9 Hip circumference	51.5	54.5	57.9	61.6	63.8	67.4	72.0	76.6	81.3	85.1	90.5	90.1	96.8
10 Biceps circumference	15.3	15.7	16.6	17.4	17.7	18.5	19.7	21.0	21.8	22.3	23.9	23.5	23.7
11 Wrist circumference	10.9	11.1	11.5	12.0	12.1	12.6	13.1	13.7	14.2	14.5	15.0	15.0	15.8
12 Thigh circumference	29.5	31.3	33.3	35.2	36.9	38.8	42.0	44.9	47.6	49.9	52.9	52.6	56.7
13 Height	86.5	95.8	103.8	111.6	118.2	125.7	133.7	140.5	147.7	154.0	159.9	166.0	176.8
14 Nape to floor	69.7	77.9	85.3	92.4	98.2	105.0	112.7	119.1	125.9	131.6	136.7	141.8	152.3
15 Crutch to floor	35.9	40.0	44.6	49.5	53.7	58.4	63.3	67.1	71.4	74.5	77.5	79.7	83.8
16 Scye depth	60.8	68.1	74.4	80.9	86.5	92.3	99.3	105.0	111.2	116.4	120.8	124.5	133.1
17 Waist to floor	50.0	56.8	62.5	68.0	73.0	78.4	84.5	89.6	94.7	98.7	102.8	106.1	114.0
18 Hip to floor	38.4	44.5	49.4	54.5	59.0	63.9	69.0	73.5	77.9	81.4	84.5	86.9	92.1
19 Knee to floor	22.3	25.6	28.4	30.5	32.8	35.4	38.0	40.4	42.4	44.1	45.7	47.1	49.8
20 Nape to waist	19.2	21.3	23.3	24.9	25.9	27.5	29.4	30.8	32.3	34.3	35.9	37.5	41.8
21 Waist to hip	11.6	12.3	13.1	13.5	14.0	14.5	15.4	16.1	16.9	17.3	18.3	19.2	21.9
22 Nape to bust point	18.7	19.7	20.9	22.1	22.7	23.8	25.1	26.5	28.6	29.9	32.4	32.5	35.5
23 Shoulder wrist (straight)	27.1	30.2	32.8	35.6	38.0	41.1	43.7	45.9	48.8	51.1	53.0	54.4	58.0
24 Across front	21.6	22.0	23.0	24.4	25.1	25.8	26.8	27.8	29.4	30.6	32.5	32.6	33.7
25 Shoulder breadth	21.8	23.7	26.0	27.9	28.7	30.3	31.7	33.5	34.9	36.1	38.1	39.1	42.3
26 Across back	20.6	22.2	24.2	25.6	26.0	27.2	28.6	30.3	31.7	32.4	34.6	35.4	36.8

Expanding on the body measurement tables captured in Tables 4.18 and 4.19, increments were established using the mean values as discussed in paragraph 4.5 and recorded in Tables 4.12 to 4.17. These initial increments are likely to be inconsistent because all the calculated and rounded measurements still need to be linked together before the development of three dimensional fit dummy prototypes. Referring to the height measurements for boys (Table 4.20) as an example, the increment results from sizes 1 to 13, can be recorded as 8.8 cm, 8.6 cm, 7.8 cm, 7.5 cm, 7.1 cm, 6.4 cm, 5.7 cm, 6.1 cm, 6.9 cm 7.8 cm 8.6 cm and 10.3 cm. Similarly, referring to Table 4.21 as an example of the increment results for girls, from sizes 1 to 13, increments can be recorded as 9.2 cm, 8.0 cm, 7.8 cm, 6.6 cm 7.5 cm, 7.9 cm, 6.8 cm, 7.2 cm, 6.3 cm, 5.9 cm, 6.1 cm and 10.9 cm. It is therefore evident that it is important to develop the body measurements from a range which has both minimum and maximum values in order to achieve greater consistency in the increments.

The relative consistency of increments can, however, only be achieved once the fit dummy prototype body dimensions are finalised for the full range of fit dummies. Subsequent analysis will make it possible to compile a more consistent set of increments for all important body measurements, which can then be captured in the final size charts for product development. This aspect of size chart development will not be covered by this study. The continued analysis for the purposes of this study will, however, mostly comprise the rounding off of actual body measurements within the given range of minimum (mean minus 2 standard deviations) and maximum (mean plus two standard deviations) values of which Tables 4.16 and 4.17 are examples. Recorded below are Tables 4.20 and 4.21 as examples of body measurement tables indicating the initial (pre fit dummy prototype development), and inconsistent, increments between measurements in the total age range of 13 sizes. These were calculated (according to calculations in Tables 4.14 and 4.15) by subtracting the small size measurement from that of the bigger size. The initial increments are therefore the differences in the body measurements that will be used as a basis for the different size fit dummy prototypes (paragraph 4.8).

TABLE 4.20: BODY MEASUREMENT TABLE AND INCREMENTS FOR BOYS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

SIZE DESIGNATION																									
Size code	1		2		3		4		5		6		7		8		9		10		11		12		13
Height range (cm)	86-92		93-100		101-109		110-117		118-124		125-131		132-136		137-142		143-148		149-156		157-164		165-172		173-179
Age range (years)	1~2		2~3		3~4		4~5		5~6		6~7		7~8		8~9		9~10		10~11		11~12		12~13		13~14
BODY MEASUREMENTS (cm): Boys																									
1 Weight	13.2	2.0	15.2	2.7	17.9	2.6	20.5	2.6	23.1	3.7	26.9	2.8	29.7	5.0	34.7	3.4	38.0	6.1	44.2	6.5	50.7	7.1	57.8	6.7	64.5
2 Vertical trunk	87.6	4.9	92.5	6.1	98.6	4.6	103.2	5.6	108.8	5.3	114.1	4.4	118.5	4.9	123.4	5.0	128.4	6.0	134.4	7.9	142.3	7.3	149.6	5.6	155.2
3 Head circumference	49.9	1.1	51.0	0.8	51.8	0.4	52.2	0.4	52.6	0.7	53.3	0.3	53.6	0.6	54.2	0.4	54.5	0.5	55.0	0.4	55.5	0.7	56.2	0.1	56.3
4 Neck base circumference	28.2	1.0	29.2	1.2	30.4	1.0	31.4	0.9	32.3	1.2	33.5	0.7	34.2	1.1	35.4	1.2	36.6	1.5	38.1	1.8	39.9	2.7	42.6	2.5	45.2
5 Armhole circumference	21.3	1.1	22.5	1.9	24.4	1.0	25.4	0.9	26.3	1.5	27.8	0.8	28.7	1.9	30.6	1.0	31.6	1.7	33.3	1.7	35.0	1.9	36.9	2.7	39.6
6 Shoulder circumference	60.9	2.3	63.2	3.5	66.7	3.6	70.3	3.1	73.5	3.4	76.9	3.1	80.0	3.6	83.5	3.5	87.1	4.4	91.5	4.6	96.1	5.2	101.2	5.5	106.8
7 Chest circumference	50.4	1.6	51.9	3.0	54.9	1.6	56.5	2.7	59.2	2.7	61.9	1.7	63.6	3.7	67.3	2.1	69.4	3.5	72.9	2.9	75.8	3.6	79.4	3.6	83.0
8 Waist circumference	49.0	0.9	50.0	1.7	51.6	1.4	53.0	1.4	54.4	2.5	56.9	0.9	57.8	3.2	60.9	1.3	62.2	3.1	65.3	1.3	66.7	3.5	70.1	1.7	71.8
9 Hip circumference	51.2	2.9	54.0	3.1	57.2	2.9	60.1	2.7	62.8	3.8	66.6	2.6	69.1	4.3	73.5	2.8	76.3	3.9	80.2	3.4	83.6	4.2	87.8	2.2	90.0
10 Biceps circumference	15.5	0.2	15.7	0.7	16.4	0.5	17.0	0.5	17.5	0.8	18.3	0.8	19.1	1.2	20.3	0.7	21.0	0.8	21.9	1.5	23.4	1.1	24.4	0.2	24.7
11 Wrist circumference	11.6	-0.1	11.5	0.2	11.7	0.6	12.3	0.2	12.5	0.4	12.9	0.3	13.3	0.5	13.8	0.4	14.2	0.7	14.9	0.7	15.6	0.7	16.3	0.4	16.8
12 Thigh circumferece	29.4	1.3	30.7	1.8	32.5	1.5	34.0	1.7	35.7	2.4	38.0	1.5	39.5	3.1	42.6	1.9	44.5	1.8	46.4	1.2	47.6	3.2	50.8	1.8	52.6
13 Height	87.7	8.8	96.6	8.6	105.2	7.8	113.0	7.5	120.4	7.1	127.6	6.4	134.0	5.7	139.7	6.1	145.8	6.9	152.7	7.8	160.5	8.6	169.0	10.3	179.3
14 Nape to floor	70.3	8.0	78.3	8.0	86.3	6.8	93.1	6.9	100.0	6.6	106.5	5.9	112.4	5.6	118.0	5.6	123.6	6.4	130.0	7.3	137.3	7.0	144.2	7.0	151.3
15 Crutch to floor	35.0	4.7	39.7	5.1	44.9	4.8	49.7	4.6	54.3	4.8	59.0	3.7	62.8	3.6	66.3	3.4	69.7	3.5	73.2	4.2	77.5	3.8	81.2	3.9	85.2
16 Scye depth	61.1	7.2	68.4	7.1	75.5	6.1	81.6	6.6	88.1	5.8	94.0	4.6	98.6	5.2	103.7	5.2	108.9	5.9	114.8	6.2	121.0	6.2	127.2	9.3	136.5
17 Waist to floor	50.3	6.1	56.4	6.6	63.0	5.6	68.6	5.3	73.9	5.4	79.3	4.7	84.0	4.4	88.4	4.4	92.8	4.8	97.6	5.6	103.2	6.0	109.2	5.3	114.5
18 Hip to floor	39.6	5.1	44.6	5.9	50.5	5.0	55.5	4.7	60.2	4.8	65.0	4.3	69.4	3.7	73.1	3.9	77.0	3.7	80.7	4.1	84.8	5.1	89.9	4.1	94.0
19 Knee to floor	22.4	3.3	25.7	3.0	28.8	2.3	31.0	2.5	33.6	2.4	36.0	2.3	38.3	2.2	40.4	1.8	42.2	2.4	44.6	1.9	46.4	2.6	49.0	2.3	51.3
20 Nape to waist	19.9	2.1	21.9	1.8	23.8	1.2	25.0	1.7	26.7	1.3	27.9	1.1	29.0	1.2	30.2	1.5	31.7	1.9	33.6	1.9	35.5	1.7	37.2	2.1	39.3
21 Waist to hip	10.8	1.0	11.8	0.7	12.5	0.6	13.1	0.6	13.7	0.6	14.3	0.3	14.6	0.7	15.3	0.4	15.8	1.1	16.9	1.5	18.4	0.9	19.3	1.2	20.5
22 Nape to bust point	19.1	0.7	19.8	1.4	21.3	0.8	22.1	1.1	23.2	1.0	24.2	1.1	25.3	1.0	26.3	1.0	27.3	1.3	28.6	1.8	30.4	1.8	32.2	2.4	34.6
23 Shoulder wrist (straight)	27.2	3.2	30.4	3.2	33.6	2.8	36.4	2.7	39.1	2.5	41.6	1.8	43.5	2.7	46.2	1.8	48.0	2.6	50.6	2.8	53.4	2.4	55.8	3.5	59.3
24 Across front	21.6	0.5	22.0	1.1	23.1	0.6	23.8	1.0	24.8	0.9	25.7	0.7	26.5	1.0	27.4	0.9	28.3	1.2	29.5	1.7	31.2	1.5	32.7	1.1	33.8
25 Shoulder breadth	22.2	1.9	24.1	2.1	26.2	2.0	28.2	1.5	29.7	1.0	30.8	1.4	32.2	1.5	33.7	1.1	34.8	1.8	36.6	2.3	38.8	1.6	40.4	3.2	43.6
26 Across back	20.9	1.6	22.5	2.3	24.8	1.4	26.2	1.2	27.4	1.2	28.6	0.8	29.4	1.6	31.0	1.3	32.3	1.3	33.7	1.7	35.4	1.6	36.9	3.0	39.9

Key: Actual measurement (thin box) Increment (thick box)

TABLE 4.21: BODY MEASUREMENT TABLE AND INCREMENTS FOR GIRLS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

SIZE DESIGNATION																									
Size code	1		2		3		4		5		6		7		8		9		10		11		12		13
Height range (cm)	86-92		93-99		100-108		109-114		115-121		122-130		131-137		138-144		145-151		152-156		157-162		163-168		169-175
Age range (years)	1~2		2~3		3~4		4~5		5~6		6~7		7~8		8~9		9~10		10~11		11~12		12~13		13~14
BODY MEASUREMENTS (cm): Girls																									
1 Weight	12.8	2.0	14.8	2.7	17.5	3.0	20.4	2.0	22.4	3.3	25.7	4.8	30.6	5.0	35.6	5.8	41.4	5.1	46.5	7.0	53.5	1.0	54.5	9.8	64.3
2 Vertical trunk	85.6	6.0	91.6	5.6	97.2	5.8	103.0	3.6	106.6	5.5	112.1	6.8	118.9	6.0	124.9	6.9	131.8	5.2	137.0	6.7	143.7	3.3	147.0	13.3	160.3
3 Head circumference	48.0	2.1	50.1	0.9	50.9	0.5	51.4	0.7	52.1	0.5	52.6	0.5	53.1	1.0	54.1	0.7	54.8	0.4	55.2	0.2	55.4	0.3	55.7	0.8	56.5
4 Neck base circumference	27.7	1.1	28.8	1.0	29.8	1.0	30.8	0.5	31.3	1.2	32.5	1.1	33.6	1.2	34.7	1.9	36.6	1.4	38.0	1.5	39.4	0.7	40.1	2.0	42.1
5 Armhole circumference	21.0	1.0	22.0	1.6	23.6	1.5	25.2	0.6	25.8	1.8	27.6	1.6	29.2	1.5	30.7	1.3	32.0	1.1	33.1	1.7	34.8	0.8	35.6	2.2	37.7
6 Shoulder circumference	60.1	2.5	62.6	4.0	66.6	3.8	70.4	1.8	72.1	4.2	76.4	3.9	80.3	4.7	85.0	3.6	88.6	3.4	91.9	5.1	97.1	1.2	98.3	4.2	102.5
7 Bust circumference	49.0	1.7	50.7	2.9	53.6	1.9	55.5	2.6	58.1	2.7	60.8	3.7	64.6	4.1	68.6	4.2	72.8	2.4	75.2	6.1	81.3	-0.1	81.1	4.4	85.5
8 Waist circumference	48.2	1.2	49.4	1.5	50.9	1.8	52.7	0.7	53.4	1.9	55.3	2.5	57.8	2.4	60.2	2.3	62.5	1.6	64.1	3.0	67.1	-0.9	66.2	2.6	68.8
9 Hip circumference	51.5	3.0	54.5	3.3	57.9	3.7	61.6	2.1	63.8	3.6	67.4	4.6	72.0	4.6	76.6	4.7	81.3	3.8	85.1	5.4	90.5	-0.4	90.1	6.8	96.8
10 Biceps circumference	15.3	0.4	15.7	0.9	16.6	0.8	17.4	0.3	17.7	0.9	18.5	1.2	19.7	1.3	21.0	0.8	21.8	0.5	22.3	1.6	23.9	-0.4	23.5	0.2	23.7
11 Wrist circumference	10.9	0.2	11.1	0.4	11.5	0.5	12.0	0.1	12.1	0.5	12.6	0.5	13.1	0.6	13.7	0.5	14.2	0.3	14.5	0.5	15.0	0.0	15.0	0.9	15.8
12 Thigh circumferece	29.5	1.8	31.3	2.0	33.3	1.9	35.2	1.7	36.9	1.9	38.8	3.2	42.0	2.9	44.9	2.7	47.6	2.2	49.9	3.0	52.9	-0.2	52.6	4.0	56.7
13 Height	86.5	9.2	95.8	8.0	103.8	7.8	111.6	6.6	118.2	7.5	125.7	7.9	133.7	6.8	140.5	7.2	147.7	6.3	154.0	5.9	159.9	6.1	166.0	10.9	176.8
14 Nape to floor	69.7	8.1	77.9	7.4	85.3	7.1	92.4	5.8	98.2	6.9	105.0	7.6	112.7	6.5	119.1	6.7	125.9	5.7	131.6	5.0	136.7	5.1	141.8	10.5	152.3
15 Crutch to floor	35.9	4.1	40.0	4.5	44.6	4.9	49.5	4.2	53.7	4.8	58.4	4.8	63.3	3.9	67.1	4.3	71.4	3.1	74.5	3.0	77.5	2.2	79.7	4.1	83.8
16 Scye depth	60.8	7.3	68.1	6.2	74.4	6.5	80.9	5.6	86.5	5.8	92.3	7.0	99.3	5.7	105.0	6.2	111.2	5.1	116.4	4.4	120.8	3.7	124.5	8.6	133.1
17 Waist to floor	50.0	6.8	56.8	5.7	62.5	5.5	68.0	5.0	73.0	5.4	78.4	6.0	84.5	5.1	89.6	5.1	94.7	4.0	98.7	4.1	102.8	3.3	106.1	7.9	114.0
18 Hip to floor	38.4	6.1	44.5	4.8	49.4	5.2	54.5	4.5	59.0	4.9	63.9	5.2	69.0	4.5	73.5	4.3	77.9	3.5	81.4	3.2	84.5	2.3	86.9	5.3	92.1
19 Knee to floor	22.3	3.3	25.6	2.7	28.4	2.1	30.5	2.3	32.8	2.6	35.4	2.7	38.0	2.4	40.4	2.0	42.4	1.8	44.1	1.6	45.7	1.3	47.1	2.7	49.8
20 Nape to waist	19.2	2.1	21.3	2.0	23.3	1.6	24.9	1.0	25.9	1.6	27.5	1.8	29.4	1.4	30.8	1.5	32.3	2.0	34.3	1.6	35.9	1.6	37.5	4.3	41.8
21 Waist to hip	11.6	0.7	12.3	0.8	13.1	0.4	13.5	0.5	14.0	0.5	14.5	0.9	15.4	0.7	16.1	0.8	16.9	0.5	17.3	0.9	18.3	1.0	19.2	2.6	21.9
22 Nape to bust point	18.7	1.1	19.7	1.2	20.9	1.2	22.1	0.5	22.7	1.1	23.8	1.3	25.1	1.4	26.5	2.1	28.6	1.3	29.9	2.5	32.4	0.1	32.5	3.0	35.5
23 Shoulder wrist (straight)	27.1	3.1	30.2	2.6	32.8	2.8	35.6	2.3	38.0	3.1	41.1	2.7	43.7	2.2	45.9	2.9	48.8	2.2	51.1	1.9	53.0	1.4	54.4	3.6	58.0
24 Across front	21.6	0.5	22.0	1.0	23.0	1.4	24.4	0.7	25.1	0.7	25.8	1.0	26.8	1.0	27.8	1.6	29.4	1.2	30.6	1.8	32.5	0.2	32.6	1.0	33.7
25 Shoulder breadth	21.8	1.9	23.7	2.3	26.0	1.8	27.9	0.9	28.7	1.6	30.3	1.4	31.7	1.8	33.5	1.4	34.9	1.2	36.1	2.0	38.1	1.0	39.1	3.2	42.3
26 Across back	20.6	1.6	22.2	2.1	24.2	1.4	25.6	0.3	26.0	1.2	27.2	1.4	28.6	1.7	30.3	1.4	31.7	0.8	32.4	2.1	34.6	0.8	35.4	1.4	36.8

Key: Actual measurement (thin box); Increment (thick box)

The inconsistent increments, as calculated in Tables 4.20 and 4.21 above were, apart from indicating the potential differences between the different measurements of each size fit dummy, also the indicators of growth for children between the ages of two and 14 years. These initial body measurement tables can be further analysed to identify specific growth patterns between the ages of two and 14 years. For the purposes of this study, the growth pattern in terms of height was important and will be discussed in more detail in the next section.

4.7 GROWTH PATTERNS

Growth patterns are important when developing ranges of fit dummies for children. In this study the age of gender split was of importance and the growth patterns gave evidence of the rate at which boys and girls developed either similarly or separately at various ages. Because body measurements in any survey involving children can be influenced more by age than by any other single factor as the child grows (Kunick, 1984: 22), it is necessary to recognise the importance of growth.

The measurements of the sample studied were grouped in single age groups related to specific height ranges where height measurements were used as the criterion for the sizing system (Tables 4.8 and 4.9). The single age group recorded as the age range in Table 4.22 and 4.23 (row four), refers to the period from one birthday to the day before the next birthday, while the height ranges (recorded in row two) are indicators of a child's average growth in height within that particular year. The "growth grades" (recorded in row three), give evidence of the extent to which South African children could grow in height, on average, within a 12 month period as analysed. As an example, it could be extracted from the tables below that a boy of four years could grow on average about 7 cm in height between his fourth and fifth birthdays. Similarly, a girl of four years could grow on average about 5 cm in height between her fourth and fifth birthdays. There was, however, no evidence to conclude that all children will grow in the same proportion during the same period of growth.

TABLE 4.22: ESTIMATED ANNUAL INCREASE IN HEIGHT OF BOYS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

Size code	1	2	3	4	5	6	7	8	9	10	11	12	13
Height range (cm)	86-92	93-100	101-109	110-117	118-124	125-131	132-136	137-142	143-148	149-156	157-164	165-172	173-179
Growth grade (cm)	6	7	8	7	6	6	4	5	5	7	7	7	6
Age range (years)	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14

TABLE 4.23: ESTIMATED ANNUAL INCREASE IN HEIGHT OF GIRLS BASED ON THE HEIGHT RANGES AS SIZE CRITERION

Size code	1	2	3	4	5	6	7	8	9	10	11	12	13
Height range (cm)	86-92	93-99	100-108	109-114	115-121	122-130	131-137	138-144	145-151	152-156	157-162	163-168	169-175
Growth grade (cm)	6	6	8	5	6	8	6	6	6	4	5	5	6
Age range (years)	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14

Tables 4.22 and 4.23 indicate no constant increase in height and growth between the different ages or between the different genders. There are many factors influencing anthropometric dimensions, which account for these inconsistencies. These factors have been discussed in depth in paragraph 2.6.1. The reasons for varying growth patterns between ages and genders were not investigated in this study, but the importance of the different factors should be noted. The average growth grade of boys during the 13-year period as recorded in Table 4.22, indicates a mean growth grade of 6.2 cm. In Table 4.23 this average growth grade for girls was calculated as 5.9 cm. It can thus be argued that boys grow on average only 0.3 cm more in length in a year in comparison with girls which could equate to about 3.9 cm in total over the 13 year period. This result is in line with the difference in maximum height recorded for boys and girls over a 13-year period.

To identify the specific sizes to be chosen for fit dummy prototype development, it is important to focus on the annual height increase and growth rate. The specific age of gender split could therefore be identified within the given size ranges for boys and girls. The information extracted from the graph below was interpreted and implemented when decisions were made regarding the sizes of fit dummies to be developed. In Figure 4.5 the growth patterns of boys and girls were plotted separately, with the annual increase in height measurements plotted against the increase in age.

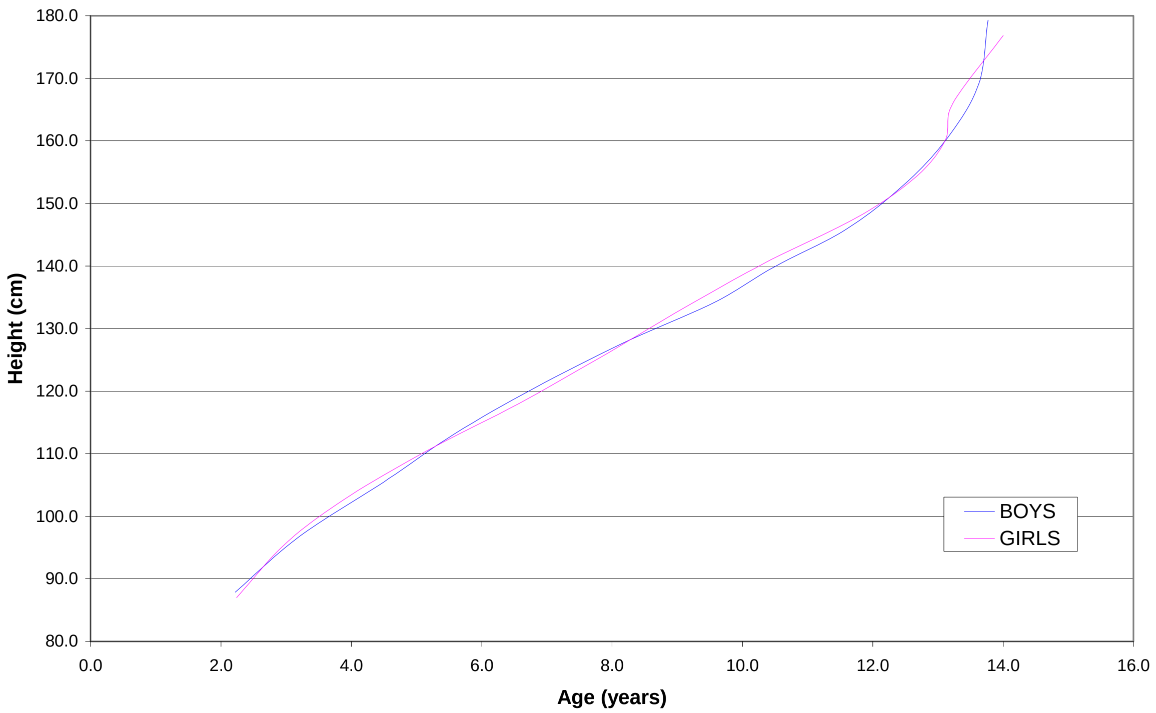


FIGURE 4.5: GROWTH PATTERNS OF BOYS AND GIRLS WITH HEIGHT MEASUREMENTS ON THE VERTICAL (Y) AXIS AND AGE ON THE HORIZONTAL (X) AXIS

The graph in Figure 4.5 illustrates the curve as an inverted "S" shape indicating growth spurts up to about age three, as well as from about age 12 up, for both boys and girls. The only difference between the two genders was considered to be the extent of the growth spurt. Between ages three and 12, the mean height values appeared to be relatively linear indicating a more steady height growth pattern for both boys and girls. This is confirmed in paragraph 2.7.4, indicating that there is less gender dimorphism up to about age twelve than in adolescents and adults.

Figure 4.5 also indicated that boys were slightly bigger than girls at age two, with girls growing a bit taller than boys between ages three and five. Thereafter, boys appear to grow taller quicker up to about age eight. From age eight to age 12, girls appear to be taller than boys, and thereafter there is a bigger increase in the height of boys than of girls. The sudden increase in height at age 13 of the girls should be ignored, since this could be evidence of not measuring enough girls in this particular age group. It can be argued that the age of gender split could appear between the ages of seven and eight years. Although the body measurements are relatively similar, on inspection of the photographs it can be seen that this assumption is based on the body mass distribution.

Before fit dummies could be developed, it was important to decide what size and gender dummies to develop, based on the height ranges as size criterion. This aspect will be discussed in the next section.

4.8 FIT DUMMY PROTOTYPE DEVELOPMENT

In the South African children's wear market; ages four, six and 12 fit dummies have traditionally been used as sample sizes by different children's wear retailers. Therefore fit dummies were developed in these particular sizes. In contrast, and as a basis for the decision regarding the sizes of fit dummy prototypes to be developed in this study, the results of the body measurement tables recorded in Tables 4.20 and 4.21 were implemented along with the interpretation of the graph in Figure 4.5 and the photographs which had been taken of the children measured. The standardised photographs taken of each child measured, are included in this study and have been described in Appendix 5: Section 7. Although not an exact replica, these visual references of silhouette, posture and stance have facilitated the development of the three-dimensional fit dummies. Based on combinations of this information, the company developing the fit dummy prototypes was able to develop fit dummies suitable for the South African children's wear market.

As a starting point, the body measurement tables (Tables 4.20 and 4.21) were implemented as ranges of key body measurements according to the specific height ranges. Furthermore, the interpretation of Figure 4.5 indicated that up to about age 12, there is no significant difference between the height measurements of boys and girls. There could, however, be significant differences in terms of the body mass distribution and the proportions of the upper torso versus the lower torso. Based on height measurements, it appeared that for the sample studied, it was acceptable to develop "unisex" fit dummies of any age up to age 12. The fit dummy prototypes developed were all based on body measurements of children whose measurements were close to the mean values of the seven key measurements in Tables 4.16 and 4.17. Within each size category it was possible to select photographs of a number of different children, facilitating the three-dimensional dummy development in terms of silhouette, posture and stance. Figures 4.6 (a) and (b), 4.8 and 4.10 are examples of photographs of some of the children selected.

The first dummy to be developed was the “unisex” fit dummy prototype for size three, height range 101 to 109 cm and the age range of 3 to 4 years, as captured in Figure 4.7. Based on the photographs of the boys’ silhouette and shape in Figures 4.6 (a) and the girls’ silhouette and shape in Figure 4.6 (b), the development of the “unisex” dummy of this size was confirmed. The 1 cm difference between the maximum height range of boys and girls was ignored in this particular development.

FIGURE 4.6(a): SIZE THREE (BOY) PHOTOGRAPHIC EXAMPLES SELECTED AS BASIS FOR THE DEVELOPMENT OF THE FIT DUMMY PROTOTYPE SILHOUETTE AND POSTURE

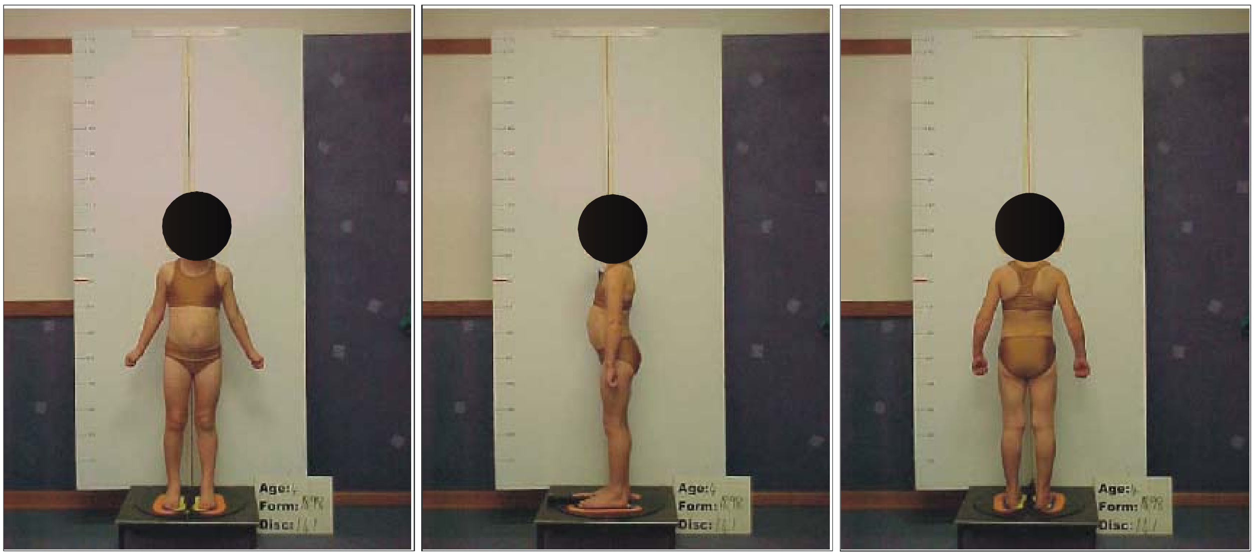


FIGURE 4.6(b): SIZE THREE (GIRL) PHOTOGRAPHIC EXAMPLES SELECTED AS BASIS FOR THE DEVELOPMENT OF THE FIT DUMMY PROTOTYPE SILHOUETTE AND POSTURE

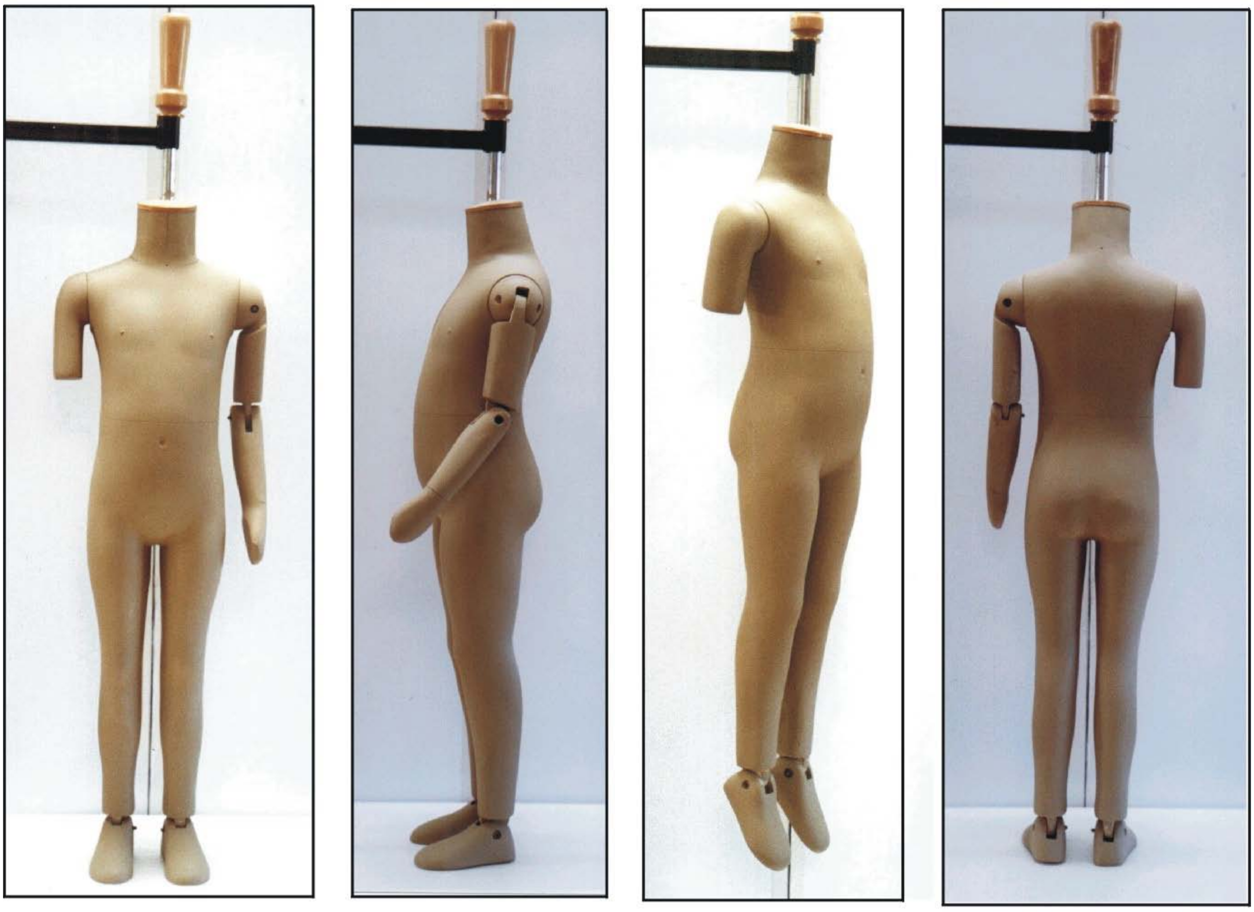


FIGURE 4.7: SIZE THREE "UNISEX" FIT DUMMY PROTOTYPE (Van Huyssteen, 2003:8)

On completion of the "unisex" size three fit dummy prototype, it became evident from the photographs in Figures 4.8 and 4.10 that the fit dummies for the ages above 12 years needed to be specifically male or female in shape and silhouette. On inspection of the photographs and after comparison of the body shape and silhouette, focussing on the body mass distribution and figure types, the gender dimorphism, as discussed in paragraphs 2.7.4 and 4.7, was evident.

Figures 4.9 and 4.11 are photographs of the fit dummies developed, based on the height sizing system developed in this study. The development of the fit dummy prototype for boys was based on the key measurements of the height range of 157 to 164 cm and age range of 11 to 12 years, as recorded in Table 4.20. On the other hand, the fit dummy prototype developed for girls was based on the key measurements of the height range of 157 to 162 cm and age range of 11 to 12 years, as recorded in Table 4.21.

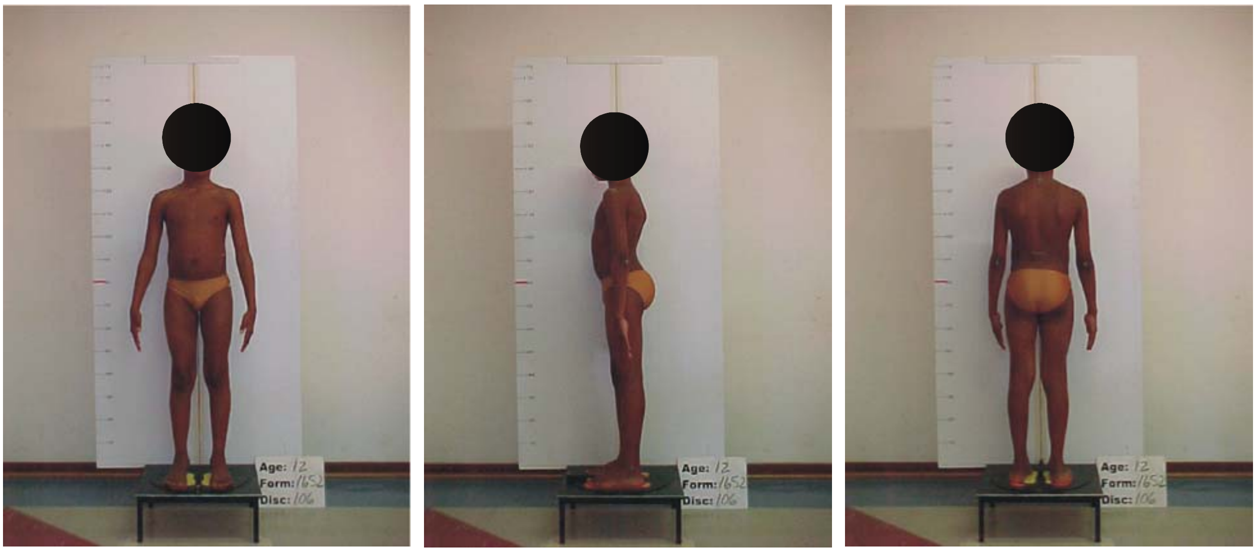


FIGURE 4.8: SIZE 11 (BOY) PHOTOGRAPHIC EXAMPLES SELECTED AS BASIS FOR THE DEVELOPMENT OF THE FIT DUMMY PROTOTYPE SILHOUETTE AND POSTURE

FIGURE 4.9: SIZE 11 BOYS FIT DUMMY PROTOTYPE (Van Huyssteen, 2003:9)

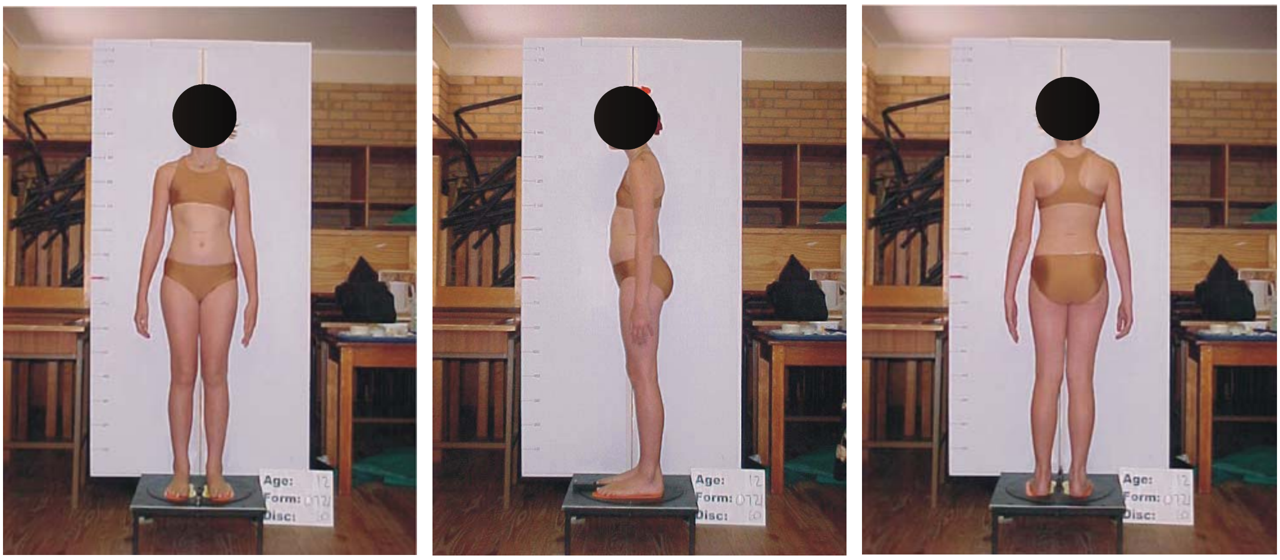


FIGURE 4.10: SIZE 11 (GIRL) PHOTOGRAPHIC EXAMPLES SELECTED AS BASIS FOR THE DEVELOPMENT OF THE FIT DUMMY PROTOTYPE SILHOUETTE AND POSTURE

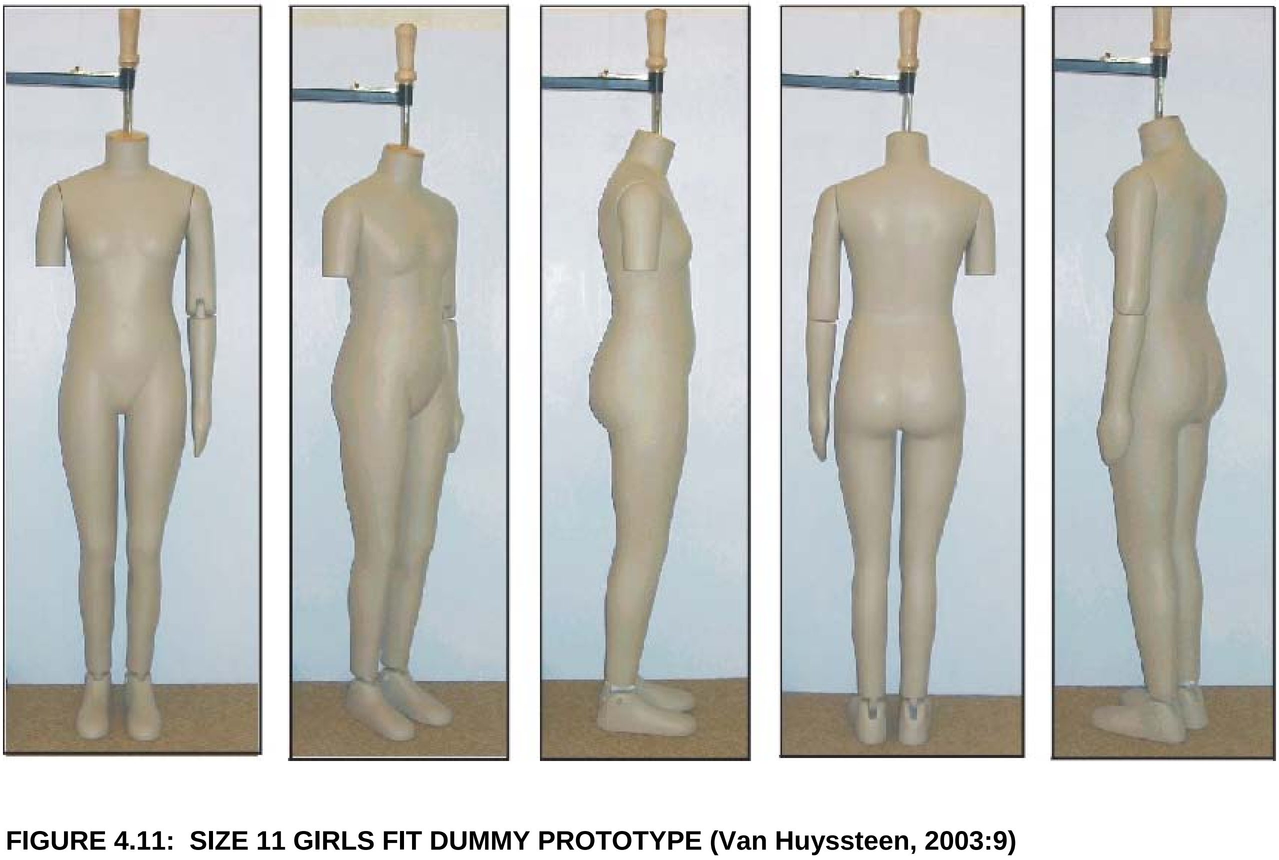


FIGURE 4.11: SIZE 11 GIRLS FIT DUMMY PROTOTYPE (Van Huyssteen, 2003:9)

The development of three-dimensional fit dummies was an essential phase in the compilation of body measurement tables suitable for use as size charts in pattern drafting and garment development. Only once the vertical, horizontal, depth and width measurements were all linked in the three-dimensional figure would it be possible to determine absolute values for individual points of measuring. The linking of all these measurements in the three-dimensional fit dummy prototype design would undoubtedly fall within the measurement ranges of Tables 4.18 and 4.19 for each measuring point. In this instance, the actual achieved measurement would be a value somewhere between the minimum and maximum values of the particular measurement range. The value of the actual body measurement would, however, influence the grade rule between the individual measurements in the drafting of patterns for different sizes.

The development of size charts for pattern drafting should be done using a similar approach as for body measurement table development. These charts should, however, be based on single body measurements as obtained from the three-dimensional fit dummies. These measurements also should be rounded measurements, preferably to the nearest 0.5 cm. The development of increments, better known as grade rules, between sizes should be based on the value of the difference between two sizes, and will also be a rounded measurement in order to achieve relatively even grades between different sizes. The final set of grade rules should be similar to Tables 4.20 and 4.21. In this instance the actual grade rules developed should be more detailed and be applicable for implementation in pattern drafting and grading.

4.9 CONCLUDING SUMMARY

The discussion of the results of the empirical study has been conducted in three stages, starting with the discussion of whether the data and body measurements and classification of the subjects measured, the capturing, editing and analysis of the data and finally the visual display of the data characteristics on a scatter plot are reliable. Analysis of the data began with the selection of key measurements based on the correlation coefficients. These were implemented to develop size designation systems for boys and girls separately, with the development of increments between sizes for the fit dummy prototype range development. At this stage the minimum and maximum values within the size ranges were demarcated for each key measurement. The discussion of the results concluded with the compilation of body measurement tables based on the growth patterns identified and suitable for the development of three-dimensional fit dummy prototypes in the specific size ranges demarcated for this study. Further developments in this regard will be discussed in Chapter 5.

CHAPTER 5

CONCLUSIONS, RECOMMENDATIONS AND IMPLICATIONS FOR INDUSTRY

5.1 INTRODUCTION

Developing standardised measuring methodologies and techniques relevant to the development of reliable and accurate body measurement tables to implement as a basis for the development of new sizing systems and fit dummy ranges for application in the South African children's wear market was the purpose and broad objective set for this study. In an effort to achieve this objective, Chapter 1 introduced the research topic in terms of the problem statement and motivation of the study.

Chapter 2 gave an overview of relevant literature pertaining to this study and focused on the most important aspects and concepts, such as conducting anthropometric surveys, developing size charts, international and standard sizing codes as well as developing sizing systems and size designation systems. Not only did this chapter cover the important and theoretical aspects of how to implement such a study, it also included summaries of measurement types and references to previous studies by which selection of particular measurements could be done for specific applications and outcomes pertaining to short term, smaller scale anthropometric surveys.

The research methodology of the empirical study employed was recorded in Chapter 3. The execution of the empirical study was discussed and the structure of the anthropometric survey conducted was recorded. This included the standards to which children were measured (in line with international requirements) while strict quality control measures were implemented to ensure the validity, reliability and accuracy of recorded data. The empirical study was conducted in three phases of which the first pilot study focussed on exploring and developing measuring methodologies, measuring instruments and a measuring guide. In the second pilot study the measuring methodologies, instruments and measuring guide were tested and refined. During the final study, anthropometric data was captured according to the standards recorded in the Field Worker Manual for the development of sizing systems and body measurement tables.

The discussion of the results of the statistical analysis was presented in Chapter 4. Initially the identification of key measurements as a basis for the development of the sizing systems was discussed. Thereafter, the guidelines for the development of body measurement tables suitable for the development of fit dummy prototypes were structured and implemented. The complete data analysis procedure was therefore recorded in this chapter.

Finally, Chapter 5 consists of conclusions, limitations identified during the study as well as recommendations and implications for industry regarding the body measurement tables developed for fit dummy prototype development and the proposed new sizing systems for the South African children's wear market. Recommendations for further research related and consecutive to this study were made.

5.2 CONCLUSIONS

The goals set for this original and renewed anthropometric study were met. This study addressed some of the sizing related shortcomings identified within the South African children's wear market. Demarcating and implementing workable solutions as corrective measures addressed these. Based on the results of the empirical study, the following conclusions can be made:

In the South African children's wear market; age has traditionally been used as the basis for the sizing and size designation systems applied by all leading children's wear retailers. The results of this study clearly show that age is not a good control measurement, given the lack of strength of the correlation of this relationship with all other measurements. The vertical measurement height was identified as the preferred control measurement to be implemented as a basis for a new and improved sizing system for the South African children's wear market in accordance with the hypothesis formulated for this study. Height is strongly correlated with all other measurements, indicating a very strong positive relationship with all other measurements. Although vertical trunk was the measurement with the highest correlation coefficient, height was selected over vertical trunk for practical reasons because it is the better known of the two and is also a less "invasive" measurement to take. By implication, height was found to be a better indicator of size of most of the other parts of the body than age. This result has far reaching effects on the current systems applied by the children's wear industry and indicates that consumers will be able to make better fit decisions if the sizing and size designation systems are based on a height.

It could be summarised from the results of this study that any size designation system developed for the South African children's wear market should be a "multi-indicator" system. It is recommended that such a system should be based on the link between height ranges, age ranges and/or numerical size indicators. Age was still important, both because of traditional practices and because it is the most common "measurement" available and known to the children's wear consumer. The numerical size indicator, on the other hand, accommodates the specific system needs of the retail company implementing the size designation system. To be successful in its implementation, this update will have to be managed carefully by retailers to achieve the desired results. Consumers should be exposed to these updates during a phasing in period while both the old and the new and improved size designation systems are used in garments. This process may take some time to succeed, depending on the way in which retailers, and by implication also manufacturers, approach this implementation. Implementing the new sizing system could entail introductory promotions since the consumers should be made aware of and guided into this new and better way of sizing garments. In the long run it will be to the benefit of both retailers and consumers.

Based on the above, height was selected and successfully implemented as the control measurement on which the newly developed sizing system was based. Due to the importance of height, the sizing system was based on height clusters, while dividing the target population into different height (size) groupings. The results of the cluster analysis indicated clusters of sufficient size to accommodate the potential growth of children over a one-year period. Because it was possible to identify minimum and maximum values for each cluster, these values (or measurements) could be implemented with great success in the development of fit dummy prototypes. Since it is impossible to base the body measurements of the three-dimensional fit dummy prototype on specific single measurement values, by implementing the measurement ranges fit dummy prototype developers were able to link the vertical and horizontal measurements both successfully and with ease.

This important update and innovative implementation of a new sizing system clearly distinguishes the new fit dummy prototype range from the current one. These new fit dummy prototypes with improved posture and stance; correct landmark positions and detachable arms with 360° movement facilitate the fitting of garments. It is now possible for technical experts to simulate the dressing action of a child and improve the fitness for purpose assessment when fitting garments.

It has also bee possible in this study to identify key measurements as important size indicators. Seven measurements, which were either good indicators of size or important for fit dummy and product development, were singled out. This is a very important addition to the available knowledge of South African children's wear body measurement tables, since it is now possible to select key measurements on a scientific basis. Since the measurements are true to life, the selection of garment sizes is facilitated, leading to increased consumer satisfaction.

One of the most advantageous results of this study is that the measurements of a full range of fit dummy prototypes were developed. The fit dummy prototypes were based on data that was scientifically based. The ease with which the three dimensional shapes were developed confirms that the measurements achieved through analysis are workable. The benefit for the retailers and manufacturers is that the new range fit dummy prototypes are authentic and follow a natural progression and development in size based on that of real children. This important application underpins further improvements that could be made in product development. Although this aspect has not yet been scientifically tested, it seems that consumers appear to react positive to the improvements.

Specific growth patterns have been identified for both boys and girls separately, indicating the occurrence of certain growth spurts at different ages and stages of development. It was therefore possible to identify the age of gender split at between the ages of 7 to 8 years. Increments were developed to indicate the differences in all body measurements between the different size fit dummy prototypes. These increments between sizes were found to be irregular in most instances, and due to growth factors identified within the target population. Size charts for use in pattern and garment development can only be developed once the body measurement tables of the complete set of dummies have been confirmed. Similarly, grade rules for application in pattern and garment development can be developed only on completion of these final size charts. Because children grow at different rates, the knowledge of growth patterns has given retailers greater insight into the number of sizes that should be developed within a specific product range. As an example, due to the growth in height and leg length, more sizes will be needed to optimise the fit of trousers, while groupings of sizes should suffice for garments of types such as loose fitting T-shirts.

The results of this research can therefore be considered as renewing previous knowledge while being, at the same time, original in it's application. The main benefit of this survey was that more detailed as well as more accurate and scientifically sound data on the size and shape of the typical South African children's wear consumer has been made available. This study has made a major contribution to this particular market sector, with specific benefit to the children's wear manufacturers, leading children's wear retailers and all children's wear consumers. With access to this new and improved data, children's wear manufacturers and retailers could now use and implement it in both fit dummy and product development. This information, therefore, reduces the confusion amongst retailers regarding children sizes. Simultaneously, implementation of this information has resulted in increased consumer satisfaction. However, the original aspect of this research lies in the development of new body measurement tables for fit dummy prototype development. This new height based sizing system is the basis for an improved size designation system for industry. The implementation of the new height based sizing system, in contrast with the current age based systems, has led to a renewed outlook in industry regarding its application in both manufacturing and at retail level.

A further important contribution to the South African children's wear industry was the development, refinement and recording of detailed methodologies for anthropometric surveys of this nature within the South African context. For the first time, information of this nature was scientifically standardised and recorded in such a format that consecutive and comparative studies can be executed with great ease and the highest level of accuracy and success. The nature of the processes, the standardisation of equipment and the clear and concise method of instruction, supported by descriptive photographs throughout the entire measuring process, was a great asset to the South African children's wear industry. An added advantage was that not only could this information be applied in the specific market sector, but it could also be used as a basis for similar or related studies. With regard to surveys by means of 3D scanning, these research results could be a well-structured basis to take as a starting point because of the nature and application of the measurements and methodologies successfully applied in this research study.

The primary limitations on this anthropometric survey could be attributed to budgetary constraints, and a shortage of time and manpower to be able to conduct a survey of this nature. Because most studies of this nature have been conducted randomly, a scientific approach such as has been followed in this study is imperative. In the following section aspects regarding the limitations important in this study are recorded.

5.3 LIMITATIONS

This study was designed with circumspection to yield accurate and reliable data. Sections 2.10.3.3 to 2.10.3.5 described all the measures that should be taken to ensure valid and reliable results. Although these important aspects were not downscaled in this study, some restrictions had to be implemented in certain areas, which resulted in the following limitations:

The geographical area where children were measured was restricted to selected areas in the Western Cape and Gauteng, in the ratio 2:1. The question of the study covering wider geographical areas was debated, but although the impact of different geographic areas according to the recommendations in paragraph 2.10.2.4 were supported and considered in this study the selection and implementation thereof was limited due to budgetary constraints.

Children could only be measured during a fixed period of 59 five-hour working days, with a total of 44 working days in the Western Cape and 15 in Gauteng. Furthermore, measuring times were limited by the teaching timetables at schools. Although field workers were available to measure in the afternoons, children at primary and secondary schools were not on the premises. At day care centres and nursery schools, the scheduled sleeping times and the time when parents fetched their children restricted these measuring periods.

Although the ages of children were recorded in 12-month intervals, with further data analysis and interpretations of trends it would, however, be possible to achieve extended results and more detailed conclusions.

The analysis of the data focused on the development of a sizing system for boys and girls separately, including the development of body measurement tables which is to be recommended as a basis for the development of fit dummy prototypes only. This survey operates from the premise that once the fit dummy prototypes and body measurement tables had been developed, technical experts would be able to continue with the successful application and implementation of these systems into product development.

The limitations mentioned were identified as important guidelines in structuring further studies. Related practical problems, with important implications for industry pertaining to measuring and data collection, were identified through proper debriefing discussions between the researcher, field co-ordinator and fieldworkers on completion of the final study. These were recorded in detail as Appendix 6. Considering the success of the final study, regardless of the limited budget, these are important aspects to focus on during consecutive similar studies. The following section deals with recommendations and implications for industry.

5.4 RECOMMENDATIONS AND IMPLICATIONS FOR INDUSTRY

The recommendations that follow were made to the industry for implementing the new sizing system. The data presented as a basis for the final fit dummy prototype development, may well need to be managed and adjusted by industry to comply with their needs so as to be applicable within a specific context. In this study, the data collected was grouped and arranged according to specific height clusters, resulting in the development of both sizing systems and size designation systems based on the height measurements of all children measured in the sample. Furthermore, in instances where only certain sectors of the sample population were to be the focus, industry would be able to extract only the necessary information for that sector.

The comprehensive body measurement tables developed in this study serve as an excellent basis for fit dummy prototype development within a range of the minimum and maximum values of all measurements. This enables the fit dummy prototype developer to interpret the measurements correctly and to link vertical and horizontal measurements to achieve excellent results in developing authentic fit dummy prototypes in terms of the posture, stance and total body measurements, with specific focus on the key measurement locations. These minimum and maximum values also allow retailers to develop clothes to fit children during a certain period of growth within a specific size designation.

Retailers and manufacturers within the South African children's wear market sector each have a specific preference as to styling and, in particular, in the fit, over body tolerance and fitness for purpose of their ranges. Although they will be using the same range of fit dummy prototypes, the specific fit and over body tolerance of their own ranges could very well differ between the two genders, in the sizes (influenced by styling based on fitness for purpose restrictions and requirements) and, more specifically, between retailers. Because more accurate, reliable and more comprehensive information is now available to industry, technical experts and retailers can now make better decisions and be more effective in producing the product offered.

Each retail company choosing to implement the new height based sizing system will have the option of deciding which specific size designation system would be more suitable for both their consumers and their internal systems. This choice could be based on the proposed system discussed in Section 4.4.4 (Tables 4.8 and 4.9).

The identification and implementation of the different important body landmarks for measuring has facilitated fit dummy prototype development and will, even more so, facilitate improved pattern drafting, garment development and fit assessments, resulting in an improved product offering for the typical South African children's wear consumer.

5.5 RECOMMENDATIONS FOR FURTHER STUDY

Based on the results of this study it has been possible to make recommendations that could be implemented for further study. The objectives set and results achieved through this research could be implemented and expanded in successive studies. Limited reference has been made to further areas of development of the measurement tables in this study. The development of body measurement tables and size charts for pattern drafting and garment development can be finalised on completion of the fit dummy prototype ranges. These final size charts will be relevant for application in product development, starting with pattern drafting, garment development and subsequent fitting trials.

More detailed analysis can be conducted on the data set, in order to identify important differences between, for example, the two sectors of the study population and geographic areas. Aspects such as the important size indicators in different population affiliations, growth pattern differences and differences in the body mass distribution, body shape, silhouette and stance can also be studied successfully.

The changes in width, height and weight with the increase in age have been recognised in this study. These changes need to be thoroughly understood in order to make clothing that fits children comfortably and is suitable for its intended purpose. However, it is a requirement that information should be updated regularly over time taking into consideration the change in rate of growth from one generation to another.

Important deductions can be made regarding the selection of critical measurements as indicators of the total body size and as size indicators of the size of specific parts of the body. With this information, consecutive studies may need to focus only on the most important and key measurements for sizing and sizing system development. Through this, the cost of such a study would be reduced dramatically.

The framework developed in this study for a short term, relatively small scale manual method of measuring children, can be adapted for implementation in similarly measuring infants and adult groups, with focus on the South African clothing industry. In support of the current infants survey being conducted by Figure Forms, and the “Fit for the People” initiative by African Body Dimensions, great needs exist in various target markets, such as the newborn to toddler age group, the young adult or teenager age groups, and specifically the male and female adult groups of various ages and heights, including special groups such as the large size figure types for both the male and female market sectors. This list is endless in the South African context, and all these sectors are due for original research or updates to their sizing policies. Similarly, the methodologies and specific equipment developed in this study could be adopted for these studies.

5.6 CONCLUDING REMARKS

The purpose of this study was to develop standardised measuring methodologies and techniques relevant to the development of reliable and accurate body measurement tables to implement as a basis for the development of a new sizing system and fit dummy prototype ranges for application in the South African children's wear market. It is believed that the standards set and methodologies designed, developed and implemented in this survey have had a positive impact on the sizing and fit of children's wear in the South African context. The results open up new avenues for manufacturers, retailers and consumer alike. Implementation of this sizing system has resulted in an increase in sales and fewer returns due to poor fit, which means greater customer satisfaction, and at the same time, increased profitability for retailers.

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APPENDIX 1

Anatomical terms and other relevant terms

ANATOMICAL TERMS

(BSI, 1990:7; Lohman *et al.,* 1988:11; Cooklin, 1991:304; Barcsay, 1999:11 & Kunick, 1984: 38-39)

Acriomiale (bone shoulder)
The outermost points that can be palpated along the spines of the scapulae (shoulder blades), with the arms hanging down.

Acromion
Shoulder point.

Anterior (ventral)
To the front. This term applies to the surface of the face and front of the trunk and limbs, the hands being held palms forward.

Axilla
The armpit.

Bitrochanteric
Body width at hip level.

Cervicale (nape)
The prominent bone at the base of the back of the neck (spinous process of the seventh cervical vertebra).

Distal
Away from the body. In the limbs, this means further from the trunk.

Elbow
The most prominent body protuberance of the olecranon process (elbow joint), when the subject's right hand is placed on the hip (fingers pointing forward, thumb pointing back).

Fibular (peroneal)
In limbs, this term refers to the outer side of the lower leg.

Girth
Circumference.

Hip

The point of the maximum hip circumference in a horizontal plane.

Inferior (caudal)

Away from the head, in a downward direction toward the sole of the foot.

Knee crease

The point in the mid-line of the popliteal crease at the back of the knee under the normal weight bearing.

Larynx

Adams apple.

Lateral

Toward the outer sides of the body. This term refers to the body parts farther from the median plane.

Medial

Toward the midline of the body. This term designates those parts of the body, closer to the median plane of the body.

Metacarpophalangeal crease

The flexion crease of the right middle finger where the palmar base of the finger meets the palm of the hand.

Neck point

The points where the neck joins the shoulders in the mid-shoulder planes.

Posterior (dorsal)

To the back. This term applies to the surface opposite to the anterior. In limbs, this term refers to the side opposite to the palm or the sole.

Proximal

Toward the main mass of the body. In the limbs, this means closer to the trunk.

Radial

In the forearm this term refers to the side related to the radius, the outer of the two bones of the forearm, extending from the elbow to the wrist.

Scye

Armhole.

Subcutaneous

Under the skin.

Superior (cranial, cephalic)

Toward the head, toward the top. This term means the direction toward the calvaria (upper part of the skull).

Thenar eminence (wrist crease)

The crease where the thickened, muscular portion of the hand forming the base of the thumb joins the arm.

Tibial

In limbs, this term refers to the side of the tibia, the inner and thicker bone of the lower leg (shin bone).

Tibiale

The back of the knee joint. Also referred to as the point at the upper inside (medial) edge on the head of the tibial bone of the lower leg.

Trunk Line

From the base of the armhole to the waist at the side.

Ulnar

In limbs, this term refers to the side of the ulna, the inner of the two bones of the forearm.

Ulna point (wrist)

The most distal point of the ulna bone (wrist end) outside of the forearm with the right hand placed on the hip, as for the elbow.

Upper arm scye mark (shoulder point)

The most prominent and usually highest point approximately 20 to 30 mm in from the marked acromiale, ie. where the outer end of the clavicle (collar bone) meets the acromion (acromio-clavicular joint).

OTHER RELEVANT TERMS

Anthropometry: Measurement of the human body.

Landmark: A prominent point of the skeleton that can be located under the skin by inspection and palpation.

Maturation: Period of maturing, development.

Nomenclature: Systematic naming.

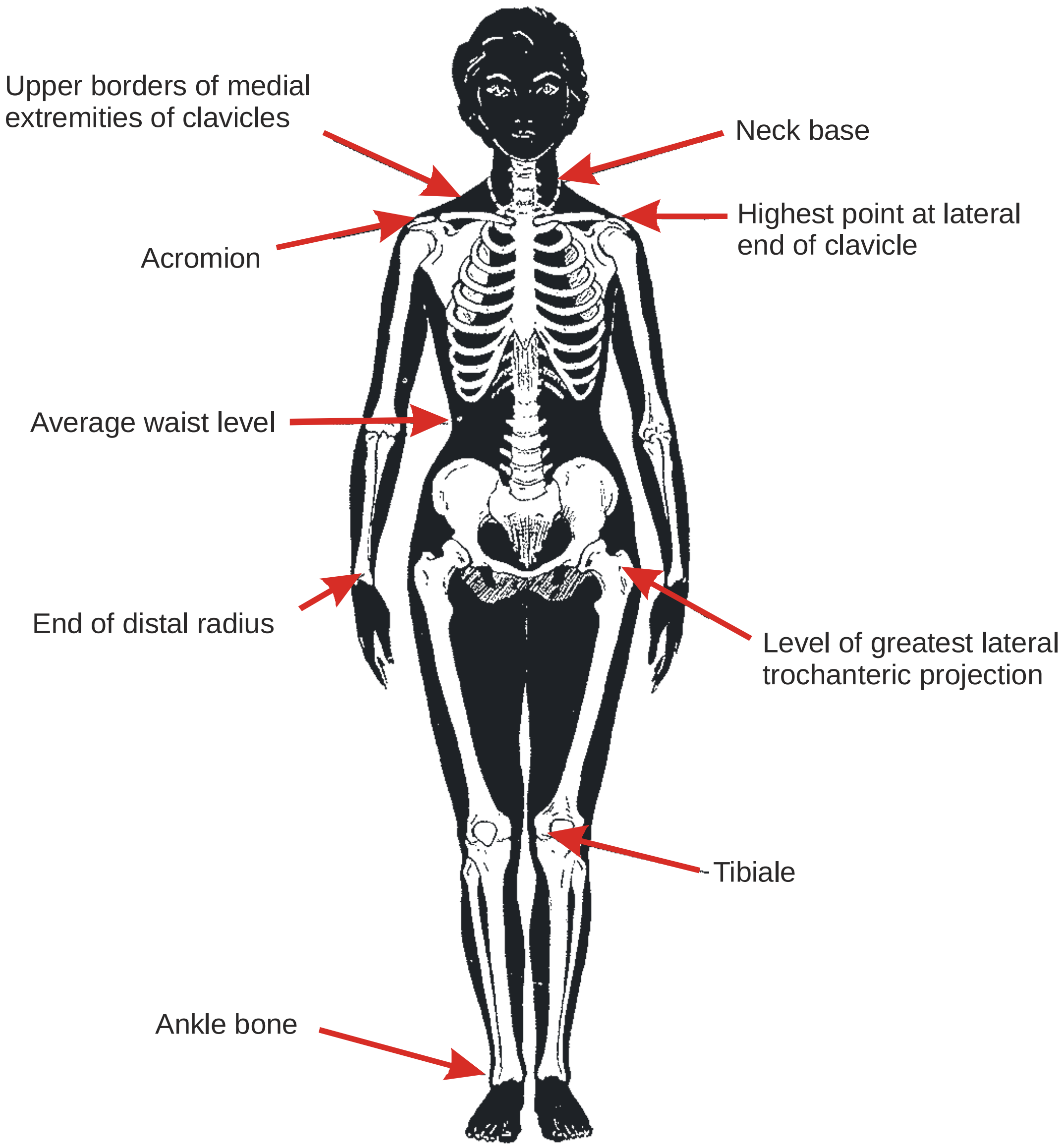
The Frankford Horizontal Plane: This refers to the position the subject is in when looking straight ahead (in the line of vision) with the head horizontal, and the sagittal plane of the head vertical.

APPENDIX 2

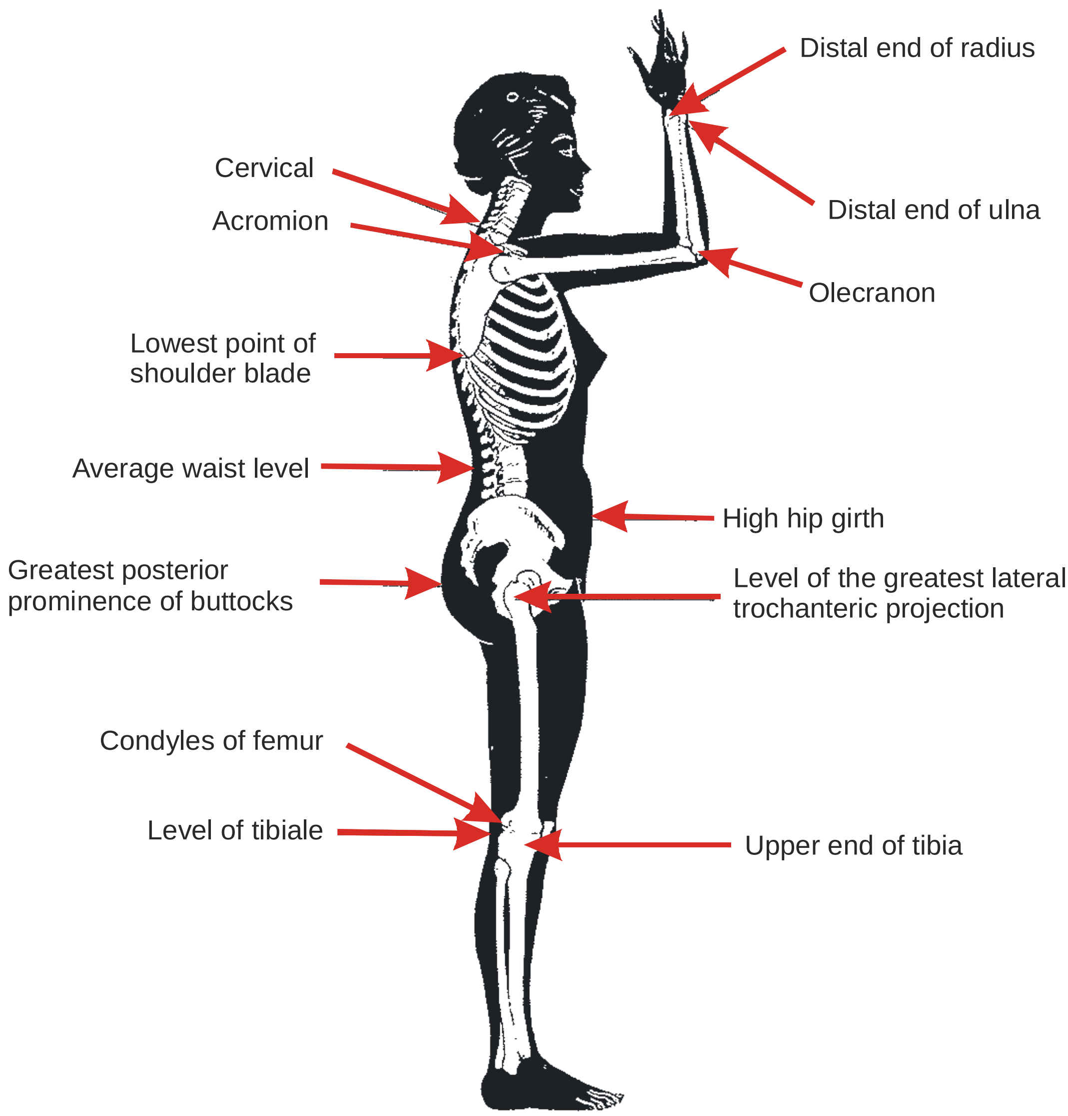
The human body with bone drawings

(Kunick, 1984: 35-37)

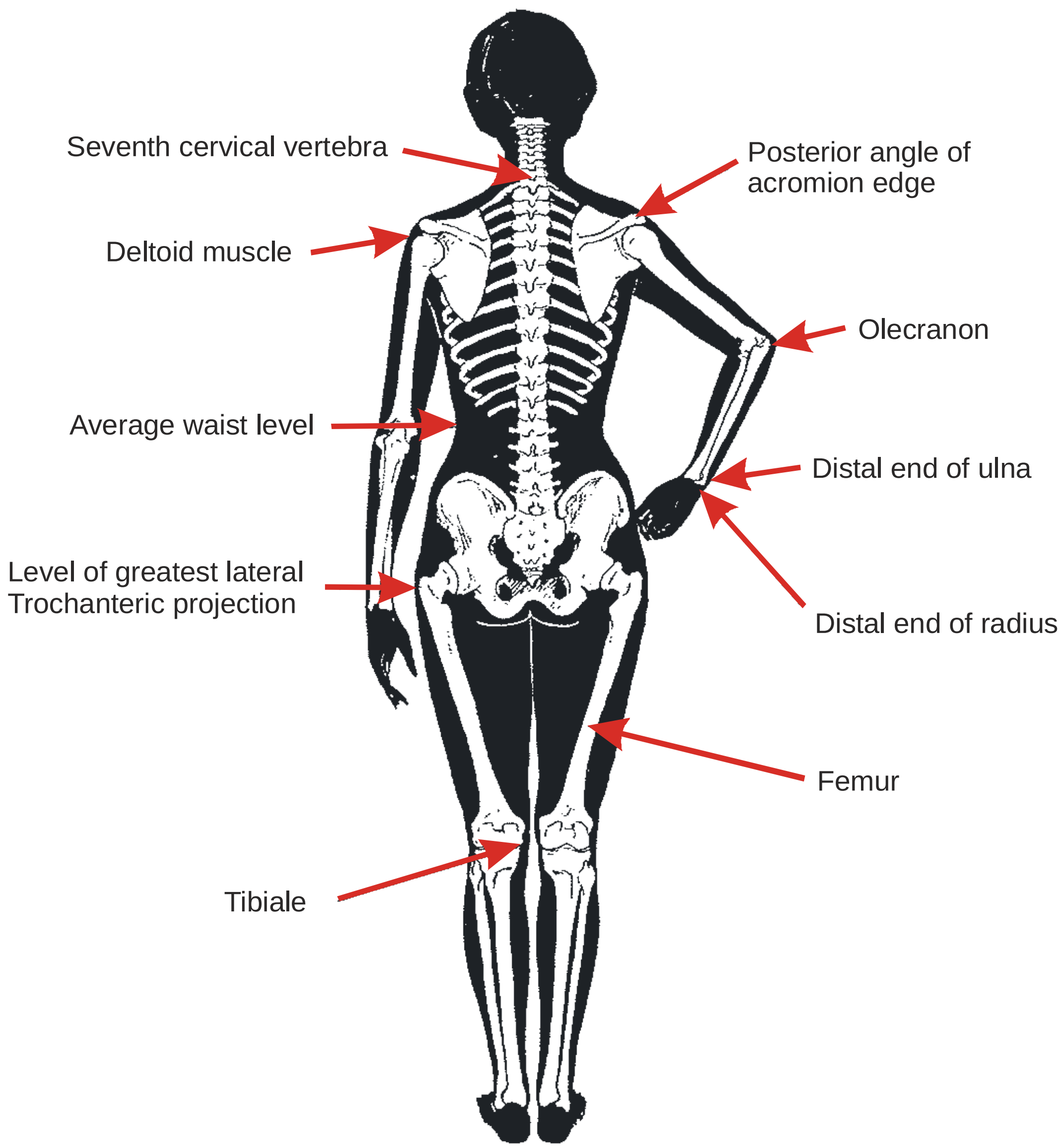
FRONT VIEW



SIDE VIEW


Distal end of radius
Cervical
Acromion
Distal end of ulna
Olecranon
Lowest point of shoulder blade
Average waist level
High hip girth
Greatest posterior prominence of buttocks
Level of the greatest lateral trochanteric projection
Condyles of femur
Level of tibiale
Upper end of tibia

BACK VIEW


Seventh cervical vertebra
Posterior angle of acromion edge
Deltoid muscle
Olecranon
Average waist level
Distal end of ulna
Level of greatest lateral Trochanteric projection
Distal end of radius
Femur
Tibiale

APPENDIX 3

Body measurement project: children's wear, ages 2 to 8 (boys and girls)

This document comprises five sections, including:

1. Planning of measuring activities

This includes information on each of the measuring centres, the measuring dates and times, the profile of the children to be measured, the child's dress code during measuring, indemnity, field worker groups as well as a list of equipment needed.

2. Guide for field workers

This comprises the field worker "code of conduct" and lists important guidelines when handling and dressing the children, their posture and stance, points of measuring as well as the responsibilities of each field worker.

3. Indemnity form

The *indemnity form* (Appendix 1a) which had to be completed and signed by parents and/or guardians before any child could be measured.

4. Measurement chart

Each child's measurements were recorded on a separate *measurement chart* (Appendix 1b).

5. Measuring guidelines

The "*How to measure guide"* contains specifications on preparing the child for measuring, measuring each of the height, length, girth and width measurements as well as information on how to weigh the child. It also provides guidelines on taking photographs.

APPENDIX 3a

Indemnity form

INDEMNITY FORM

I herewith grant permission to the Quality Assurance Team from The Foschini Group to measure my child.

I agree to have the measurements, as listed on the reverse of this form, taken over underwear or swimwear providing it is done in the presence of a teacher from Kiddies Campus.

Yes ☐ No ☐

Name of child: …………………………………………………………… Date: ……………………………

Signature of parent: …………………………………………… Mother ☐ Father ☐

Personal Information of Child

Name of child: ☐

Name of parent to contact: ☐

Date of birth: Year ☐ Month ☐ Day ☐

Tel. of parents: (w) ☐ (h) ☐

Language: Afrikaans ☐ English ☐

School: ☐

School Tel.: ☐

Gender: Girl ☐ Boy ☐

Area of home: Town ☐

Suburb ☐

Extramural activities your child takes part in (please list i.e. ballet, karate, etc.):

INDEMNITY FORM

I herewith grant permission to the Quality Assurance Team from The Foschini Group to measure my child.

I agree to have the measurements, as listed on the reverse of this form, taken over underwear or swimwear providing it is done in the presence of a teacher from Kiddies Campus.

Yes	**X**	No	

Name of child: **AAAAAA BBBBBB**…………………………………… Date: **16.02.1999**

Signature of parent: ……………………………………………

Mother	**X**	Father	

Personal Information of Child

Name of child: **AAAAAA BBBBBB**

Name of parent to contact: **AAAAAA BBBBBB**

Tel. of parents: (w) **000 000 0000** (h) **000 000 0000**

School: **AAAAAA BBBBBB**

School Tel.: **000 000 0000**

Date of birth:

Year	**1994**
Month	**2**
Day	**16**

Language:

Afrikaans	**X**
English	

Gender:

Girl	**X**
Boy	

Area of home: Town **CAPE TOWN**

Suburb **DURBANVILLE**

Extramural activities your child takes part in (please list i.e. ballet, karate, etc.):

BALLET
MONKEYNASTICS

APPENDIX 3b

Measurement chart

Attention Parents: This sheet is for your information only.
DO NOT complete this part of the form.

	Age group	2	3	4	5	6	7	8
	Dates measured							
1	**HEIGHT**							
2	Nape height to floor							
	LENGTH							
3	Back nape to waist							
4	Side waist to crutch							
5	Side waist to knee							
6	Side waist to ankle							
7	Side waist to floor							
8	Shoulder							
9	Nape to elbow							
10	Nape to wrist							
11	Crutch (front to back waist)							
12	Vertical trunk							
	GIRTH							
13	Head							
14	Chest							
15	*NSP to bust point							
16	Neck base							
17	Biceps							
18	Elbow							
19	Wrist							
20	Waist							
21	Hip							
22	*Waist to hip							
23	Thigh							
24	Mid thigh							
25	Knee							
26	Calf							
27	Ankle							
	WIDTH							
28	Shoulder width							
29	Shoulder circumference							
30	Across back							
31	**WEIGHT**							

* Length measurement

APPENDIX 3c

Equipment

1. Tape measure (to measure with)
2. Tape measure (on grid)
3. Tape measure (to measure neck base chain measurements with)
4. Grid
5. Foot position marker
6. Elastic band (for waist measurements)
7. Elastic band (for ankle measurements)
8. Measuring chain (for neck base measurement)
9. Press Stick
10. Bathroom scale
11. Camera
12. Films (36 exp.)
13. Number cards (up to 50)
14. Easter eggs
15. Stationery (clipboard, pen and 30 cm ruler)
16. Table (minimum 66 cm X 55 cm)

APPENDIX 4

Body sizing and measurement project: boys and girls, ages 9 to 14

This document comprises eight sections, including:

1. About this project

The first section deals with the objectives of the study, how to use the measuring guide and who could take part in the study.

2. Participants to do

This section deals with all the tasks and responsibilities of each participant. The participants were the supervisor, the fieldworkers (measurers and scribes), the teachers, as well as parents and children.

3. Supervisor

The supervisor's responsibilities, contained in an in depth plan and structure of the study. For each activity a time allocation was added. These activities include:

- Identifying the schools which are to participate
- First visit to schools to introduce study
- Second visit to schools to finalise the measuring plan
- Preparation of indemnity forms
- Identifying field workers
- Paper work: measuring time table, indemnity form collection and measurement chart preparation
- Preparation of equipment
- Identifying children for field worker training sessions
- Field worker training

- Implementation

4. Fieldworkers

The instructions to fieldworkers deals with the measurers and scribes separately. Measurers are responsible for the comfort of the child during the measuring period, the preparation of the child for measuring, as well as the measuring itself. They are also given information on how to communicate with the child as well as how to photograph the child. Scribes receive information on how to check the completed indemnity forms before measuring starts, how to interpret the measurement flow chart and how to use the measurement chart.

5. Teachers, parents and children

Teachers are given information on contact with the supervisor, the completion of indemnity forms, the preparation of the children for measuring as well as their assistance to the field workers on the day of measuring. The information to parents deals with the completion of the indemnity forms. The section on children deals with their willingness to participate.

6. Equipment

The section lists and describes the equipment needed in the measuring centre as supplied by the participating schools, as well as that needed by the measuring team to perform all measuring activities.

7. How to measure guide

The last section focused on the measuring of boys and girls separately. This section of the guide gives instructions on the activities involved in preparing the child for measuring, as well as how and where all the measurements should be taken.

8. Appendix

This section consists of various letters to schools and parents as well as forms to be used by the supervisor in fulfilling the administrative function. Training questionnaires for field workers are also included.

APPENDIX 4a

Indemnity form and measurement chart

INDEMNITY FORM

I herewith grant permission to ______________ on behalf of the Quality Assurance Team from Foshini Stores to measure my child. I agree to have the measurements, as listed on this form, taken over underwear or swimwear providing it is done in the presence of a teacher from ______________ (the school).

YES ☐ ☐ **NO**

1. Personal Information of Child

Please complete the following in CAPITAL letters and use a cross ☒ where necessary

Name of Child:

Date of birth: D D / M M / Y Y Y Y

Gender: ☐ **Boy** ☐ **Girl**

Language: ☐ **Afrikaans** ☐ **English**

School:

School Tel:

Area of home: **Town**

Suburb

Extramural activities your child partakes in (please list, i.e. ballet, karate):

1.

2.

3.

4.

5.

6.

Name of parent to contact:

Tel of parents: **(w)**

(h)

Date: D D / M M / Y Y Y Y

Signature of parent:

☐ **Mother** ☐ **Father**

FOR OFFICE USE ONLY:

SECTOR: ☐

Scribe

Supervisor

Teacher

Survey : 29

Page : 1

2. Measurement Chart of Child

Parents are requested not to complete the rest of the form

Name of Child:

Date of birth: D D / M M / Y Y Y Y

Sector:

Gender: Boy Girl

Language: Afrikaans English

Back nape to waist	.
Side waist to crutch (seated)	.
Side waist to knee	.
Side waist to ankle	.
Side waist to floor	.
Shoulder	.
Nape to elbow	.
Nape to wrist	.
Crutch (front-back waist)	.
Vertical trunk	.
Head	.
Bust/Chest	.
Underbust (girls only)	.
NSP to bust/chest point	.

Armhole Girth	.
Bicep	.
Elbow	.
Hand	.
Wrist	.
Waist	.
Hip	.
Waist to hip	.
Thigh	.
Mid-Thigh	.
Knee	.
Calf	.
Ankle	.
Instep / heel girth	.
Shoulder width	.
Shoulder circumference	.
Across back	.
Weight (kg)	.

Scribe

Supervisor

Teacher

Name of Child:

Date of birth: D D / M M / Y Y Y Y

Sector:

Gender: Boy Girl

Language: Afrikaans English

Height .

Front view photo (slide number)

Disc number

Nape to floor .

Side view photo (slide number)

Disc number

Back view photo (slide number)

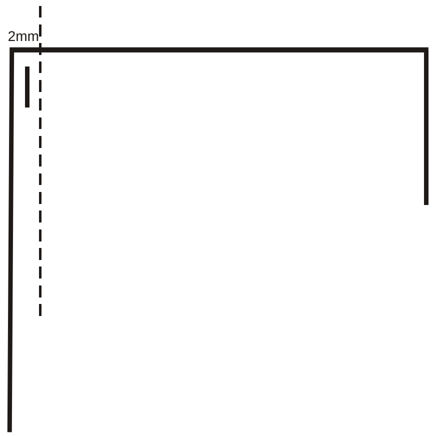
Disc number

Neck base (Number of beads) .

APPENDIX 4b

Instructions on how to photocopy and complete the indemnity form and measurement chart (“Formic form”)

1. Photocopying the forms:
1.1 Copy the form square.
1.2 Staple all the sheets together about 2 mm (straight) in, at the left top corner – this staple will be removed later on when reading the forms.



2. Completing the forms
2.1 Complete the <u>front page</u> in **ink**.
2.2 Complete the <u>measurement sheet</u> in **pencil**.
2.3 Always write in CAPITAL LETTERS.
2.4 All <u>signatures</u> should be in **ink**.

APPENDIX 4c

Questionnaires

QUESTIONNAIRE FOR SUPERVISORS

1. Describe what is incorrect about the posture in the picture below.

....

....

....

....

....

....

....

2. When taking the elbow measurement do you start from the NECK SHOULDER POINT or the BACK NAPE position?

....

3. When measuring the VERTICAL TRUNK do you start and end at the NECK SHOULDER POINT or the BACK NAPE position?

....

4. Does the child keep his/ her arms and hands away from the area being measured?

Yes ☐ No ☐

5. Describe the posture when measuring the HIP.

....

....

....

6. Describe what is incorrect about the posture of the subject in the picture below.

....

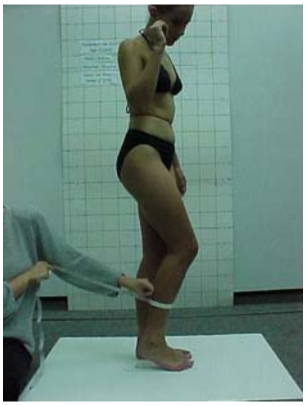
....

....

....

....

....



7. At what angle should the ruler be held when measuring the HEIGHT of the child?

....

8. Describe the POINTS that need to be marked with the soft marking pen.

....

....

....

9. On which colour line should the FOOT MARKER be aligned when taking the BACK NECK TO FLOOR MEASUREMENT?

....

10. Name the two measuring points concerned in measurements for which the measurer needs assistance?

....

....

11. What are the 3 requirements for a measurer?

....

....

....

12. What are the 2 requirements for the CHILD to be measured?

....

....

13. What is the DRESS CODE for the child being measured?

....

....

14. Which tools are provided by the Foschini group?

....

15. If the INDEMNITY FORM is not complete, may you proceed with measuring?

Yes ☐ No ☐

0 - 0 - 0

QUESTIONNAIRE MARKING SHEET (Supervisors)

1. The child is standing with his head and arm bent.
2. Back nape position.
3. Neck shoulder point.
4. No.
5. The child should stand upright with his/her hands next to the body, looking straight ahead.
6. The child is bending her knee and arm and looking down at the measurer.
7. 90 degrees.
8. Shoulder point (x2)
   Nape
   Wrist
   Ankle
9. Green Line
10. The shoulder point to bust /chest and the waist to hip measurement.
11. She must be a parent.
    She must have an ability to communicate clearly and work sympathetically with children.
    She must have experience and understanding of sewing and/or pattern making.
12. The child must be willing to:

12.1 wear the measuring beads and ribbon.

12.2 follow instructions from measurer and teacher on how to stand for each measurement.

13. Child to be barefoot and wearing underwear or swimwear (girls to wear a two piece swimsuit.)
14. Measuring beads
    Foot marker
15. No.

QUESTIONNAIRE FOR MEASURERS

1. Describe what is incorrect about the posture in the picture below.

....

....

....

....

....

....

....

2. When taking the elbow measurement do you start from the NECK SHOULDER POINT or the BACK NAPE position?

....

3. When measuring the VERTICAL TRUNK do you start and end at the NECK SHOULDER POINT or the BACK NAPE position?

....

4. Does the child keep his/ her arms and hands away from the area being measured?

Yes ☐ No ☐

5. Describe the posture when measuring the HIP.

....

....

....

6. Describe what is incorrect about the posture of the subject in the picture below.

....

....

....

....

....

....

7. At what angle should the ruler be held when measuring the HEIGHT of the child?

....

8. Describe the POINTS that need to be marked with the soft marking pen.

....

....

....

9. On which colour line should the FOOT MARKER be aligned when taking the BACK NECK TO FLOOR MEASUREMENT?

....

11. Name the two measuring points concerned in measurements for which the measurer needs assistance?

....

....

10. What are the 2 requirements for the CHILD to be measured?

....

....

11. What is the DRESS CODE for the child being measured?

....

....

12. If the INDEMNITY FORM is not complete, may you proceed with measuring?

Yes ☐ No ☐

0 - 0 - 0

QUESTIONNAIRE MARKING SHEET (Field workers)

1. The child is standing with his head and arm bent.
2. Back Nape position.
3. Neck shoulder point.
4. No.
5. The child should stand upright with his/her hands next to the body looking straight ahead.
6. The child is bending her knee and arm and looking down at the measurer.
7. 90 degrees.
8. Shoulder point (x2)
   Nape
   Wrist
   Ankle
9. Green Line.
10. The shoulder point to bust /chest and the waist to hip measurement.
11. The child must be willing to:

11.1 wear the measuring beads and ribbon.

11.2 follow instructions from measurer and teacher on how to stand for each measurement.

12. Child to be bare feet and wearing underwear or swim wear (girls to wear two piece swimsuit.)
13. No.

APPENDIX 4d

Equipment

1. Equipment per measuring centre:
1.1 Grid
1.2 Measuring grid with tape measure and foot marker
1.3 Scales
1.4 Camera and films
1.5 Tripod
1.6 Press stick
1.7 Full length mirror

2. Equipment per measuring team:
2.1 Table
2.2 Tape measure (X2)
2.3 Measuring beads
2.4 Ribbon
2.5 Foot marker
2.6 Soft marking pen
2.7 Clipboard
2.8 Pencil and eraser
2.9 30 cm ruler
2.10 Name tags

APPENDIX 5

Children's dummy development: field worker manual

CHILDREN'S DUMMY DEVELOPMENT

Field Worker Manual

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The data obtained from this survey is the property of The Foschini Group (Exact! and Foschini Children's wear), Ackermans, The Edcon Group (Edgards, Sales House and Jet), Pep Stores, Topics, Woolworths and Figure Forms as well as the initiators of this study. Neither this manual, nor the data obtained on this survey may be reproduced or sold without the written consent of the Managing Body of the survey.

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CONTENTS

1. INTRODUCTION

1.1 WHAT IS THIS PROJECT ALL ABOUT?

Welcome as part of the national CHILDREN'S DUMMY DEVELOPMENT RESEARCH PROJECT. This project is financially supported by a group of South African Clothing Retail Companies: The Foschini Group (Exact! and Foschini, Children's wear), Ackermans, The Edcon Group (Edgars, Sales House and Jet), Pep Stores, Topics, Woolworths as well as Figure Forms. The purpose of this project is to measure South African children, both boys and girls, between the ages of two and fourteen years, from various cultural backgrounds.

The information gathered during this research will enable us to identify important differences between different figure types. This will help the clothing retailers to develop appropriate children's dummies with a result of garment sizing to meet South African customers' requirements. Each participant in this project plays an essential role in the total success of the research. The people who participate are field managers, various field workers, teachers from identified schools as well as parents and children.

1.2 HOW TO USE THIS GUIDE

This guide consists of six sections:

- A description of the people who participate in this project with a brief explanation of each participant's tasks and responsibilities.
- Important documentation such as:
  - Forms and letters the field manager will need, and
  - Forms the field workers will need.
- A list of equipment needed to successfully complete the project.
- An indication of the position of landmarks on the body and skeleton.
- Descriptions and illustrations of how children should be prepared for the photographing and measuring processes.
- Descriptions and illustrations of how children should be measured.

At the beginning of each section, there will be a list of contents and references of each particular section.

2. PARTICIPATION IN THIS PROJECT

2.1 WHO ARE THE PARTICIPANTS AND WHAT MUST THEY DO?

Apart from the children and their parents, a field manager, various field workers as well as teachers participate in this project. Listed below is the recommended profile of each participant. Only female field workers will be allowed to participate in this project. Each of the participants has certain tasks and responsibilities. These are described in the following sections.

2.2 THE FIELD MANAGER

2.2.1 Profile

Listed below are the requirements for the field managers. The field manager must:

- Be from the province and city where the measuring actually takes place;
- Be bilingual and have an ability to communicate clearly;
- Have experience in project leading;
- Have strong administrative and organising skills.

2.2.2 Responsibilities

To be effective, the field manager has to plan and perform tasks in an appropriate sequence within a time schedule for the completion of each task. These tasks involve:

- All local travel and accommodation arrangements;
- Organising the Indemnity Forms;
- Sample selection; and
- Activities regarding project implementation and preparation of paperwork.

2.2.3 Accommodation and travel

The Field Manager should:

- Arrange accommodation and transport for all field workers;
- Arrange for payment and confirmation of the above.

2.2.4 Interaction with schools

The Field Manager should:

- Select nursery schools, primary and secondary schools according to guidelines.
- Communicate with headmasters of these schools to discuss and confirm participation.
- Discuss availability of a contact teacher. It is recommended that two teachers are available to help on the day of measuring.
- Discuss the measuring process as described in the measurement guidelines.
- Discuss availability of required facilities. The minimum requirements for the room are:
    - An area to dress or undress (a screen or a fitting booth is recommended)
    - A ordinary desk / table for administrative use
    - 1-3 mirrors
    - 5 small tables for smaller children to stand on
    - 8 chairs

    - 1 dustbin
    - Effective lighting - NO DIRECT SUNLIGHT
    - A classroom should be negotiated which can be set up as a measuring centre
- Follow-up calls closer to commencement of measuring period to finalise:
    - Delivery schedule of indemnity forms to contact teacher(s);
    - Date of handing out indemnity forms - at least three weeks beforehand;
    - Date of return of indemnity forms - at least one week beforehand;
    - Sorting and preparation of the required number of forms;

2.2.5 Indemnity forms

The field manager should:

- Prepare a form for each child. These forms should all be fully completed and signed before any measurements can be taken.
- Hand out at least 20 indemnity forms per age group for distribution.
- Prepare at least 15 indemnity forms per age group for measuring.
- Supply the school(s) involved with enough indemnity forms and be very prompt in delivery and collection of forms on the dates negotiated:
    - Deliver forms for distribution at least three weeks beforehand;
    - Collect forms for measuring at least five days beforehand to prepare;
- Check and sign all indemnity forms personally to ensure all forms are correctly completed and parents' approval for child participation has been received.
- Continue to prepare a measurement chart for each child.

2.2.6 Sample selection

When selecting the sample size, the field manager should communicate with the contact teacher whilst keeping the following in mind:

- Only those children who have received WRITTEN PERMISSION from one or both of their parents may be measured, providing the child consents on the day of measuring.
- The sample quota to be measured is: at least 10 children per age, per gender and per sector.
- Both BOYS and GIRLS should be measured, according to the prescribed quota.
- Children must be measured according to the prescribed quota.
- Children are selected according to their AGE CLASSIFICATION. The child's age group is determined on the day of measuring, i.e. if the child is 2 years and 3 months on that day, the child is measured in the 2 - 3 year age group. If the child turns 3 on the day of measuring, the child will fall into the 3 - 4 year age group.
- Children should not be selected according to their height.
- All two-year-old children should be already potty trained.

2.2.7 Project implementation

- The field manager should leave a copy of the measuring manual and completed indemnity form at each school to assist with enquiries by parents.
- Once the measuring team arrive, the field manager hands over all the prepared indemnity forms to the field co-ordinator.

2.3 FIELD WORKERS

2.3.1 Field co-ordinator

2.3.1.1 Profile

She must:

- Be from Cape Town or environment.
- Be able to travel away from home for long periods at a time (i.e. 4 weeks).
- Be bilingual and have an ability to communicate clearly and be able to work sympathetically with children.
- Have experience in and understanding of sewing and / or pattern making.
- Have experience in and understanding of operating cameras.
- Be available to undergo extensive training in operational aspects of the project.

2.3.1.2 Responsibilities

2.3.1.2.1 Indemnity forms

The co-ordinator is responsible for:

- The management of all the prepared indemnity forms once they have been received from the field manager.
- To file the forms correctly before and after measuring.
- To check all forms before measuring and to sign them as approved as soon as the form has been completed and BEFORE the child leaves the measuring centre.
- The safeguarding of all the completed indemnity forms until they are handed over to the field manager.

2.3.1.2.2 General housekeeping

- Check all basic equipment, as supplied by the school, before measuring team can set up the room.
- Brief all field workers on the room layout before unpacking - select photographic area first.
- Keep all paperwork neat and tidy at all times.
- Ensure that the room is clean and “fresh” throughout the day.
- Use black bags in dustbin as supplied and ensure the room is tidy when the field workers leave the room at the end of the day.
- Ensure that no sweet papers are lying around in the classroom,.
- Ensure that all equipment is cleaned daily.
- Ensure that all swimwear used is laundered daily after use.

2.3.1.2.3 Supervision

The co-ordinator should:

- Familiarise herself with all the aspects of the measuring process in order to fill in if one of the field workers is not able to attend.
- She should, in conjunction with the measurers, properly brief the scribes on their function. She should focus on the effective and efficient performing of their function.
- She should not allow any child to participate in the project if he or she is not willing.
- Ensure that all children receive a sweet as a thank you token before they leave the centre.

2.3.1.2.4 Briefing of scribes

The scribes participating in Gauteng should be properly briefed by the field co-ordinator and measurers before measuring can commence in that province. The following need to be concentrated on:

- Effective communication with each measurer.
- The accurate and efficient method of completing the measurement chart.
- Understanding of the measuring process as listed in the measuring guide.

2.3.2 Photographer

2.3.2.1 Profile

She must:

- Be from Cape Town or environment.
- Be able to travel away from home for long periods at a time (i.e. 4 weeks).
- Be bilingual and have an ability to communicate clearly and able to work sympathetically with children.
- Have experience and understanding of operating cameras.
- Be available to undergo extensive training.

2.3.2.2 Responsibilities: preparing the child for measuring

Before measuring can begin, the photographer is responsible for preparing the child by accurately and consistently marking landmarks on the child's body. To achieve this, the photographer is responsible for:

2.3.2.2.1 Interaction with the child

- Address the child in his/her mother tongue - consult the teacher where necessary.
- Address him/her by name.
- Be friendly with child at all times - do not make negative remarks about the child, or his/her cloths, hair, etc.
- Show and explain to the child what landmarks are.
- Do not force the child to do something he/she is not comfortable with.

2.3.2.2.2 Preparation of the child

- Do not touch the child unnecessarily.
- Ask the child's permission and position the neck chain around the child's neck.
- Ask the child's permission and position the waist elastic around the child's waist.
- Ask the child's permission to mark the landmarks on the child's body.
- Mark the important landmarks on body of child as listed in the PREPARATION section.

2.3.2.3 Weighing the child

- Re-set the scale for each child.
- Ask the child to stand on the scale to be weighed.
- The weight is recorded in kg, rounded to the nearest 0.5 kg.
- Fill the weight in on the measurement chart.

2.3.2.4 Responsibilities: photographing the child

After completing the marking of landmarks, the photographer should focus on an accurate and consistent method of photographing the children from the prescribed angles. To achieve this, the photographer is responsible for:

2.3.2.4.1 Setting up the equipment

Negotiate the most appropriate area of the classroom as required. Set the photographic equipment up in this specially selected area BEFORE the measuring centre opens.

2.3.2.4.2 Interaction with child

- Address the child in his/her mother tongue - consult the teacher where necessary.
- Address him/her by name.
- Be friendly with child at all times - do not make negative remarks about child, regarding his/her clothes, hair, etc.
- Do not touch the child unnecessarily.
- Do not force the child to do something he/she is not comfortable with.
- Ask the child's permission to photograph him/her.
- Briefly explain to the child the equipment which is used to photograph him/her, i.e. stand and back drop.
- Clearly instruct the children on required position, posture and stance required for each photograph - ask the teacher to assist if necessary.

2.3.2.4.3 Taking photographs

- Position the white board with the child's number, age and disc number on the left side of the stand. If you use different discs for the same child's photographs, ensure the disc numbers are consecutive. Indicate this properly on the white board and measurement chart.
- Use the correct colour foot markers for each age group.
- Ensure correct posture of child before photographs are taken - ask the teacher or field co-ordinator to assist if necessary.

2.3.3 The Measurer

2.3.3.1 Profile

She must:

- Be from Cape Town or environment.
- Be able to travel away from home for long periods at a time (i.e. 4 weeks).
- Be bilingual and have an ability to communicate clearly to adults and children.
- Be able to work sympathetically with children.
- Have experience and understanding of sewing and/or pattern making.
- Be available to undergo extensive training.

2.3.3.2 Responsibilities

The functions of the measurer focus mainly on the accurate and consistent method of measuring. To achieve this, the measurer is responsible for:

2.3.3.2.1 Setting up equipment

All measuring teams are to set up the equipment BEFORE the measuring centre opens.

2.3.3.2.2 Interaction with child

- Address the child in his/her mother tongue - consult the teacher where necessary.
- Address him/her by name.
- Be friendly with child at all times - do not make negative remarks about child, regarding clothes, hair, etc.
- Ask the child's permission to measure him/her.
- Do not touch the child unnecessarily.
- Do not force the child to do something he/she is not comfortable with.

2.3.3.2.3 Measuring the child

- Study this guide thoroughly beforehand, especially the section on HOW TO MEASURE THE CHILD.
- Efficiency, accuracy and consistency are very important during measuring.
- Clearly instruct the child on the required posture and points of measuring.
- All measurements are recorded in cm, rounded to the nearest 0.5cm.

2.3.3.2.4 Interaction with scribe

- Clearly call the actual measurement of one body part at a time to the scribe.

2.3.4 The Scribe

2.3.4.1 Profile

She must:

- Be from the province and town where the measuring centres are located.
- Be bilingual and fluent in Afrikaans or English or an appropriate black indigenous African language such as Xhosa.
- Have an ability to communicate clearly with adults and children.
- Be able to understand written instructions properly.
- Be able to write clearly.
- Have empathy with children.
- Be available for briefing beforehand.

2.3.4.2 Responsibilities

2.3.4.2.1 Preparation

Before the measuring process can start, it is important for the scribe to:

- Check that the personal information has been properly completed on the measurement chart of each child. All forms for the day's measuring should be checked before measuring commences.
- Check that the previous scribe has completed all measurements properly.
- Note the mother tongue and name of each child.
- If needed, help the measurer to set up, clean or reposition the measuring equipment.

2.3.4.2.2 Completing the measuring chart

To complete the measuring chart correctly and efficiently, it is important to:

- Know the sequence and type of measurements taken,
- Listen properly to the actual measurement as called by the measurer.
- Clearly write the actual measurement on the form - no letter to cross any of the four lines of the letterbox.
- All measurements to be recorded in cm, rounded to the nearest 0.5cm.

2.3.4.2.3 Assisting the measurer

The scribe should help the measurer to control the child's posture and stance. The child MUST:

- Relax the arms next to the body with hands open and fingers facing the floor, unless otherwise required.
- Stand up straight, looking straight ahead with the chin held horizontally.
- Always position his/her feet as required for the specific measuring positions.
- Always distribute the weight equally on both legs.

On the other hand, the child MUST NOT:

- Lift his/her chin or look down in the direction of the measuring position.
- Pull in his/her tummy during measuring.
- Stand with a hollow back.

2.4 The Teacher

2.4.1 Profile

The teacher(s) involved must:

- Be teaching at or represent the school where the measuring will take place.
- Preferably be the class teacher of the children being measured.
- Be willing to assume responsibility for the indemnity forms as required, as well as to help during measuring.

2.4.2 Responsibilities

The teacher(s) are a very important link between the children, their parents and the field workers to ensure the effective completion of the measuring process. Their close interaction with parents and the project team include:

2.4.2.1 Interaction with field manager

- To be available to meet with Field Manager to discuss project requirements.
- To commit herself to the project and accept her responsibility (i.e. important preparations and attending measuring).

2.4.2.2 Indemnity forms

- To distribute all the indemnity forms via children to parents for approval (to be done at least THREE weeks beforehand).
- To collect all completed and signed indemnity forms (at least one week beforehand).
- To check and verify personal information of child on the indemnity form.
- To separate out the indemnity forms which cannot be used.

- To hand over all indemnity forms to the Field Manager (at least FIVE days beforehand).

2.4.2.3 Preparation of children participating

- To discuss project with children beforehand in class - keep a manual handy as reference.
- To help dress the children before the measuring process begins:
- The correct size swimwear should be selected for each child (see the chart below),
- It is recommended that different sized bottoms and tops are mixed and matched to fit each child best, and
- All girls up to four years old do not have to wear a two-piece swimsuit, unless they request it.

The size breakdown:

Boys											
Label in garment	1-2 yrs	2-3 yrs	3-4 yrs	5-6 yrs	7-8 yrs	9-10 yrs	10-11 yrs	11-12 yrs	12-13 yrs	13-14 yrs	14-15 yrs
Units/size	1	6	6	6	6	6	6	6	6	6	1
Total	56 units										

Girls											
Label in garment	1-2 yrs	2-3 yrs	3-4 yrs	5-6 yrs	7-8 yrs	9-10 yrs	10-11 yrs	11-12 yrs	12-13 yrs	13-14 yrs	14-15 yrs
Units/size TOPS	~	3	3	6	6	6	6	6	6	6	3
Units/size BOTTOMS	3	6	6	6	6	6	6	6	6	6	3
Total TOPS	51 units										
Total BOTTOMS	60 units										

2.4.2.4 Assisting field workers

- To be available and present during the measuring days.
- To assist field workers with each child to achieve the required and correct posture and stance.

2.5 The Parent

2.5.1 Profile

The participation of parents in this project is very important to ensure the effective completion of the project.

- The person granting permission to the research team to measure the child must be the legal parent or guardian.
- The parent must be a parent of the child registered at one of the schools selected for the project.
- The parent must be literate. If not, the parent must grant permission to the class teacher or a responsible adult to complete the form on his/her behalf. The parent should still sign the indemnity form personally.

2.5.2 Responsibilities

Parents are requested to grant permission for the measuring of their children. In order to do this, they must:

- Complete the indemnity form properly as required.

- Sign the indemnity form as approval of child's participation.
- Return the completed form to the class teacher by the given cut off date.
- Provide clean underwear for the child to wear during the measuring session.

(PS. Parents may attend the measuring day of their child if they request to do so.)

2.6 The Child

2.6.1 Profile

The following children may participate in this project:

- A number of schools will be selected in the Cape Province and Gauteng to participate in this project. Only children registered at these schools may participate.
- In order to participate, children must have written permission from one or both of their parents, and consent on the day of measuring. Unwilling children should not be forced to be measured.
- Both boys and girls should be measured according to the prescribed quota.
- All children will qualify for measuring.
- Children between the ages of 2 and 14 years may participate. All two-year-old children should be potty trained.

2.6.2 Responsibilities

To participate the child must:

- Be willing to wear the costume provided during measuring sessions.
- Be willing to fit the measuring chain and waist ribbon to indicate landmark positions.
- Allow the field workers to mark the landmarks on the his/her body.
- Be willing to be photographed.
- Allow the field workers to measure him/her by following instructions from the measurer, scribe, field co-ordinator and teacher on how to stand for each measurement.

3. LETTERS AND FORMS

3.1 LETTERS TO PARENTS

Dear Parent

This letter serves to inform you of the CHILDREN'S DUMMY DEVELOPMENT PROJECT undertaken by eight South-African Clothing Retail Companies.

The project is undertaken in conjunction with different schools and universities in South Africa and it's aim is to establish standard measurements and growth patterns of children from ages two to fourteen years. Boys and girls will be measured to enable the group of retailers to draw reliable conclusions from the data gathered and will result in the development of clothing dummies based on the South-African figure types.

A group of thoroughly trained field workers will be responsible for measuring the children. When measuring your child, 47 measurements will be taken, for example: height, nape to floor, knee to floor, waist to floor, shoulder to elbow, shoulder to wrist, head girth, neck girth, shoulder breadth, elbow, wrist, hand, waist, hip, thigh, knee, calf, weight etc. In addition, front, side and back view photographs will also be taken of your child. Parents are requested to ensure that their children wear clean underwear during the day of measuring.

If you wish to enquire about the measuring process, please contact the school. Each participating school has a teacher responsible for the project. This teacher has a copy of the measuring manual and will be able to provide you with all information.

We appreciate your participation and involvement in this very important project.

With kind regards

Sanette van Huyssteen
Researcher

Tel: (021) 938 1634
Fax: (021) 938 7880

3.2 BRIEF AAN OUERS

Geagte Ouer

Hierdie brief dien om u in te lig oor die KINDER PASPOP-ONTWIKKELINGS-PROJEK wat deur agt Suid-Afrikaanse Klerasie Kleinhandelsmaatskappye.

Die projek word onderneem in samewerking met verskillende skole en universiteite in Suid-Afrika. Die doel is om die afmetings en groeipatrone van kinders tussen die ouderdomme van twee tot veertien jaar te bepaal. Seuns en dogters sal gemeet word. Die gegewens sal bogenoemde groep kleinhandelaars in staat stel om betroubare statistiese veralgemenings te maak wat sal lei tot die ontwikkeling van klere-paspoppe gebaseer op die Suid-Afrikaanse figuurtipes.

'n Groep deeglik opgeleide veldwerkers sal verantwoordelik wees vir die meting van kinders. In die metingsproses sal sowat 47 afmetings van u kind geneem word, byvoorbeeld lengte, afstand van nekholte tot vloer, middellyf tot vloer, knie tot vloer, skouer tot elmboog, skouer tot polsgewrig, omtrek van kop, omtrek van nek, skouer breedte, dikte van bo-arm, elmboog, gewrig, hand, middellyf, heup, bobeen, knie, kuit, gewig, ensovoorts. Daarbenewens sal foto's van die voor-, sy- en agterkant van u kind geneem word. Ouers word versoek om te verseker dat hul kind skoon onderklere sal dra tydens die dag waarop meeting plaasvind.

Indien u navraag wil doen oor die meetprosedure skakel asseblief die betrokke skool. Elke deelnemende skool het 'n onderwyser wat verantwoordelik is vir die projek. Hierdie onderwyser het 'n afskrif van die afmetingshandleiding en sal dus kan help met enige navrae wat u mag hê.

Ons waardeer u samewerking en betrokkenheid by hierdie belangrike projek.

Beste groete

Sanette van Huyssteen
Navorser

Tel: (021) 938 1634
Faks: (021) 938 7880

3.3 INDEMNITY FORM AND VRYWARINGSVORM

3.3.1 Indemnity form

INDEMNITY FORM

For office use only | Supervisor Signature:

Form number: s

Please complete the following in CAPITAL LETTERS and use a X where necessary.

I hereby grant permission to measure my child. I agree to have the measurements, as listed on this form, taken over swimwear as provided by the measuring team, providing it is done in the presence of a teacher from:

YES NO School tel. number:

If you do not understand the full content of this form, ask your child's teacher to explain and complete the form on your behalf.
Please remember to sign the form for approval.

Signature of parent:

I agree my child being measured by a female field worker. YES NO

PRINT parent's name:

PRINT parent's surname: **Mother:** **Father:**

Tel. number of parent: H W C

If you do not wish your child to participate in this project,
PLEASE DO NOT COMPLETE THIS SECTION OF THE FORM.

For office use only
Date of measuring: d d m m 2 0 0 y

1. PERSONAL INFORMATION OF CHILD

Name of child: **Date of birth:** d d m m 1 9 y y

Surname of child: **Gender:** Boy Girl

Area of home: Suburb: **Home language:** Afrikaans: Specify other below:

Town: English:

Province: Xhosa:

Extramural activities your child partakes in (please list i.e. ballet, karate): Zulu:

1 4

2 5

3 6

3.3.2 Vrywaringsvorm

VRYWARINGSVORM

Alleenlik vir kantoor gebruik | Toesighouershandtekening:

Vorm nommer: s

Voltooi asseblief hierdie vorm in DRUKSKRIF en gebruik 'n X waar van toepassing.

Ek verleen hiermee goedkeuring dat my kind gemeet mag word. Ek stem in dat die mates, soos agterop gelys, bo-oor swemklere soos voorsien, geneem mag word deur die span veldwerkers, mits dit in die teenwoordigheid van 'n onderwyser geskied.

JA NEE Skool tel. nommer:

Indien u nie die volle inhoud van hierdie vorm verstaan nie, versoek asseblief u kind se onderwyser om dit aan u te verduidelik.
U word versoek om hierdie vorm te onderteken.

Handtekening van ouer:

Ek verleen toestemming dat my kind deur 'n vroulike veldwerker gemeet word. JA NEE

Naam van ouer in DRUKSKRIF:

Van van ouer in DRUKSKRIF: **Moeder:** **Vader:**

Tel. nommer van ouer: H W C

Indien u nie ten gunste van u kind se deelname aan hierdie projek is nie,
MOET ASSEBLIEF NIE HIERDIE DEEL VAN DIE VORM VOLTOOI NIE!

Alleenlik vir kantoorgebruik
Datum van meting: d d m m 2 0 0 y

1. PERSOONLIKE INLIGTING VAN KIND

Naam van kind: **Geboortedatum:** d d m m 1 9 y y

Van van kind: **Geslag:** Seun Dogter

Woongebied: Voorstad: **Huistaal:** Afrikaans: Spesifiseer ander:

Stad: Engels:

Provinsie: Xhosa:

Buitemuurse aktiwiteite waaraan u kind deelneem (lys asseblief, bv. ballet, karate): Zulu:

1 4

2 5

3 6

3.4 MEASUREMENT CHART

2. MEASUREMENT CHART OF CHILD

Fill in the boxes or mark the appropriate choice with a X.

For office use only

Age: s Form no.:

Name of child:

Surname of child:

Date of measuring: d d m m 2 0 0 y

Date of birth: d d m m 1 9 y y

4 **Language:** Afrikaans 1 English 2 Zulu 3 Xhosa 4 Specify other: 5

5 **Gender:** Boy 1 Girl 2

PREPARATION

Fill the blocks with the correct numbers:

6 Weight ,

Supervisor Signature:

PHOTOGRAPHER (disc numbers)

Fill the blocks with the correct numbers:

7 DISC 1

8 DISC 2

9 Front view

10 Side view

11 Back view

TEAM 1

Fill the blocks with the correct numbers:

12	Neck base	,
13	Armhole	,
14	Elbow (**BENT**)	,
15	Knee (**BENT**)	,
16	Height	,
17	Nape to floor	,
18	Crutch to floor	,
19	Scye depth	,
20	Waist to floor	,
21	Hip to floor	,
22	Knee to floor	,
23	Ankle to floor	,
24	Nape to waist	,
25	Nape to shoulder	,
26	Stern to waist	,

TEAM 2

Fill the blocks with the correct numbers:

27	Head girth	,
28	Head arc	,
29	Cervical brow	,
30	Neck girth	,
31	Bust / Chest	,
32	Under bust (**GRL**)	,
33	Nape to bust point	,
34	Nape - u/bust (**GRL**)	,
35	Inter-nipple position	,
36	Across front	,
37	Shoulder circ.	,
38	Shoulder breadth	,
39	Across back	,
40	Waist	,
41	Hip	,

TEAM 3

Fill the blocks with the correct numbers:

42	Shldr - elbow (**STR**)	,
43	Shldr - wrist (**STR**)	,
44	Shldr - elbow (**BNT**)	,
45	Shldr - wrist (**BNT**)	,
46	Biceps (upper arm)	,
47	Elbow (**STR**)	,
48	Wrist	,
49	Thigh	,
50	Knee (**STR**)	,
51	Calf	,
52	Ankle	,
53	Instep & heel girth	,
54	Back neck	,
55	Hand	,
56	Crutch	,
57	Vertical trunk	,

4. EQUIPMENT

4.1 INTRODUCTION

It is the responsibility of the Field Co-ordinator to ensure that all groups use and apply the correct equipment for each activity. Different groups are, however, responsible for specific equipment during the course of the project. A checklist is given at the end of this section with details of all the equipment, quantities required per measuring centre as well as the uses of each piece.

4.2 EQUIPMENT PROVIDED BY SCHOOLS

The Field Manager should arrange the availability of the following equipment in each measuring centre as provided by the school:

- 1 X Dust bin
- 1 X Desk / table for administrative use
- 8 X Chairs
- 1 X Classroom as measuring centre
- 1 - 3 Mirrors
- 1 X Screen or fitting booth
- 5 X Small tables (for smaller children only)

4.3 ADDITIONAL EQUIPMENT AND MAINTENANCE

4.3.1 Equipment

The additional equipment needed for the project, as listed below, is the responsibility of measuring **TEAM TWO** and should be housed in each measuring centre:

CARRY BAG 1:

- Air freshener
- Baby oil
- Black bags
- Clipboards
- Cotton wool
- Eraser refills
- Gusset liners
- Hand lotion
- HB pencil refills
- Keys (4 spares)
- Measuring charts
- Opti-plan files
- Paper towels
- Pens
- Pres Stick
- Scissors
- Spray cans of disinfectant

- Stapler
- Staples
- Wet ones

CARRY BAG 2:
- Sweets / tattoos

Measuring **TEAM THREE** will assume the responsibility for this carry bag.

CARRY BAG 3:
- Swimwear
- Woolite

4.3.2 Maintenance

- Equipment to be cleaned daily in the required manner.
- All used swimwear to be laundered daily.

4.4 PREPARATION EQUIPMENT AND MAINTENANCE

4.4.1 Equipment

The following equipment is the responsibility of the **PHOTOGRAPHER** assisted by measuring **TEAM ONE**.

CARRY BAG 4:
- Chain
- Elastic bands
- Hair clips
- Manual
- Marking pencils (black and white)
- Marking pencil sharpener
- Scale

4.4.2 Maintenance

- All equipment to be cleaned daily with disinfectant.
- Reset equipment properly before the each child is measured or weighed.

4.5 PHOTOGRAPHIC EQUIPMENT AND MAINTENANCE

4.5.1 Equipment

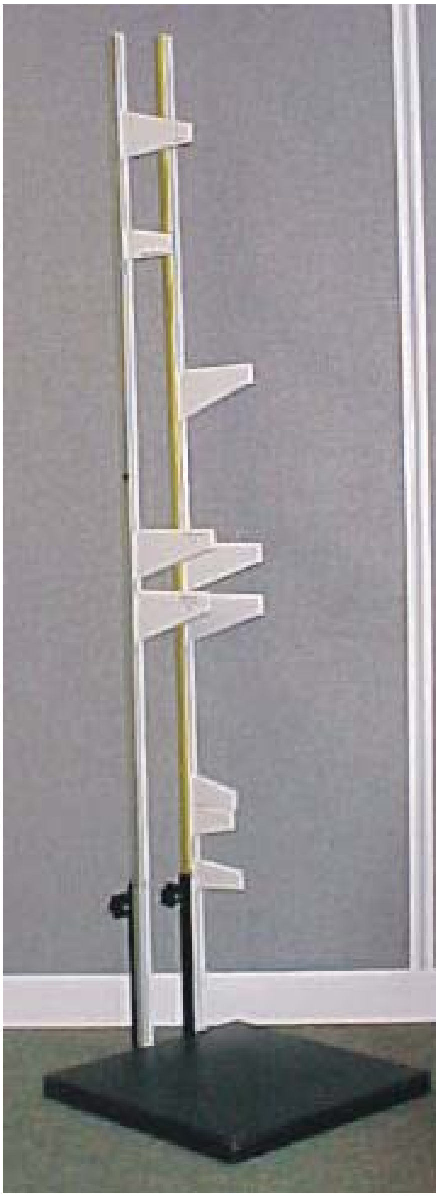
The following photographic equipment is the responsibility of the **PHOTOGRAPHER.**

CARRY BAG 4:
- Digital camera with spare battery and charger
- Discs

- Grid with white clamp and metal beam
- Manual
- Masking tape
- Metal tape measure
- Stand
- Tripod
- Whiteboards with pens and an eraser

4.5.2 Maintenance

- Check equipment properly for each child and reset if necessary.
- Clean the stand daily with disinfectant.



4.6 MEASURING EQUIPMENT AND MAINTENANCE

4.6.1 Equipment

Each measuring team is responsible for the following equipment:

CARRY BAG 4:
Team One:
- Anthropometer (with all the attachments)
- Carry bag
- Chain
- Manual
- Metal ruler
- Step (white container)
- Tape measure (75 cm)

Team Two:
- Carry bag
- Manual
- Mirror
- Tape measure A (75 cm)
- Tape measure B (150 cm)

Team Three:
- Callipers
- Carry bag
- Elastic bands
- Manual
- Mirror (optional)
- Tape measure A (75 cm)
- Tape measure C (2 m)

4.6.2 Maintenance

- All equipment to be cleaned daily with disinfectant, etc. - or else when necessary.
- Reset equipment regularly for consistency of measurements.

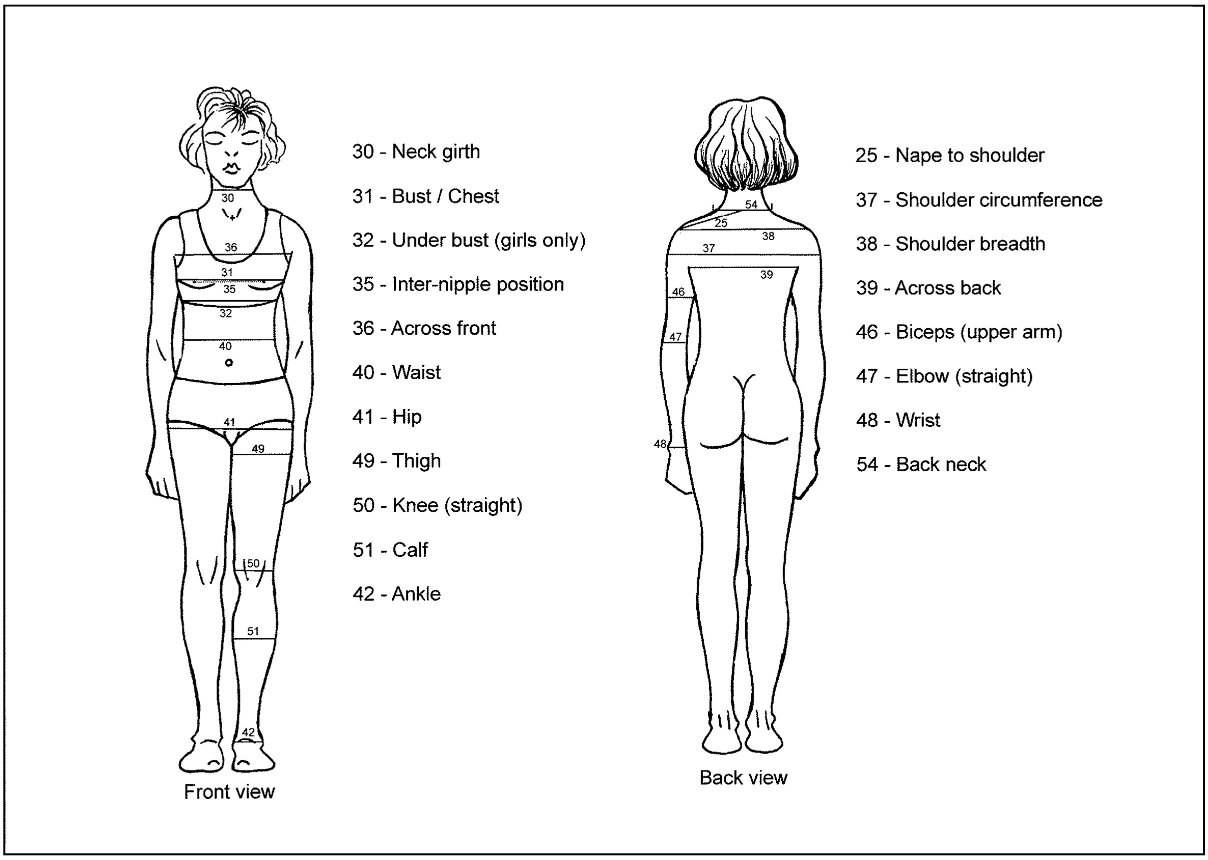
4.7 EQUIPMENT CHECKLIST

	Equipment	No. of units	Prep	Equipment uses	Photo's	Equipment uses	Team 1	Equipment uses	Team 2	Equipment uses	Team 3	Equipment uses
1	Anthropometer Vertical posts Measuring devices Base	1 2 10 1					X	Height measurements				
2	Air fresher	1										
3	Baby oil	1										
4	Black bags	1 packet									X	For dirty laundry
5	Caliper	1									X	Back neck & hand width
6	Carry bag	5			X	For digital camera						
7	Clipboard	8	X	To hold paperwork	X	To hold paperwork	X	To hold paperwork	X	To hold paperwork	X	To hold paperwork
8	Cotton wool	1	X	Remove landmarks for corrections			X	Remove landmarks for corrections	X	Remove landmarks for corrections	X	Remove landmarks for corrections
9	Digital camera Batteries Carry bag Charger Cord for charger Instruction booklet	1 2 1 1 1 1			X	For all photographs						
10	Diskettes	4 boxes of 10 each			X	For all photographs						
11	Dust bins	1										
12	Elastic (different sizes)	20 X age 1-6 30 X age 7-13 11 X age	X	To mark all waistlines							X	Use when measuring vertical trunk
13	Eraser	8	X	To rectify written mistakes	X	To rectify written mistakes	X	To rectify written mistakes	X	To rectify written mistakes	X	To rectify written mistakes
14	Eraser refills	1 packet										
15	Gloves	2 X boxes X 50 sets	X	Personal hygiene	X	Personal hygiene	X	Personal hygiene	X	Personal hygiene	X	Personal hygiene
16	Gusset inner	1 roll	X	To protect costume / child's hygiene								
17	Hair clips	7 (different sizes)	X	To keep girls hair away from landmark positions								
18	Hand lotion	1 bottle										
19	HB pencil	8	X	For completing measuring chart	X	For completing measuring chart	X	For completing measuring chart	X	For completing measuring chart	X	For completing measuring chart
20	HB pencil refills	1 packet										
21	Locks and keys	4										
22	Manual	5	X	Use as reference	X	Use as reference	X	Use as reference	X	Use as reference	X	Use as reference
23	Marking pencil (black eye pencil)	1	X	To mark landmark on pale bodies								
24	Marking pencil (white pencil)	1	X	To mark landmark on darker bodies								
25	Marking pencil sharpener	1	X	To sharpen marking pencils with								
26	Masking tape	1 roll			X	To mark tripod positions						
27	Measuring chain	5	X	To mark neckline and armhole			X	To measure neckline and armhole				
28	Measuring chart	one per child										
29	Metal ruler	1					X	To measure marking chain with				
30	Mirror	1 (min.) - 3 (max.)	X	To position waist ribbon level					X	For bust, underbust, waist & hip measurements	X	For crutch & vertical trunk measurements
31	Optiplan files	4										
32	Packaging	1 box										
33	Paper clips	1 box										
34	Paper towels	1 roll										
35	Pen	2										
36	Photographic grid Cross bar (center) White clamps (top) Base Feet markers	1 1 1 1 3 X sets of			X	For correct of child						
37	Presstick	1 packet			X	To position feet marker						
38	Scissors	1										
39	Scale	1	X	To weigh the child								
40	Spray can with disinfectant	2 X 500ml cans	X	To clean hair clips and equipment								
41	Stapler	1										
42	Staples	1 box										
43	Step (white bin)	1					X	For neckline, armhole, elbow- and knee bent measurements				
44	Sweets	1100										
45	Swimwear	56 boys bottoms 60 girls bottoms 51 girls										
46	Table (smaller kids)	4	X	For ease of work			X	For ease of work	X	For ease of work	X	For ease of work
47	Tape measures	3					A 75cm	For nape / stern to waist, shoulder measurements	A 75cm	For all head, neck nape to bust point, inter-nipple & across front, back & shoulder breadth measurements	A 75cm	For arm length & arm, leg & foot girth measurements
		2	X	To determine hip					B 1.5m	For chest / bust, under bust, waist, hip & shoulder circumference measurements		
		1									C 2m	For crutch & vertical trunk measurements
48	Tripod	1			X	To keep camera in regulated position						
49	Wet ones	1										
50	Woolite	1										
51	White board	7			X	For child's names and numbers						
52	White board pen	2			X	For child's names and numbers						
53	White board eraser	1			X	To clean white board						

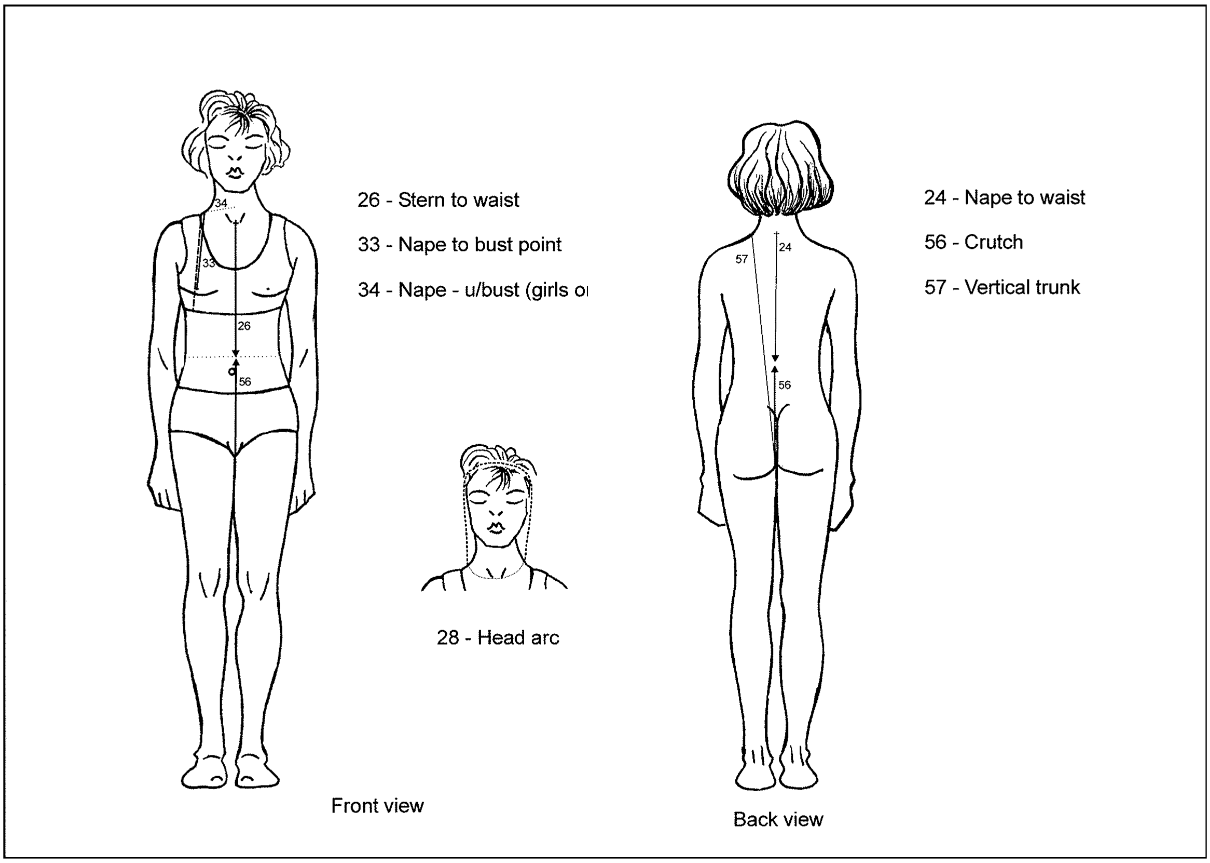
5. LANDMARK AND MEASUREMENT POSITIONS

5.1 LANDMARK AND MEASUREMENT POSITIONS

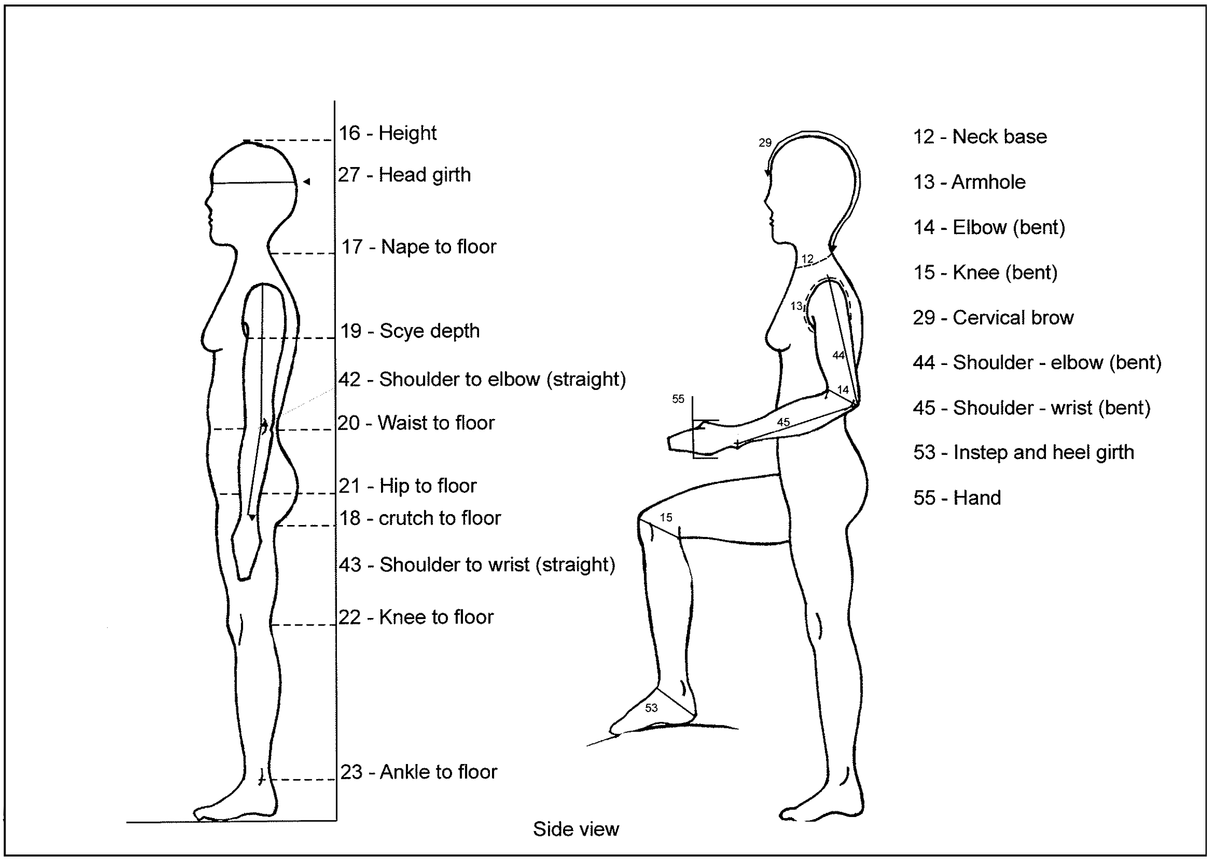
5.1.1 Width and girth landmark and measurement positions



5.1.2 Length landmark and measurement positions



5.1.3 Height, length and girth landmark and measurement positions



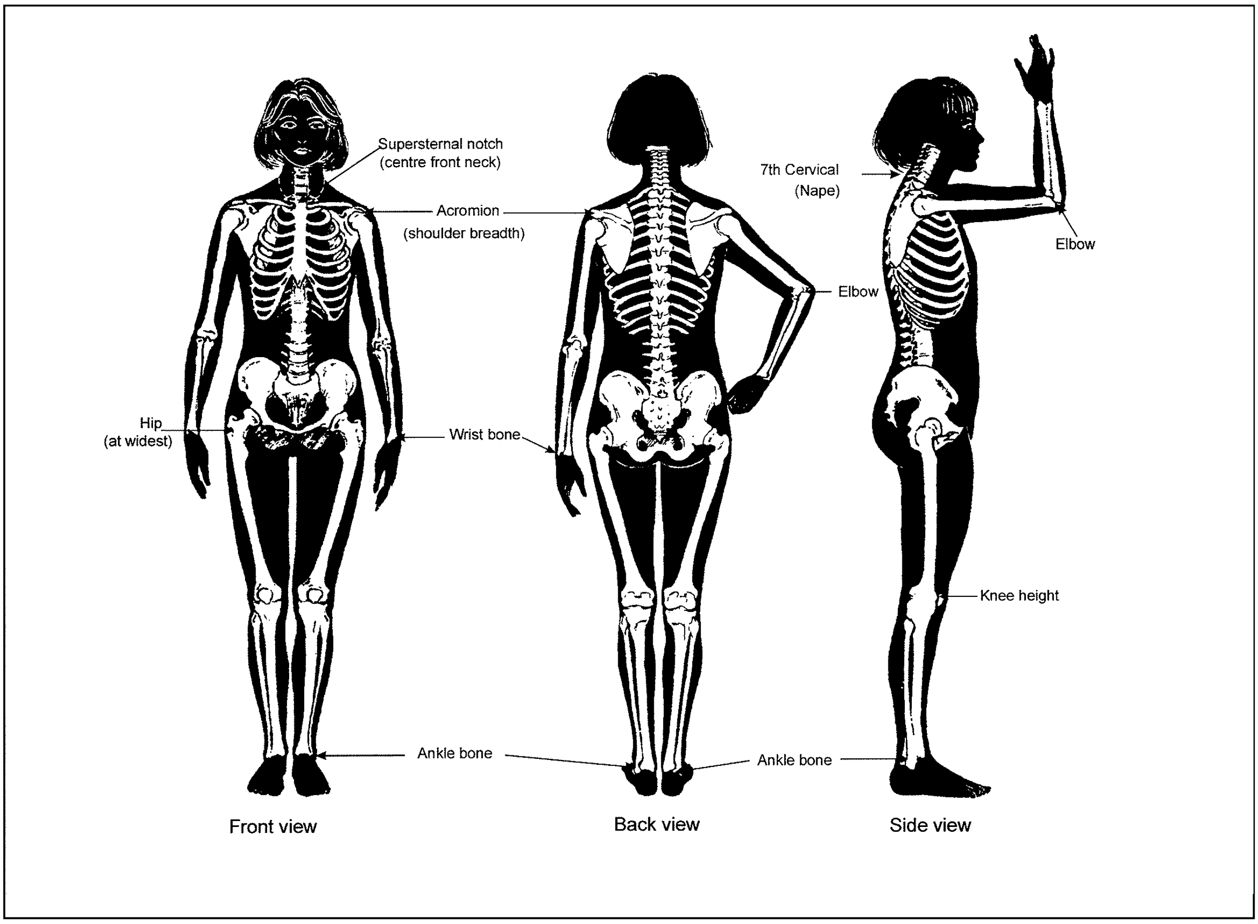
LANDMARK AND MEASURING CHECKLIST

Preparation:
6 Weight Place child on scale - to nearest 0.5kg
Markings:
1. Back Neck + 2. Front Neck + 3. 2 X Shoulder + 4. 2 X Neckline - 5. Elbow + 6. Wrist + 7. 4 X Waist - 8. 2 X Hip - (check even distance) 9. Ankle bone +

Photographer:
9 Front view Child to look at photographer
10 Side view Turn child clockwise - left side
11 Back view Child to look at grid

All measurements to be taken to the nearest decimal.

Team 1:	Team 2:	Team 3:
12 Neck base Take with a chain: around the neckline	**27** Head girth Around the head	**42** Shldr-elbow (STR) Keep arm straight: + at shoulder to + at elbow
13 Armhole Take with a chain: around the armhole	**28** Head arc From left neck marking to right neck marking over the head	**43** Shldr-wrist (STR) Keep arm straight: + at shoulder to + at wrist
14 Elbow (Bent) Take with a chain: around the bent elbow	**29** Cervical brow From front of head to back neck +	**44** Shldr-elbow (BNT) Keep arm bent: + at shoulder to + at elbow
15 Knee (Bent) Take with a chain: around the bent knee	**30** Neck girth Around the neck	**45** Shldr-wrist (BNT) Keep arm bent: + at shoulder to + at elbow
16 Height On the centre stand: top slider (1)	**31** Bust / Chest * Over the nipples around the chest	**46** Biceps Widest part of upper arm: arm straight
17 Nape to floor On the centre stand: 2nd Slider (2)	**32** Under bust (GLR) * Underneath the bust: **TIGHT** all around	**47** Elbow (STR) Around the elbow: arm straight
18 Crutch to floor On the centre stand: bottom slider (3a or 3b)	**33** Nape to bust point From the + at back neck to the nipple	**48** Wrist Around the wrist: at +
19 Scye depth Right side stand: top slider (1)	**34** Nape - u/bust (GRL) **Ask scribe to assist**: from + at back neck to centre of tape measure	**49** Thigh Around widest part of upper leg
20 Waist to floor Right side stand: 2nd slider (2)	**35** Inter-nipple position From nipple to nipple	**50** Knee (STR) Around knee: leg straight
21 Hip to floor Right side stand: 3rd slider (3)	**36** Across front Arm crease to arm crease (front)	**51** Calf Around calf above the ankle
22 Knee to floor Right side stand: 4th slider (4a or 4b)	**37** Shoulder circumf. Around widest part of shoulder	**42** Ankle Around the ankle over the +
23 Ankle to floor Right side stand: bottom slider (5)	**38** Shoulder breadth From + to + at shoulder (back)	**53** Instep and heel girth Child to lift foot: around the heel
24 Nape to waist Back of child from back neck + to waist	**39** Across back Arm crease to arm crease (back)	**54** Back neck Calliper: from shoulder neck mark to the other shoulder neck mark
25 Nape to shoulder Back of child from back neck + to shoulder +	**40** Waist Around the waist at markings	**55** Hand Calliper: hand with all fingers included over knuckles
26 Stern to waist Front of child from neck + to waist	**41** Hip * Around the hip at markings	**56** Crutch From front waist mark to back waist mark
	*** Use a mirror with these measurements**	**57** Vertical trunk To and from left neck shoulder mark, through crutch: tape underneath elastic on back and front


Supersternal notch
(centre front neck)
Acromion
(shoulder breadth)
Hip
(at widest)
Wrist bone
Ankle bone
7th Cervical
(Nape)
Elbow
Elbow
Knee height
Ankle bone
Front view
Back view
Side view

6. PREPARING THE CHILD FOR MEASURING

6.1 EQUIPMENT

The person preparing the child for measuring will use the following equipment:

1. Cotton wool
2. Elastic (different sizes)
3. Gloves
4. Gusset inners
5. Hair clips (different sizes)
6. Marking pencils (black and white)
7. Marking pencil sharpener
8. Measuring chain
9. Mirror
10. Scale
11. Spray can of disinfectant
12. Small table (for smaller children)
13. Tape measure B (150 cm)

Other equipment rotating between measuring teams:

14. Clipboard with measuring chart, pencil and eraser

6.2 HOW TO PREPARE THE CHILD FOR MEASURING

Field workers must AT ALL TIMES wear the protective gloves provided when preparing the children for measuring.

6.2.1 Dress code

The child must be comfortable, with bare feet and wearing the swimwear as provided OVER THE UNDERWEAR. Ensure that the swimwear covers the underwear properly. The teachers involved should help the children in selecting the correct size costume. Smaller children will need help with dressing and undressing.

When selecting the costume size, choose a bigger rather than a smaller size, in order not to restrict any measurements. Girls up to four years old do not have to wear a top, unless they request this. The chart below reflects all the sizes of swimwear available:

Boys											
Label in garment	1-2 yrs	2-3 yrs	3-4 yrs	5-6 yrs	7-8 yrs	9-10 yrs	10-11 yrs	11-12 yrs	12-13 yrs	13-14 yrs	14-15 yrs
Units/size	1	6	6	6	6	6	6	6	6	6	1
Total	56 units										

Girls											
Label in garment	1-2 yrs	2-3 yrs	3-4 yrs	5-6 yrs	7-8 yrs	9-10 yrs	10-11 yrs	11-12 yrs	12-13 yrs	13-14 yrs	14-15 yrs
Units/size TOPS	~	3	3	6	6	6	6	6	6	6	3
Units/size BOTTOMS	3	6	6	6	6	6	6	6	6	6	3
Total TOPS	51 units										
Total BOTTOMS	60 units										

Gusset inners should be used for protection in all bottoms and must be changed for each child.

Garments to be laundered daily.

If a girl has long hair, ensure that the hair is tied back with a butterfly hair clip as provided. Various sizes are supplied to match the thickness of the child's hair.

Position the hair clip to keep the child's hair away from the measuring areas. Position the "bun" to either side of the head not to interfere with the head arc, head girth or cervical brow measurements.

NB: THE HAIRCLIP MUST BE DISINFECTED BEFORE USED ON ANOTHER CHILD!

6.2.2 Landmarks

To ensure that measurements are accurate and consistent it is necessary to mark certain landmarks on the child's body. These are marked with a soft marking pen as provided. A black or white marking pencil can be used according to the darkness of the child's skin. Ensure that all marks show up clearly when pictures are taken.

All measurement landmarks need to be on **LEFT SIDE, BACK** or **FRONT** of the body, unless stipulated otherwise. The following landmarks should be marked with a cross: neck, shoulders, arm and leg. Please note the direction of the cross as stipulated. All the other landmarks are marked with a single line.

The measurements taken to these landmarks should be measured up to the centre of the mark or cross.

6.3 POINTS OF PREPARATION

6.3.1 Neckline

6.3.1.1 Nape

Equipment:
Soft marking pencil (black or white)

The nape is determined by bending the head forward to locate the top neck bone (7th cervical) that is the first prominent bone below the hairline. Mark this bone with a cross. The cross direction to be horizontal, facing from shoulder to shoulder.

6.3.1.2 Front stern

Equipment:
Soft marking pencil (black or white)
Chain

Mark the front neckline at stern with a cross in the direction from shoulder to shoulder.

Position measuring chain correctly around the neckline with the chain held in position on the nape and resting in the neck base in front. The chain should rest on the supersternal notch.

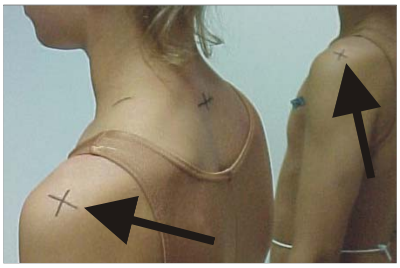
6.3.1.3 Shoulder neck points

Equipment:
Soft marking pencil (black or white)
Chain

Position the neck chain resting on the nape and front stern positions.
Mark both left and right neck points on the visual centre point of the neck (as per side view).

Mark the landmark in the shoulder direction on the highest point at the chain.

6.3.2 Shoulder points

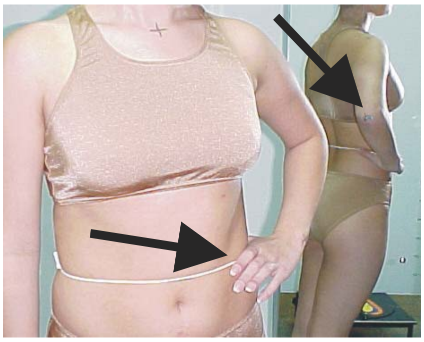


Equipment:
Soft marking pencil (black or white)

The shoulder point is at the end of the shoulder bone. Mark both shoulder points (see arrows) on the back shoulder bone. The cross direction is from neck to shoulder point.

6.3.3 Left arm

6.3.3.1 Elbow



Equipment:
Soft marking pencil (black or white)

Child to place left hand on waist with fingers facing forward and thumb facing backward. Mark the prominent elbow bone position with a cross in the direction from shoulder to wrist.

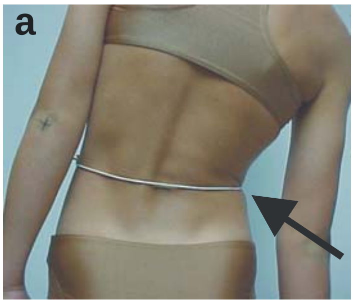
6.3.3.2 Wrist

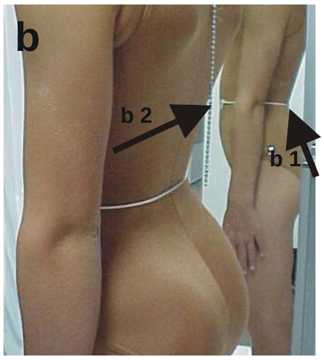
Equipment:
Soft marking pencil (black or white)

This is the prominent bone protruding at the wrist. Mark the centre of this bone with a cross. The cross direction to be from elbow to finger tips.

6.3.4 Waist

Equipment:
Elastic
Mirror
Soft marking pencil (black or white)





a. To determine the actual waistline, ask the child to pull in his/her tummy. Position the measuring elastic correctly by resting the elastic in the small of the back (see arrow) once the tummy is relaxed.

OR

Ask the child to bend side ways to position the elastic - bend to both sides. Then position the elastic as above.

b. Keep the elastic level from the small of the back (b1) towards the centre front (b2). Use the mirror to align properly.

c. & d. Mark the following landmarks with straight lines:

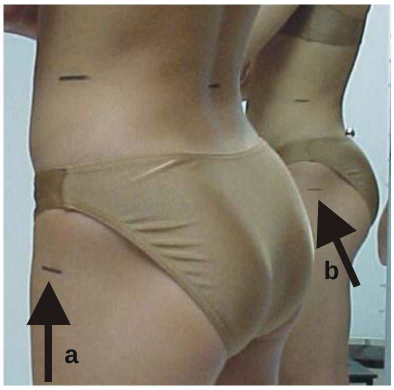
1. Back waistline (at centre back)
2. Front waistline (at centre front)

Both front and back waist landmarks should be minimum 5 cm long.

3. Left side at waistline
4. Right side at waistline

6.3.5 Hip

Equipment:
Mirror
Tape measure B (150 cm)
Soft marking pencil (black or white)



Use the tape measure to determine the visual widest part of the hip. This position is marked at widest part of hip below and in line with mark on side waist (see arrows). Note that this measuring position will mostly include the widest part of the bum.

Marks to be on BOTH SIDES of the body. Both marks should be the same distance below each waist landmark. To achieve this, first mark the one side (a) and measure the distance below the waist landmark. Then continue to mark the second landmark (b) on the other hip at the same distance below the waist landmark on that side.

6.3.6 Ankle

Equipment:
Soft marking pencil (black or white)

Mark the centre position of the prominent anklebone on the LEFT SIDE of body. Cross direction to be from floor to knee.

6.4 OTHER IMPORTANT MARKS USED AS LANDMARKS WHICH ARE NOT MARKED

6.4.1 Armhole crease

This visual landmark is the crease visible at the armhole when the arm hangs relaxed next to the body (see arrc `

6.4.2 Knee crease

This visual landmark is the horizontal crease at the back of the kneecap (see the arrow at the dotted line).

6.4.3 Mid point of nose at brow ridge

This visual landmark is the horizontal visual mark between the brows (see the dotted line).

6.4.4 Larynx (Adams apple)

This visual landmark is at the point as indicated by the field worker - about halfway between the supersternal notch and jawbone.

6.5 WEIGHING THE CHILD

6.5.1 Weight (Measurement 6)

<u>Equipment</u>:
Scale

Weigh the child wearing the correct swimwear and underwear.

The weight is recorded in kg and rounded to the nearest 0.5 kg.

7. PHOTOGRAPHING THE CHILD

7.1 EQUIPMENT

The Photographer will use the following equipment:

1. 2 X Batteries with charger and cord for digital camera
2. Digital camera, with instruction booklet, in a carry bag
3. Diskettes
4. Gloves
5. Manual
6. Masking tape
7. Metal tape measure
8. Photographic grid with stand and fixtures
9. Pres Stick
10. Tripod with fixtures
11. Whiteboards with pens and eraser

Other equipment rotating between measuring teams:

12. Clipboard with measuring chart, pencil and eraser

7.2 SETTING UP THE PHOTOGRAPHIC EQUIPMENT

Select the photographic area first, before setting up the measuring centre. When selecting this area, ensure that no movement takes place around the tripod position. About 2.5 m X 5 m should be allowed for this activity. Ensure that NO DIRECT SUNLIGHT will fall onto the equipment at any time of the day. It is preferred that, if unavoidable, daylight should fall from behind the photographer. No special lights are required since the FLASH SHOULD BE ACTIVATED AT ALL TIMES. Always set the camera up before the measuring day starts. Check this position constantly during each session.

7.2.1 Tripod settings

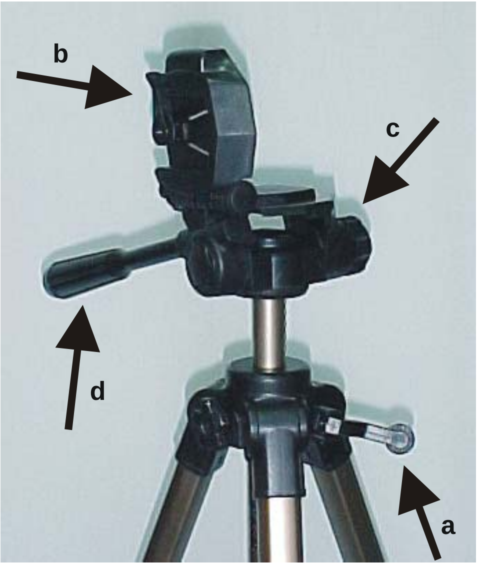
The tripod settings should be fixed beforehand. You do not have to adjust the following two settings:

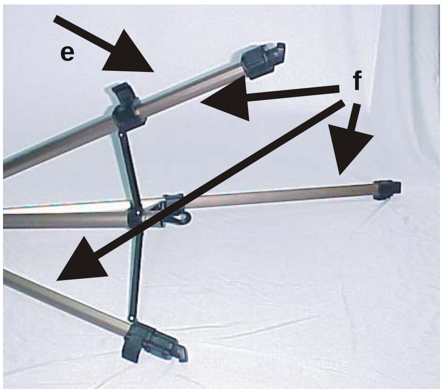
a. The gear operation handle, or
b. The side tilt lock knob.

The other two settings may need adjustment from time to time:

c. The panning lock knob, or
d. The tilt and pan control knob.

Extend only the first section of the aluminium legs by releasing the side leg lever locks (e). Once all three legs are equally extended to this position, lock the legs (f) with the same locks. Ensure that the metal radial leg braces (g) are also fully extended.





7.2.2 Preparation of camera and tripod

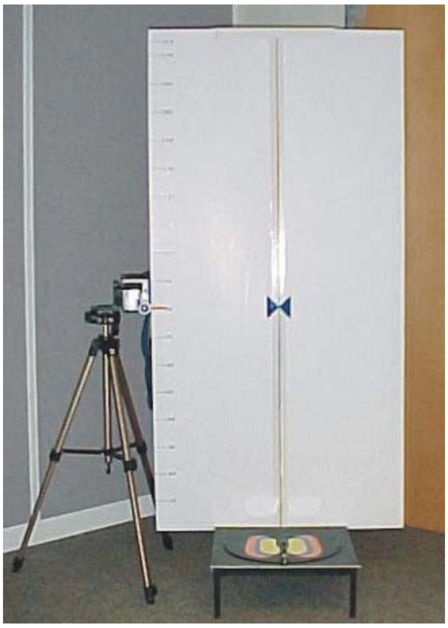
All the pre-set tripod settings as indicated in the previous instructions should not be altered unless necessary.

a. The camera should always be fixed to the mounting platform of the tripod. This platform is attached to the tripod to keep the camera in position.
b. Fix the camera to the centre of the two tripod legs (c1 & c2) as marked with arrows.

7.2.3 Grid

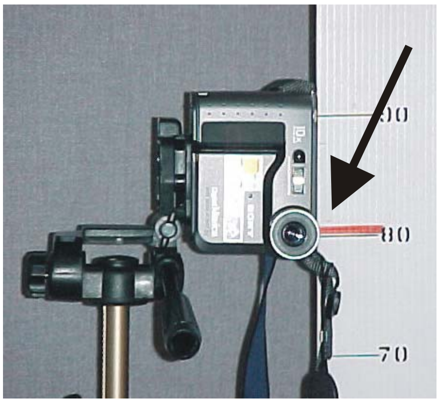
The grid as supplied is fixed to the stand with the rotating surface. Ensure that the top and centre back clamps are properly attached to the stand in order to flatten the background.

Use the arrows on the grid to focus the camera properly.



7.2.4 Camera (lens) height

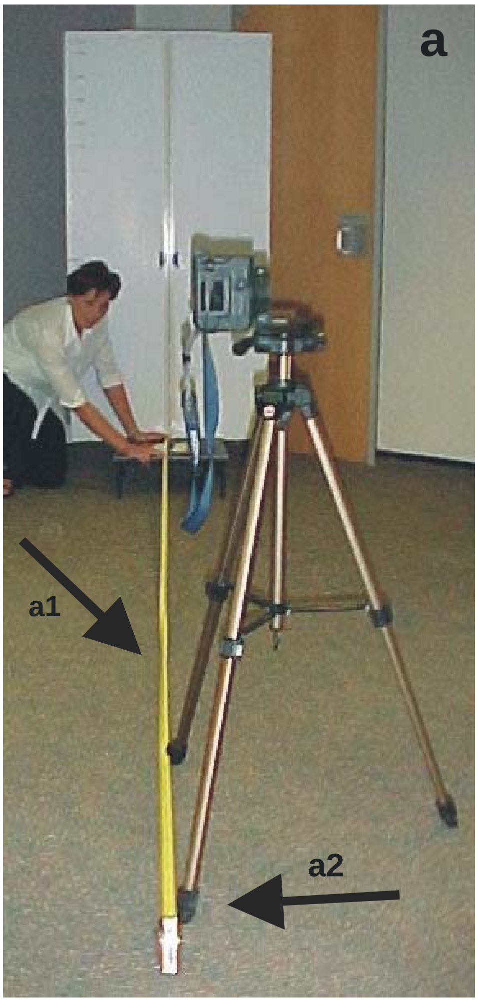
The height of the camera is determined by the centre of the grid (from floor level to the top of the grid). Start by setting up the centre of the camera lens next to the grid at the level of pre-determined centre point (see red line on left side of grid).

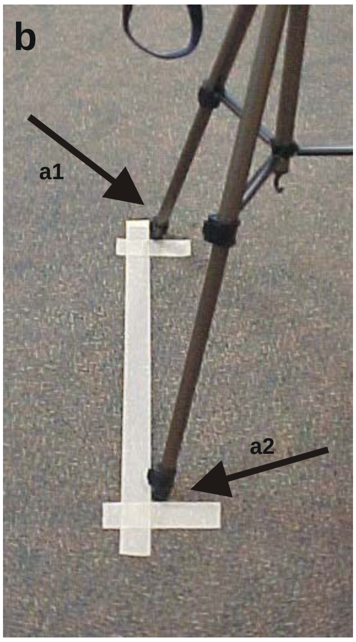


7.2.5 Camera / tripod position from grid

a. Position the camera at the required 3m distance from the grid. This distance is measured from the centre of the grid (and stand) up to the first leg (a1) of the tripod. The second leg (a2) should be in a straight line with the first one.

b. Mark this position properly with masking tape.

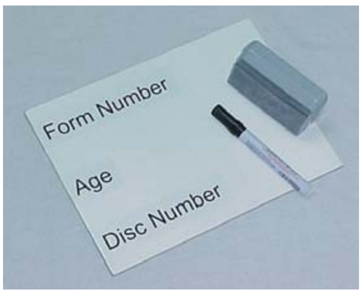




7.2.6 Diskettes

Number each computer disc individually before using. The number of each disc should be recorded on the measurement chart. If two discs are used for the photographs of one child, ensure that the disc numbers are consecutive.

7.2.7 White board, pens and eraser



Use the whiteboard to record the child's information as required:

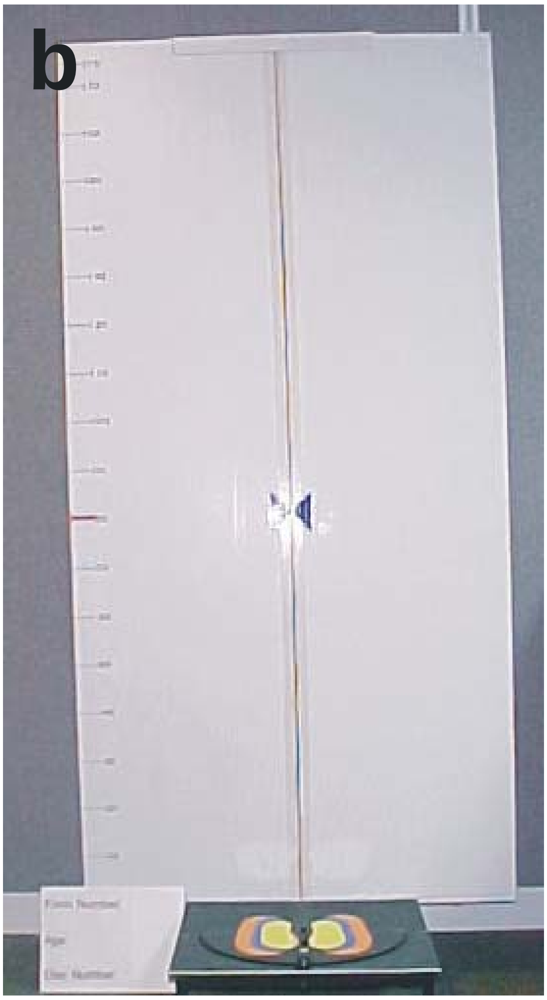
- Form number
- Age
- Disc number

Position the white board on the left side of the body, on the floor as indicated.

7.2.8 Focusing the camera

a. Use the arrows on the grid and centre this on the camera screen.
b. Once you are happy with the alignment, enlarge the picture to include everything from below the white line on the stand as for as the top of the grid.
c. Also ensure that the whiteboard on the left side is included in the photograph.
d. Activate the flash.

NB: The alignment of the camera will ALWAYS fall on the centre of the whiteboard (as marked with the arrows) and NOT on the centre of the child. DO NOT ADJUST THE ALIGNMENT ONCE IT HAS BEEN SET UP.



7.3 HOW TO PHOTOGRAPH THE CHILD

7.3.1 Posture of child

Photographs to be taken from the FRONT, LEFT and BACK of the body.

The child's posture influences the photographs taken. Therefore it is very important to **check** the child's **posture before every photograph.** Make sure the child's body is in the correct position on the correct colour foot marker on the stand surface.

The correct and required posture and stance is as follows: The child MUST:

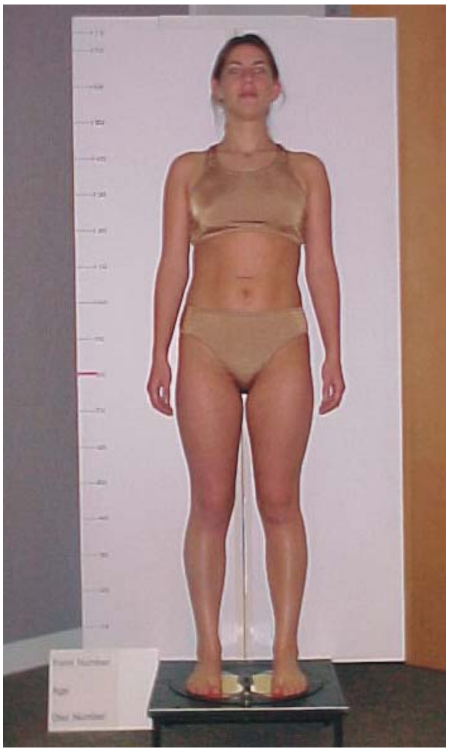
- Relax the arms next to the body with hands open and fingers facing the floor, unless otherwise required.
- Stand up straight, looking straight ahead with the chin held horizontally.
- Always position his/her feet as required for the specific measuring positions.
- Always distribute the weight equally on both legs.

On the other hand, the child MUST NOT:

- Lift his/her chin or look down in the direction of the measuring position.
- Pull in his/her tummy during measuring.
- Stand with a hollow back.

Check the position of the tripod, etc. before taking photographs. Keep the flash activated at all times. Ensure that no helpers are in the photograph, since this can distort the focus.

7.3.2 Front view (Measurement 9)



Equipment:
Camera on tripod
Stand with grid
Whiteboard

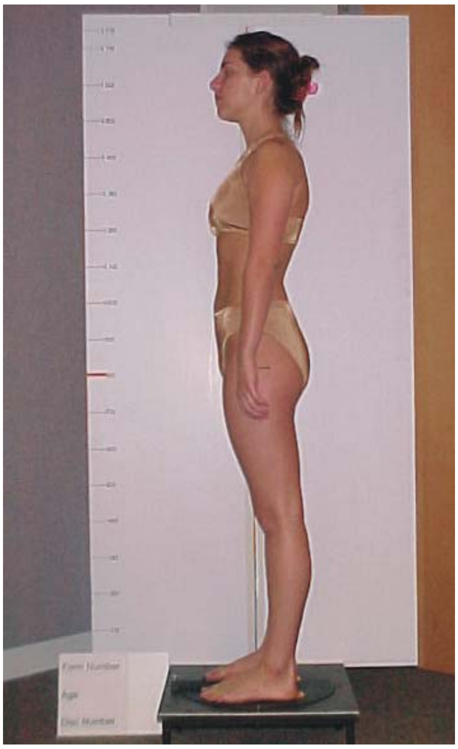
Use the foot markers on the stand as guidelines. The child should FACE the photographer with the centre of the body in line with the centre line on the grid. The line down the centre of the grid must AT ALL TIMES be visible at the crutch. To achieve this it might be necessary for children, where the thighs are touching, to stand with the feet wider apart.

The child should look straight ahead into the lens with the arms hanging comfortably next to the body, but not touching the body.

Write the disc and photograph numbers on the measurement chart.

7.3.3 Side view - left (Measurement 10)

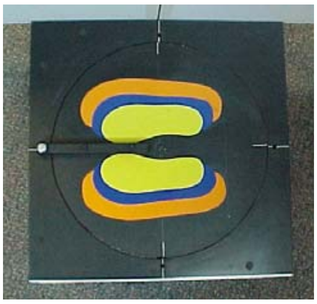
Equipment:
Camera on tripod
Stand with grid
White board



Turn the stand surface to reposition the child sideways. The LEFT SIDE of the child should face the photographer with the centre of the body in line with the centre of the grid. *It might be necessary to reposition the child's feet on the foot marker.*

The child should look straight ahead with chin horizontal and the arms hanging comfortably next to the body.

The child's arms should not hide the body silhouette and body outline



If this pose is a problem, it is suggested that two separate photographs be taken. One photograph should be with the child's arms forward to show the small of the back, and the next photograph should be with the arms held backward to show the tummy.

Write the disc and photograph numbers on the measurement chart.

7.3.4 Back view (Measurement 11)

<u>Equipment</u>:
Camera on tripod
Stand with grid
Whiteboard

Turn the stand surface to reposition the child. The child should FACE THE GRID centre with the body in line with the black line down the centre grid. The line must be visible at the crutch. To achieve this it might be necessary for children, where the thighs are touching, to stand with the feet wider apart. Use the foot markers on the stand as guidelines.

The child should look straight ahead with the arms hanging comfortably next to the body, but not touching the body.

Write the disc and photograph numbers on the measurement chart.

8. MEASURING THE CHILD: Measuring team one

8.1 EQUIPMENT

Team one will use the following equipment:

1. Anthropometer with base, centre and left side vertical posts
2. Elastic (different sizes)
3. Gloves
4. Manual
5. Measuring chains
6. Metal ruler
7. Step (white container)
8. Table (for smaller children)
9. Tape measure (75 cm)

Other equipment rotating between measuring teams:

10. Clipboard with measuring chart, pencil and eraser

8.2 HOW TO MEASURE THE CHILD

Field workers must AT ALL TIMES wear protective gloves when measuring the child.

8.2.1 Point of measuring

Measurements will be taken at the **FRONT, LEFT** or **BACK** of the body as prescribed. Please follow the instructions closely.

8.2.2 Posture of child

The child's posture influences the measurements taken. Therefore it is very important to **check** the **posture before each measurement.** Make sure the child's body is in the correct position and stance as indicated for each point of measuring.

The correct and required posture and stance is as follows: The child MUST:

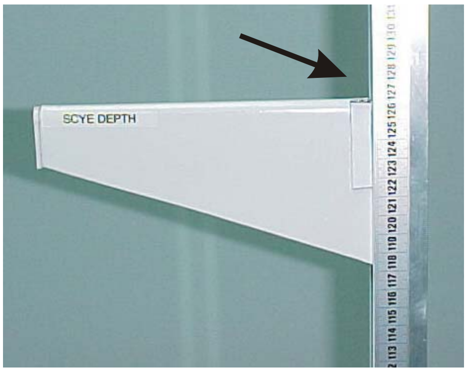
- Relax the arms next to the body with hands open and fingers facing the floor, unless otherwise required.
- Stand up straight, looking straight ahead with the chin held horizontally.
- Always position his/her feet as required for the specific measuring positions.
- Always distribute the weight equally on both legs.

On the other hand, the child MUST NOT:

- Lift his/her chin or look down in the direction of the measuring position.
- Pull in his/her tummy during measuring.
- Stand with a hollow back.

8.2.3 Height and length measurements

Height and length measurements will be taken with an Anthropometer or an ordinary tape measure to the nearest decimal. The equipment needed and the relevant landmarks on the body are mentioned in the description of each measurement. The picture indicates the point of measuring on the Anthropometer.

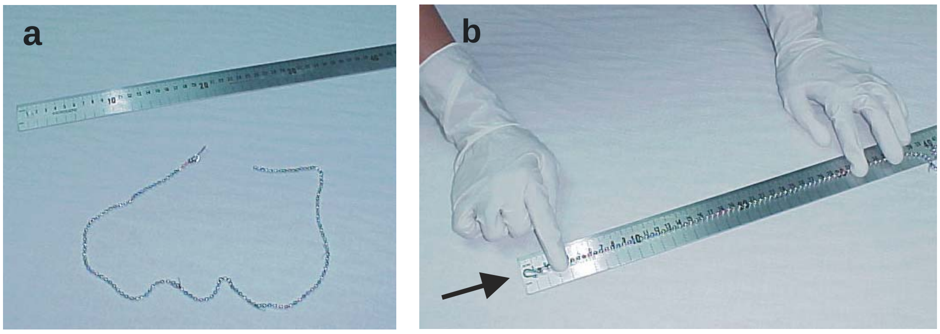


The **child's posture and stance,** as described in the previous section, should be controlled and standardised before any measurement is taken.

8.2.4 Girth measurement

a. All girth measurements in this section must be measured with the measuring chain and metal ruler as provided.
b. Remember always to include the hook (clasp) of the chain when measuring.

The relevant landmarks on the body are identified with the explanation of each measurement. Measurements should be recorded to the nearest decimal.



8.3 MEASURING WITH MEASURING CHAIN AND METAL RULER

8.3.1 Neck base (Measurement 12)

Equipment:
Chain
Metal ruler

Landmark:
Four marks around neckline

Place the chain around the neckline to match all four landmarks. Remove the chain and measure on the metal ruler.

8.3.2 Armhole (Measurement 13)

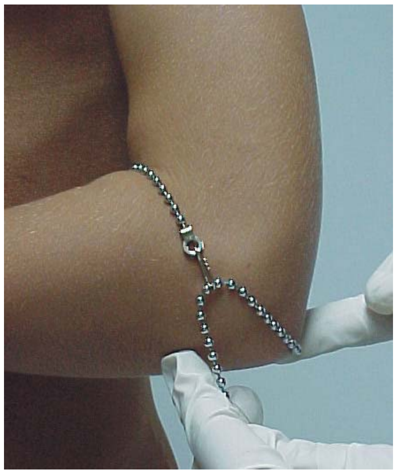
Equipment:
Chain
Metal ruler

Landmark:
Shoulder point on LEFT SIDE

a. First lift the left arm to position the chain under the arm. Position the chain to finish at the shoulder point landmark.
b. Relax the arm again to hang straight next to the body. The chain should not be too tight in order to restrict the measurement.

Remove the chain and measure on the metal ruler.

8.3.3 Elbow: BENT
(Measurement 14)

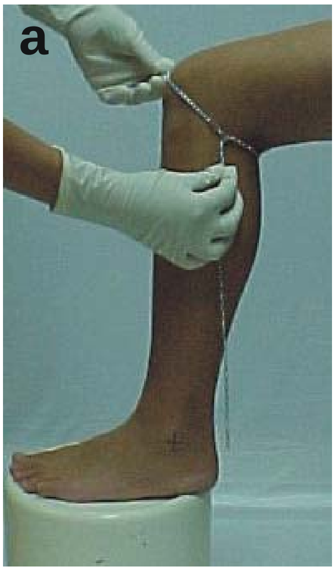


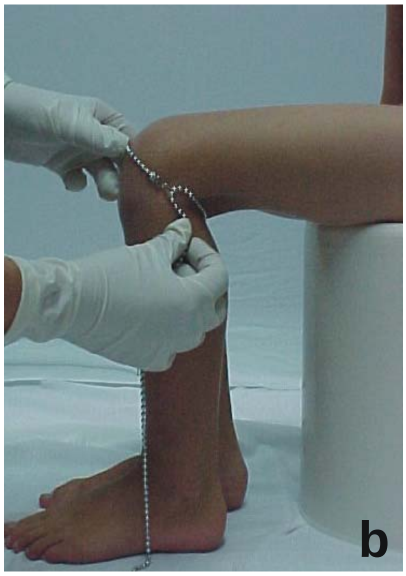
Equipment:
Chain
Metal ruler

Landmark:
Elbow landmark on LEFT SIDE

Bend the left arm to the front waist in order to hold the hand parallel to the waist landmark. Ensure the chain is not too tight around the elbow. The chain must past over the elbow bone.
Remove the chain and measure the chain on the metal ruler.

8.3.4 Knee: BENT
(Measurement 15)





Equipment:
Chain
Metal ruler
Step (white container)

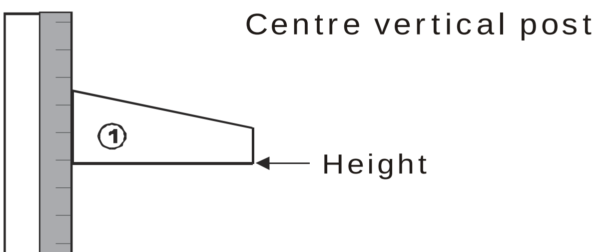
Landmark:
Crease at back of knee

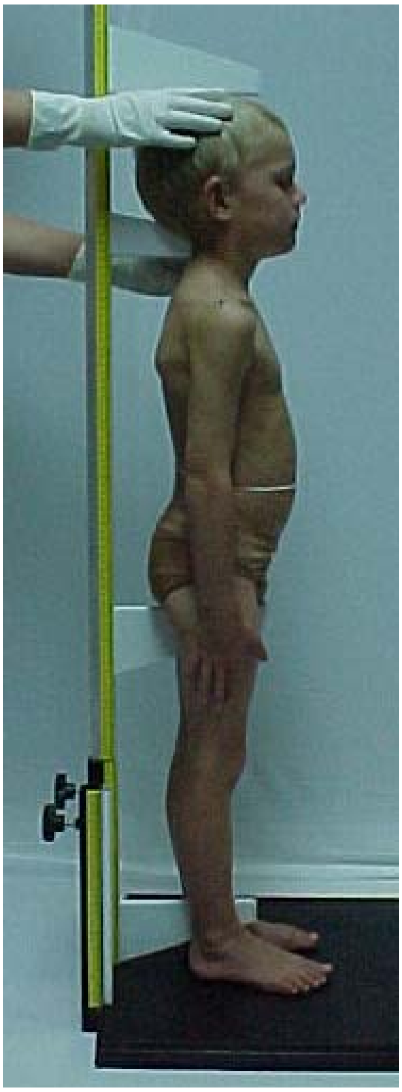
a. Bigger children to place the LEFT foot on the step.
b. Smaller children to sit on the step.

Position the chain over the centre of the LEFT KNEE with the chain level around the knee. Always keep the knee bent at a 90-degree angle. The chain must pass over the widest part of the knee and should not restrict the measurement.
Remove the chain and measure the chain on the metal ruler.

8.4 MEASURING WITH THE ANTHROPOMETER: CENTRE VERTICAL POST

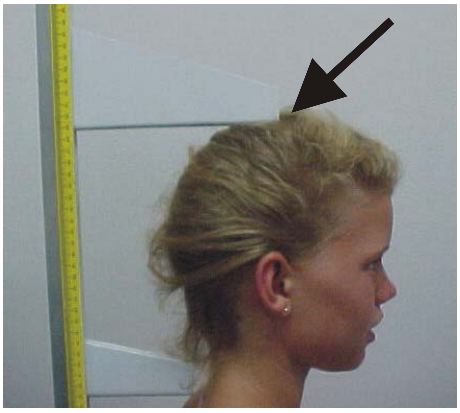
The centre vertical post should be used for the three measurements down the centre back of the child's body. ***Note:*** *The second crutch height measuring device at the bottom of the vertical post should only be used for the smaller children where the crutch measurement overlaps with the join in the equipment. It is also recommended to keep the Anthropometer on a small table to be able to measure more accurately.*





First set up the equipment in line with each point of measuring before writing the measurements on the measuring chart. The child's **posture** and **stance** is very important and should be controlled during this measuring process. Ensure that the child stands in a comfortable position with the feet a short distance apart, looking straight ahead with the chin horizontal and arms hanging relaxed next to the body. The child should face away from the centre vertical post. **The child will tend to move the body in the direction of the measuring device. This should be rectified before any measurement may be taken.**

8.4.1 Height (Measurement 16)



<u>Equipment</u>:
Anthropometer with centre vertical post

Take the measurement level with the top of the child's head

Note: *The hair clip should not interfere with this measurement.*

8.4.2 Nape to floor
(Measurement 17)

<u>Equipment</u>:
Anthropometer with centre vertical post

<u>Landmark</u>:
Nape

Measure at the centre of the nape landmark.

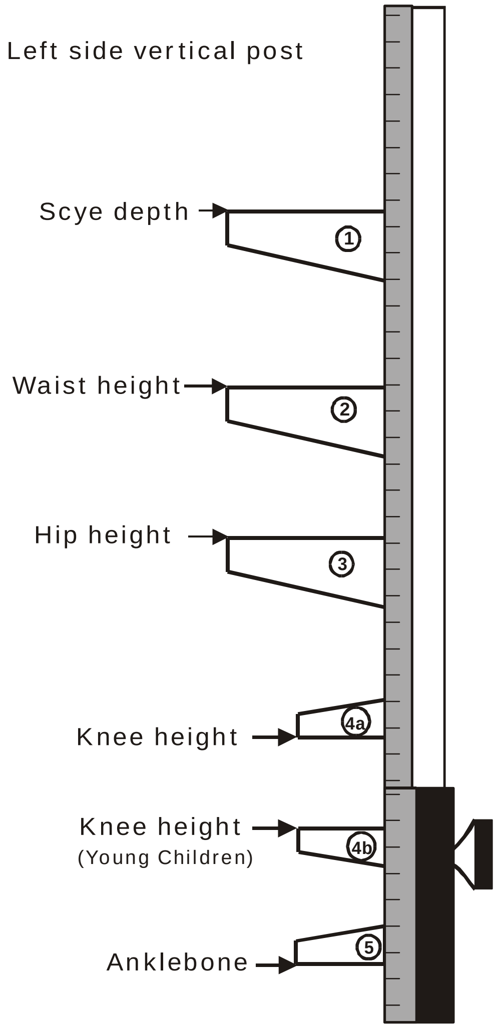
8.4.3 Crutch to floor
(Measurement 18)

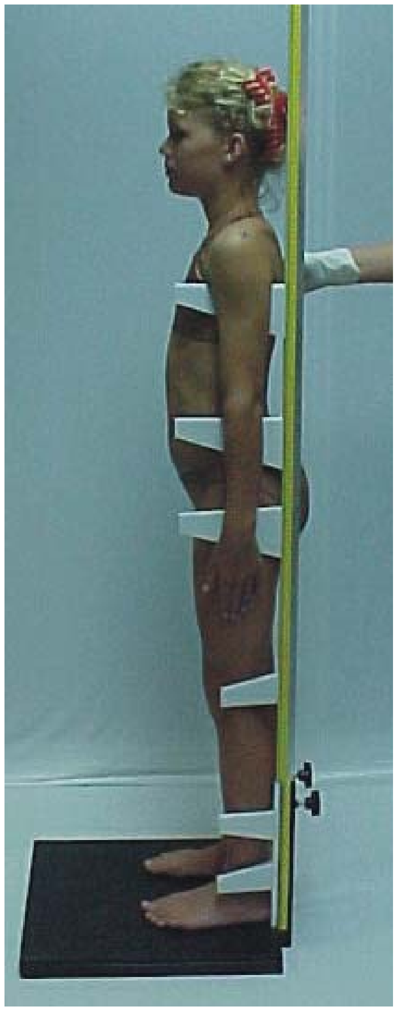
<u>Equipment</u>:
Anthropometer with centre vertical post

Measure at the centre of the crutch whilst the legs are comfortably apart.

8.5 MEASURING WITH THE ANTHROPOMETER: LEFT SIDE VERTICAL POST

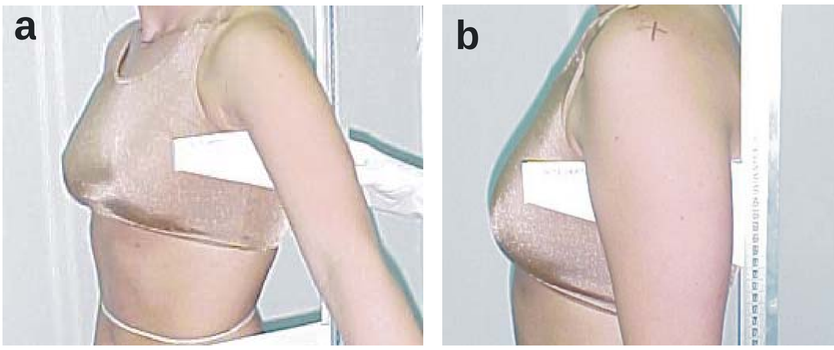
Remove the Centre Vertical Post and insert the Left Side Vertical Post into the side fitting to be able to measure the following five measurements. All measurements should be taken on the LEFT SIDE of the body. ***Note:*** *The second knee-measuring device at the bottom of the vertical post should only be used for the smaller children where the knee measurement overlaps with the join in the equipment. It is also recommended to put the Anthropometer on a small table to be able to measure more accurately.*





First set up the equipment in line with each point of measuring before writing the measurements on the measuring chart. The child's **posture** and **stance** is very important and should be controlled during this measuring process. Ensure that the child stands in a comfortable position with the outside of the feet hip distance apart, looking straight ahead with the chin horizontal and arms hanging relaxed next to the body. The child should face away from the left side vertical post. **The child will tend to move the body in the direction of the measuring device. This should be rectified before any measurement may be taken.**

8.5.1 Scye depth (Measurement 19)

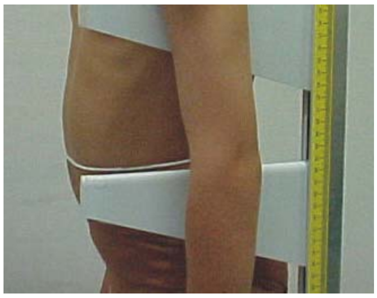


Equipment:
Anthropometer with left side vertical post

a. Ask the child to lift his/her arm to position the measuring device. When the arm is relaxed, the device should not lift the arm.

b. Take the measurement straight at the LEFT armpit with arm hanging relaxed and straight next to body.

8.5.2 Waist to floor (Measurement 20)

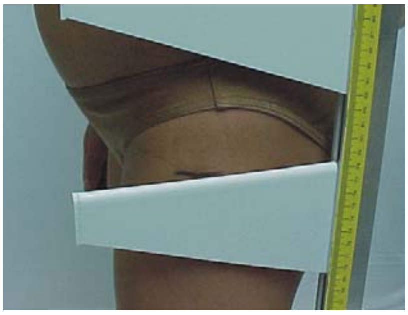


Equipment:
Anthropometer with left side vertical post

Landmark:
Waist landmark on LEFT side

Measure on LEFT SIDE of body at the centre of waist landmark.

8.5.3 Hip to floor (Measurement 21)

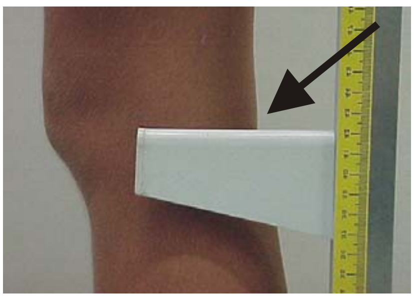


Equipment:
Anthropometer with left side vertical post

Landmark:
Hip landmark on LEFT side

Measure on LEFT SIDE of body at the centre of hip landmark.

8.5.4 Knee to floor (Measurement 22)



Equipment:
Anthropometer with left side vertical post

Landmark:
Crease at knee on LEFT side

Measure at the centre of knee crease.

8.5.5 Ankle to floor (Measurement 23)

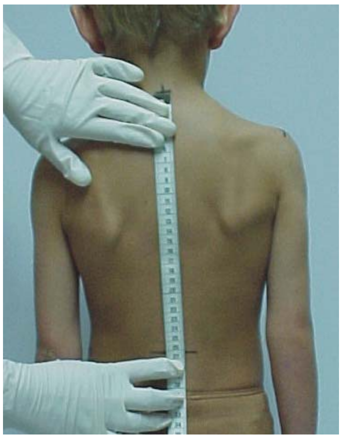
Equipment:
Anthropometer with left side vertical post

Landmark:
Ankle landmark on LEFT side

Measure at the centre of anklebone.

8.6 MEASURING WITH TAPE MEASURE A (75 cm)

8.6.1 Nape to waist (Measurement 24)

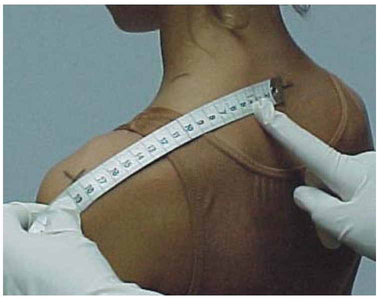


Equipment:
Tape measure A (75 cm)

Landmarks:
Nape
Waist at CB

The child must FACE AWAY from the measurer. Measure from nape to waist landmark with tape measure on body contour.

8.6.2 Nape to shoulder (Measurement 25)



Equipment:
Tape measure A (75 cm)

Landmarks:
Nape
Shoulder point on LEFT SIDE

The child must FACE AWAY from the measurer. Measure on LEFT SIDE of body from nape to centre of left shoulder point landmark.

8.6.3 Stern to waist (Measurement 26)

Equipment:
Tape measure A (75 cm)

Landmarks:
Stern landmark
Waist landmark at CF

The child must FACE the measurer. Measure from centre of stern landmark to front waist landmark with tape measure on body contour.

9. MEASURING THE CHILD: Measuring team two

9.1 EQUIPMENT

Team Two will use the following equipment:

1. Gloves
2. Manual
3. Mirror
4. Table (for small children)
5. Tape measure A (75 cm)
6. Tape measure B (150 cm)

Other equipment rotating between measuring teams:

7. Clipboard with measuring chart, pencil and eraser

9.2 HOW TO MEASURE THE CHILD

Field workers must AT ALL TIMES wear protective gloves when measuring the child.

9.2.1 Point of measuring

Measurements will be taken at the **FRONT, LEFT** or **BACK** of the body as prescribed. Please follow the instructions closely.

9.2.2 Posture of child

The child's posture influences the measurements taken. Therefore it is very important to **check** the **posture before each measurement.** Make sure the child's body is in the correct position and stance as indicated for each point of measuring.

The correct and required posture and stance is as follows: The child MUST:

- Relax the arms next to the body with hands open and fingers facing the floor, unless otherwise required.
- Stand up straight, looking straight ahead with the chin held horizontally.
- Always position his/her feet as required for the specific measuring positions.
- Always distribute the weight equally on both legs.

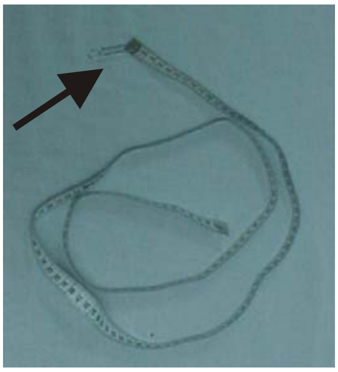
On the other hand, the child MUST NOT:

- Lift his/her chin or look down in the direction of the measuring position.
- Pull in his/her tummy during measuring.
- Stand with a hollow back.

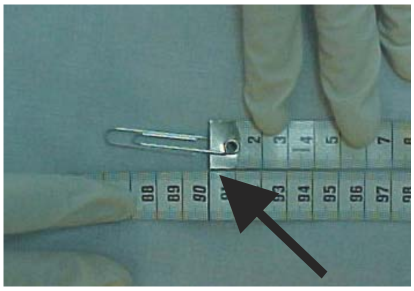
9.2.3 Girth measurements

All girth measurements must be taken without fingers inside the tape measure. The equipment needed, as well as the landmarks on the body, are mentioned with the description of each measurement.

Two lengths of tape measure will be used: 75 cm and 150 cm. The paper clip extension to the front of the tape measure is for ease of measuring and a better grip.



When measuring girth, ensure that the tape measure passes as shown in the diagram to be able to record an accurate measurement. Measurements are recorded to the nearest decimal.



9.2.4 Width measurements

The equipment needed, as well as the landmarks on the body, are mentioned with the explanation of each measurement. Measurements are recorded to the nearest decimal.

The 75 cm tape measure will mainly be used for this type of measurement.

9.3 MEASURING WITH REGULAR TAPE MEASURES A (75cm) & B (150cm)

9.3.1 Head girth (Measurement 27)

<u>Equipment</u>:
Tape measure A (75 cm with extension)

The child must FACE the measurer. Measure around widest part of head with the tape measure level above the eyebrows.

The tension of the tape may not restrict the measurement, but must flatten the child's hair.

9.3.2 Head arc (Measurement 28)

<u>Equipment</u>:
Tape measure A (75 cm with extension)

<u>Landmarks</u>:
Neck shoulder points on both left and right sides

Measure the distance in front of the ears, straight from the left neck shoulder point to the right neck shoulder point over the crown of the head.

This measurement does not have to be taken on the body contour.

9.3.3 Cervical brow (Measurement 29)

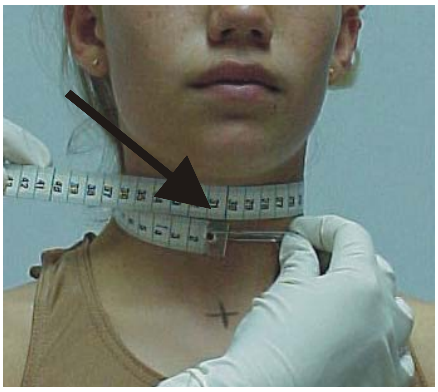
<u>Equipment</u>:
Tape measure A (75 cm with extension)

<u>Landmarks</u>:
Nape
Mid point of nose at brow ridge

Measure the distance from the mid point of the nose at the brow ridge up to the nape over the crown of the head.

This measurement does not have to be taken on the body contour.

9.3.4 Neck girth (Measurement 30)

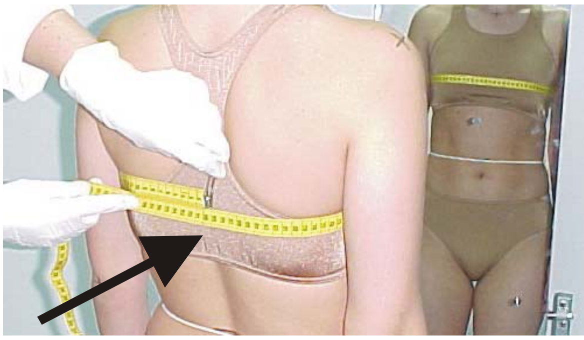


<u>Equipment</u>:
Tape measure A (75 cm with extension)

<u>Landmarks</u>:
Larynx (Adam's apple)
Nape

Measure with tape measure flat on surface of neck at Larynx and ±1.5 cm above the nape. The child to keep his/her head straight, looking straight ahead whilst keeping his/her chin level.

9.3.5 Bust / chest (Measurement 31)



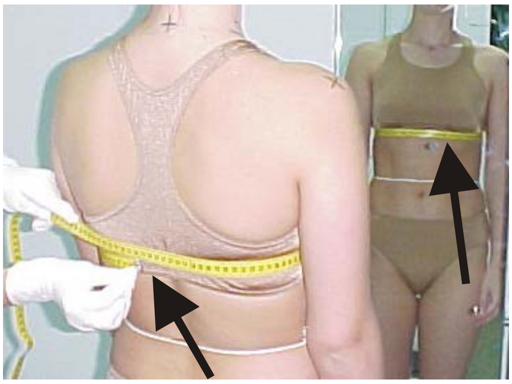
It is recommended that measurers have assistance when taking this measurement.

<u>Equipment</u>:
Tape measure B (150 cm with extension)
Mirror

The child must FACE the MIRROR.

Measure with tape measure straight around the front and back of the body, over the widest part of the bust ("nipple line").

9.3.6 Under bust (GIRLS ONLY) (Measurement 32)

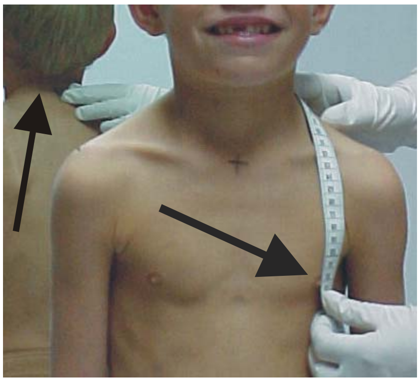


<u>Equipment</u>:
Tape measure B (150 cm with extension)
Mirror

The child must FACE the MIRROR.

Measure with tape measure **tight** and straight around front and back of the body **directly** underneath the bust.

9.3.7 Nape to bust point (Measurement 33)

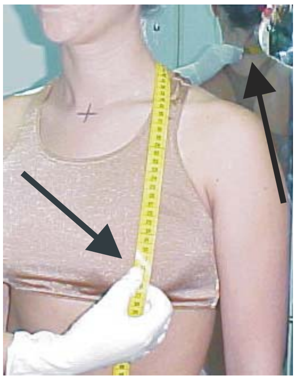


It is recommended that measurers have assistance when taking this measurement.

<u>Equipment</u>:
Tape measure A (75 cm with extension)
Tape measure B (150 cm with extension)

<u>Landmarks</u>:
Nape
Bust point

The bust point should be in line with the mid arm. If this measuring point is distorted, please try to correct by ensuring the underwear is suitable before the measurements are taken.



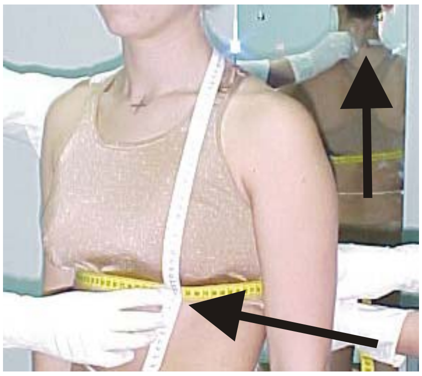
Measure on LEFT SIDE of the body, from the nape point to the widest part of bust up to **the nipple position**.

Keep the tape measure on the body contour.

9.3.8 Nape to under bust point (GIRLS ONLY) (Measurement 34)

NB: Do not move tape measure after previous girth measurement has been taken.

It is recommended that measurers have assistance when taking this measurement.



<u>Equipment</u>:
Tape measure A (75 cm with extension)
Tape measure B (150 cm with extension)

<u>Landmarks</u>:
Nape
Under bust point

Measure on LEFT SIDE of body, from the nape point to the under bust position up to **the upper side of the other tape measure which is around the body.**

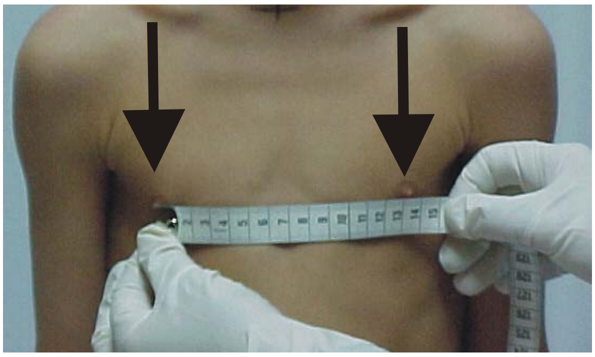
Keep the tape measure on the body contour.

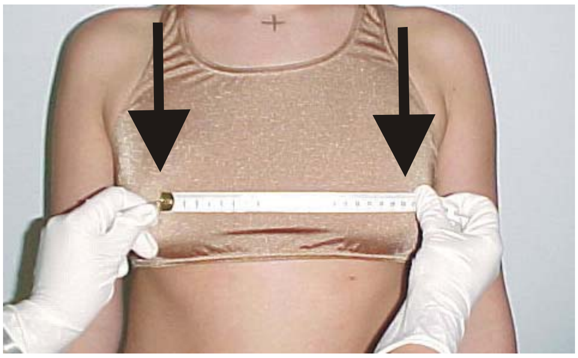
9.3.9 Inter-nipple position (Measurement 35)

<u>Equipment</u>:
Tape measure A (75 cm)

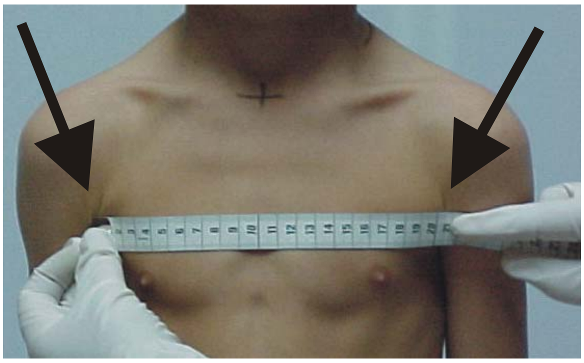
Measure straight across from nipple point to nipple point. **Keep the tape measure straight.**

This measurement will NOT be taken on the body contour.





9.3.10 Across front (Measurement 36)



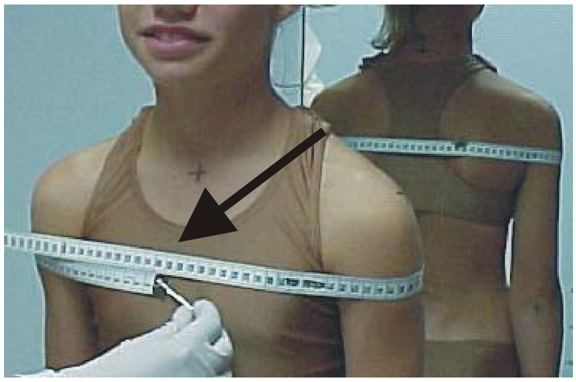
Equipment:
Tape measure A (75 cm with extension)

Landmarks:
Creases at front armholes

The child must FACE the measurer.

Measure from the centre of the armhole creases across the front. **Measure along the body contour**.

9.3.11 Shoulder circumference (Measurement 37)



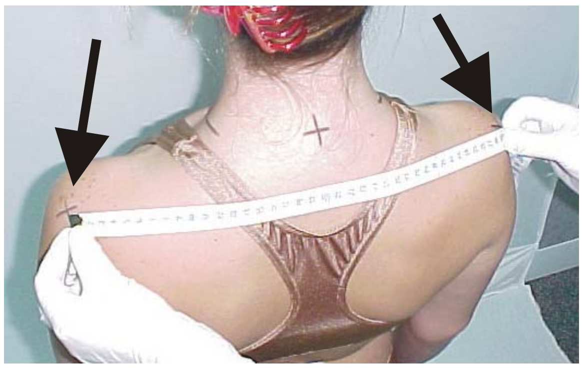
Equipment:
Tape measure B (150 cm with extension)
Mirror

Landmarks:
Armhole creases (front & back)

The child must FACE the measurer. Place tape measure level and straight around front and back of the body at the armhole creases.

(With most children this measurement will be above bust point.)

9.3.12 Shoulder breadth (Measurement 38)



Equipment:
Tape measure A (75 cm with extension)

Landmarks:
Landmark on LEFT shoulder
Landmark on RIGHT shoulder

The child's back must FACE the measurer with shoulders in a upright but relaxed position.

Measure straight across back from centre of landmark on the left shoulder point to the centre of the landmark on the right shoulder point along the body contour.

9.3.13 Across back
(Measurement 39)

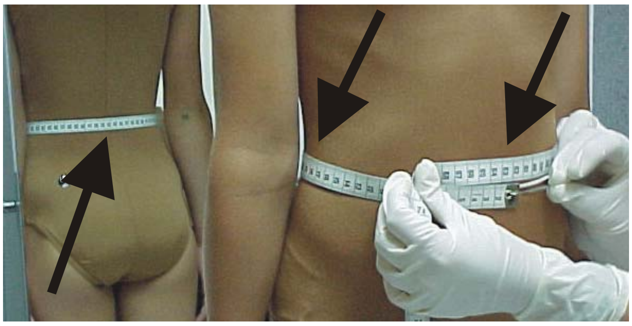
Equipment:
Tape measure A (75 cm with extension)

Landmarks:
Crease at back armholes

The child's back must FACE the measurer. The child's posture must be correct.

Measure straight across the back at the centre of the armhole creases. **Do not measure on the body contour.**

9.3.14 Waist
(Measurement 40)



Equipment:
Tape measure B (150 cm with extension)
Mirror

Landmarks:
Waist (front, back and sides)

The child must FACE the mirror. Position the centre of the tape measure on all four landmarks. The posture of child to be correct – the child to relax tummy.

9.3.15 Hip
(Measurement 41)

Equipment:
Tape measure B (150 cm with extension)
Mirror

Landmark:
Hip on LEFT side
Hip on RIGHT side

The child should face with the right side of the body to the mirror. Measure at the widest part of the hip with tape measure straight across the back.

10. MEASURING THE CHILD: Measuring team three

10.1 EQUIPMENT

Team Three will use the following equipment:

1. Caliper
2. Elastic (different sizes)
3. Gloves
4. Manual
5. Mirror (optional)
6. Sweets / Tattoos
7. Table (for smaller children)
8. Tape measure A (75 cm)
9. Tape measure C (2 m)

Other equipment rotating between measuring teams:

10. Clipboard with measuring chart, pencil and eraser

10.2 HOW TO MEASURE THE CHILD

Field workers must AT ALL TIMES wear protective gloves when measuring the child.

10.2.1 Point of measuring

Measurements will be taken at the **FRONT, LEFT** or **BACK** of the body as prescribed. Please follow the instructions closely.

10.2.2 Posture of child

The child's posture influences the measurements taken. Therefore it is very important to **check** the **posture before each measurement.** Make sure the child's body is in the correct position and stance as indicated for each point of measuring.

The correct and required posture and stance is as follows: The child MUST:

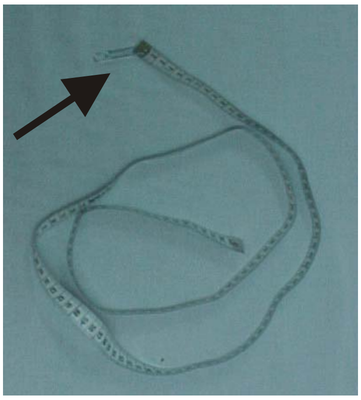
- Relax the arms next to the body with hands open and fingers facing the floor, unless otherwise required.
- Stand up straight, looking straight ahead with the chin held horizontally.
- Always position his/her feet as required for the specific measuring positions.
- Always distribute the weight equally on both legs.

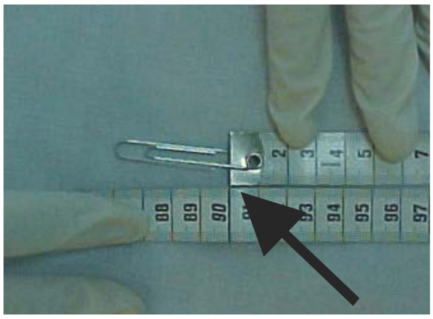
On the other hand, the child MUST NOT:

- Lift his/her chin or look down in the direction of the measuring position.
- Pull in his/her tummy during measuring.
- Stand with a hollow back.

10.2.3 Girth measurements

All girth measurements must be taken without any fingers inside the tape measure and to the nearest decimal. The equipment needed, as well as the landmarks on the body, are mentioned with the description of each measurement.





Two lengths of tape measures will be used: 75 cm and 2.5 m. The paper clip extension to the front of the tape measure is for ease of measuring and a better grip.

When measuring girth, ensure the tape measure passes as shown in the diagram to be able to record an accurate measurement.

10.2.4 Width measurements

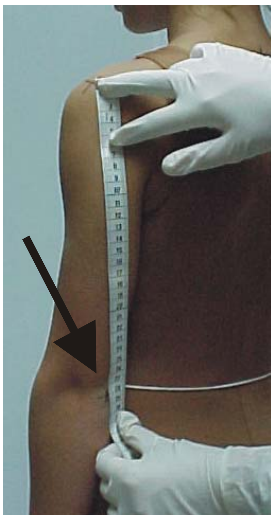
The equipment needed, as well as the landmarks on the body, are mentioned with the explanation of each measurement.   Measurements are taken to the nearest decimal. A 75 cm tape measure will mainly be used for this type of measurement. A calliper will also be used for some of the measurements. Be careful not to hurt the child with the sharp edges of the calliper.

10.2.5 Length measurements

The equipment needed, as well as the landmarks on the body, are mentioned with the explanation of each measurement.   Measurements are taken to the nearest decimal. A 2 m tape measure will mainly be used for this type of measurement.

10.3 MEASURING WITH TAPE MEASURE A (75 cm)

10.3.1 Shoulder to elbow length: STRAIGHT (Measurement 42)



Equipment:
Tape measure A (75 cm)

Landmarks:
LEFT shoulder point landmark
LEFT elbow landmark

The child must stand with his LEFT SIDE to measurer with arm straight.

Measure from shoulder point landmark to elbow bone landmark.

10.3.2 Shoulder to wrist length: STRAIGHT (Measurement 43)

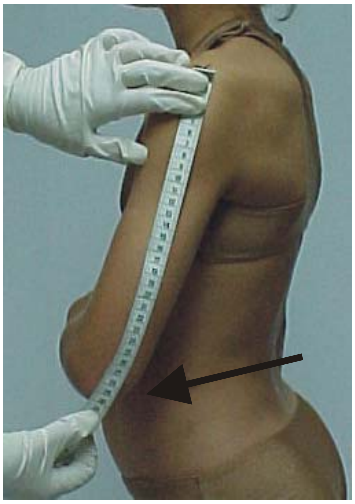
Equipment:
Tape measure A (75 cm)

Landmarks:
LEFT shoulder point landmark
LEFT wrist landmark

The child must stand with his LEFT SIDE to measurer, with the left arm straight.

Measure from shoulder landmark to the wrist landmark.

10.3.3 Shoulder to elbow length: BENT (Measurement 44)



Equipment:
Tape measure A (75 cm)

Landmarks:
LEFT shoulder point landmark
LEFT elbow landmark

The child must stand with his LEFT SIDE to measurer, with the left arm bent and in line with the waistline.

Measure from shoulder point landmark to elbow bone landmark.

10.3.4 Shoulder to wrist length: BENT (Measurement 45)

Equipment:
Tape measure A (75 cm)

Control point on body:
LEFT shoulder point landmark
LEFT wrist landmark

The child must stand with his LEFT SIDE to measurer, with the left arm bent and in line with the waistline.

Measure from shoulder landmark to the wrist landmark diagonally over the elbow landmark.

10.3.5 Biceps (upper arm) girth (Measurement 46)

Equipment:
Tape measure A (75 cm with extension)

Measure on LEFT SIDE of body in a straight line at the widest part of the arm.

To determine this widest point of the upper arm, ask the child to tighten the biceps. Then relax the arm and take the measurement.

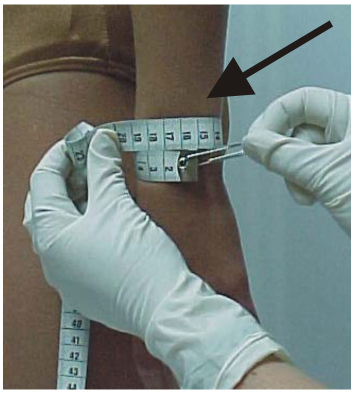
10.3.6 Elbow girth: STRAIGHT (Measurement 47)

Equipment:
Tape measure A (75 cm with extension)

Landmark:
LEFT elbow landmark

Position the tape measure around the elbow of the straightened LEFT arm hanging relaxed next to the body with the hand open.

10.3.7 Wrist girth (Measurement 48)



Equipment:
Tape measure A (75 cm with extension)

Landmark:
LEFT wrist landmark

Position the tape measure around the wrist of the straightened LEFT arm hanging relaxed next to the body with the hand open.

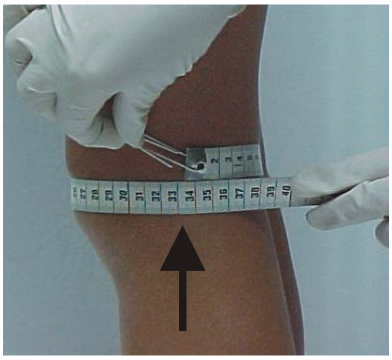
10.3.8 Thigh girth (Measurement 49)

Equipment:
Tape measure A (75 cm with extension)

The child must stand with feet comfortably apart.

Measure with tape measure level on LEFT side of body at widest part of the thigh. *(This measurement does not necessarily finish in the groin.)*

10.3.9 Knee girth: STRAIGHT (Measurement 50)



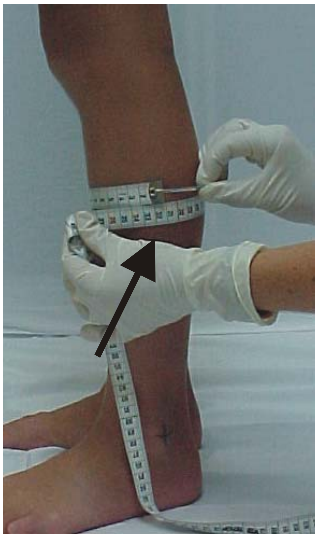
Equipment:
Tape measure A (75 cm with extension)

Landmark:
Crease at back of knee

The child must FACE the measurer with feet comfortably apart.

Measure on LEFT SIDE of body at the centre of the knee crease with tape measure level and straight around knee.

10.3.10 Calf girth (Measurement 51)



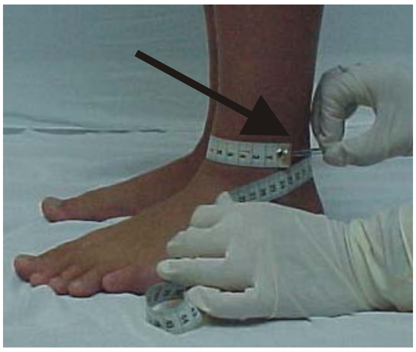
Equipment:
Tape measure A (75 cm with extension)

Landmarks:
Crease at back of LEFT knee
Ankle

The child must stand with LEFT SIDE to the measurer and with the feet comfortably apart.

Measure around the widest part of the calf, between knee crease and ankle with tape measure level and straight.

10.3.11 Ankle girth
(Measurement 52)



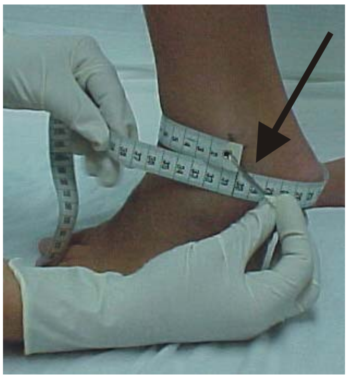
Equipment:
Tape measure A (75 cm with extension)

Landmark:
Ankle on LEFT side

The child must stand with LEFT SIDE to the measurer and with feet comfortably apart.

Measure on the outside of the leg covering the centre of the inside and outside anklebones.

10.3.12 Instep and heel girth
(Measurement 53)



Equipment:
Tape measure A (75 cm with extension)

Landmark:
LEFT ankle landmark

The child must stand with her LEFT SIDE to the measurer. Raise LEFT foot onto the ball of foot.

Measure around widest part of back of heel and over the instep.

10.4 MEASURING WITH CALIPER

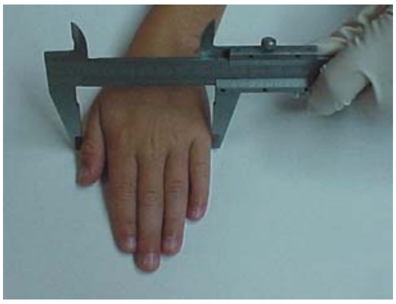
10.4.1 Neck width
(Measurement 54)

Equipment:
Calliper

Take care not to hurt the child with the sharp edges of the calliper.

Rest the calliper horizontally on the widest part of the back neck at the shoulders. *(The calliper does not necessarily meet up with the shoulder landmarks.)*

10.4.2 Hand width
(Measurement 55)



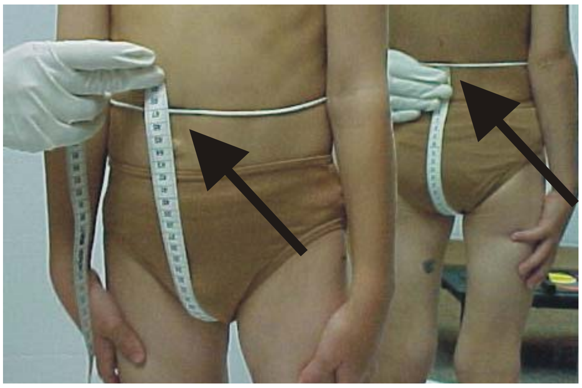
Equipment:
Calliper

With LEFT hand open and flat on the table, take the measurement with the calliper over the widest part of the hand, including the thumb (at the knuckles).

10.5 MEASURING WITH TAPE MEASURE C (2 m)

Position the waist elastic before taking the next two measurements.

10.5.1 Crutch length (Measurement 56)



Equipment:
Tape measure C (2 m)
Waist elastic
Mirror

Landmarks:
Centre front waist landmark
Centre back waist landmark

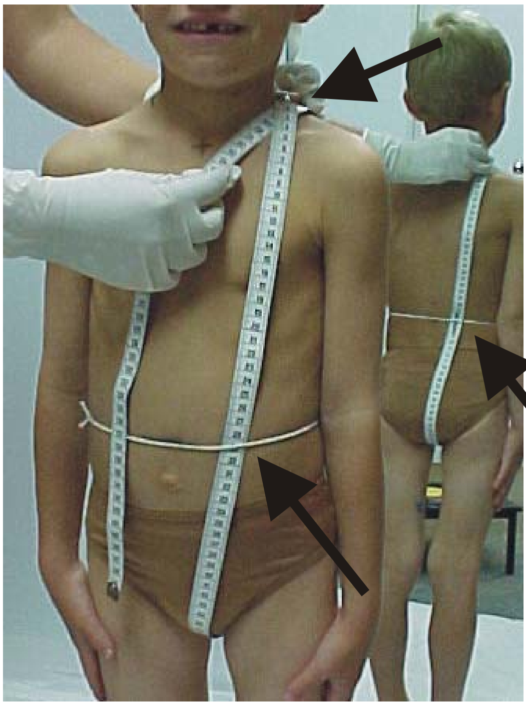
Measure from centre front to centre back waist landmarks through crutch on body contour. Keep tape measure taught.

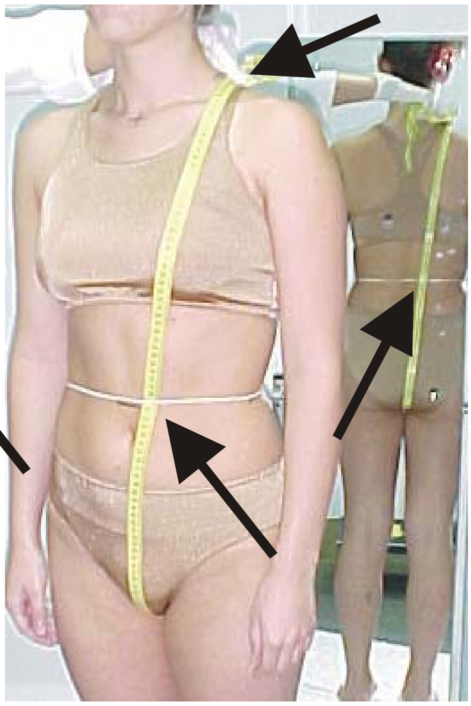
10.5.2 Vertical trunk length (Measurement 57)

Equipment:
Tape measure C (2 m)
Waist elastic
Mirror

Landmark:
LEFT neck shoulder point landmark

Measure on the LEFT SIDE of body from neck shoulder point landmark through crutch from front to back, to end at starting point. Keep tape measure on body contour and tucked under waist elastic.





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APPENDIX 5a

Letters and forms

7 November 2000

The School Principal
Linden Christian Nursery School
PO. Box 1595
Roosevelt Park
2129

Mrs Monica Millson

The group of Clothing Retail Companies, which is funding the Children's Dummy Development Project, would like to thank the school for their participation in this project.

We hereby attach a donation for the school fund, which is based on the number of children that have been successfully measured at your school.

There were five children that were successfully measured and the amount of R20.00 was paid into the following account on the 7 November 2000.

Bank:	FNB, Northcliff
Branch code:	253705
Account no:	5040 0037 939

Best wishes

Sanette van Huyssteen
Researcher

APPENDIX 5b

Indemnity form and measurement chart

INDEMNITY FORM

For office use only — Form number: s

Supervisor Signature:

Please complete the following in CAPITAL LETTERS and use a X where necessary.

I hereby grant permission to measure my child. I agree to have the measurements, as listed on this form, taken over swimwear as provided by the measuring team, providing it is done in the presence of a teacher from:

YES ☐ NO ☐ School tel. number:

If you do not understand the full content of this form, ask your child's teacher to explain and complete the form on your behalf.
Please remember to sign the form for approval.

Signature of parent:

I agree my child being measured by a female field worker. YES ☐ NO ☐

PRINT parent's name:

PRINT parent's surname: **Mother:** ☐ **Father:** ☐

Tel. number of parent: H W C

If you do not wish your child to participate in this project,
PLEASE DO NOT COMPLETE THIS SECTION OF THE FORM.

For office use only
Date of measuring: d d m m 2 0 0 y

1. PERSONAL INFORMATION OF CHILD

Name of child: **Date of birth:** d d m m 1 9 y y

Surname of child: **Gender:** Boy ☐ Girl ☐

Area of home: Suburb: **Home language:** Afrikaans: ☐ Specify other below:

Town: English: ☐

Province: Xhosa: ☐

Extramural activities your child partakes in (please list i.e. ballet, karate): Zulu: ☐

1 4

2 5

3 6

INDEMNITY FORM

For office use only	Supervisor Signature:
Form number: s 1 1 5 0 8	

Please complete the following in CAPITAL LETTERS and use a X where necessary.

I hereby grant permission to measure my child. I agree to have the measurements, as listed on this form, taken over swimwear as provided by the measuring team, providing it is done in the presence of a teacher from:

AAAAAA AAAAAAA PUBLIC PRIMARY SCHOOL

YES X NO School tel. number: 000 000 0000

If you do not understand the full content of this form, ask your child's teacher to explain and complete the form on your behalf.
Please remember to sign the form for approval.

Signature of parent:

I agree my child being measured by a female field worker. YES NO

PRINT parent's name: AAAAAAAA

PRINT parent's surname: BBBBBB **Mother:** X **Father:**

Tel. number of parent: 0233455163 W NA C NA

If you do not wish your child to participate in this project,
PLEASE DO NOT COMPLETE THIS SECTION OF THE FORM.

For office use only

Date of measuring: d d m m y: 2 8 0 7 2 0 0 0

1. PERSONAL INFORMATION OF CHILD

Name of child: AAAAAAAA

Date of birth: d d 2 0 m m 0 4 y y 1 9 9 5

Surname of child: BBBBBB

Gender: Boy X Girl

Area of home: Suburb:

Town: WORCESTER

Province: WESTERN CAPE

Home language: Afrikaans: English: Xhosa: X Zulu:

Specify other below:

Extramural activities your child partakes in (please list i.e. ballet, karate):

1 ATHLETICS
2
3
4
5
6

2. MEASUREMENT CHART OF CHILD

Fill in the boxes or mark the appropriate choice with a X.

For office use only

Age: | | s | | Form no.: | | | |

Name of child:

Surname of child:

Date of measuring: d d m m 2 0 0 y   **Date of birth:** d d m m 1 9 y y

4 **Language:** Afrikaans 1 English 2 Zulu 3 Xhosa 4 Specify other: 5

5 **Gender:** Boy 1 Girl 2

PREPARATION

Fill the blocks with the correct numbers:

6 Weight

Supervisor Signature:

PHOTOGRAPHER (disc numbers)

Fill the blocks with the correct numbers:

7 DISC 1

8 DISC 2

9 Front view

10 Side view

11 Back view

TEAM 1

Fill the blocks with the correct numbers:

12 Neck base
13 Armhole
14 Elbow (**BENT**)
15 Knee (**BENT**)
16 Height
17 Nape to floor
18 Crutch to floor
19 Scye depth
20 Waist to floor
21 Hip to floor
22 Knee to floor
23 Ankle to floor
24 Nape to waist
25 Nape to shoulder
26 Stern to waist

TEAM 2

Fill the blocks with the correct numbers:

27 Head girth
28 Head arc
29 Cervical brow
30 Neck girth
31 Bust / Chest
32 Under bust (**GRL**)
33 Nape to bust point
34 Nape - u/bust (**GRL**)
35 Inter-nipple position
36 Across front
37 Shoulder circ.
38 Shoulder breadth
39 Across back
40 Waist
41 Hip

TEAM 3

Fill the blocks with the correct numbers:

42 Shldr - elbow (**STR**)
43 Shldr - wrist (**STR**)
44 Shldr - elbow (**BNT**)
45 Shldr - wrist (**BNT**)
46 Biceps (upper arm)
47 Elbow (**STR**)
48 Wrist
49 Thigh
50 Knee (**STR**)
51 Calf
52 Ankle
53 Instep & heel girth
54 Back neck
55 Hand
56 Crutch
57 Vertical trunk

2. MEASUREMENT CHART OF CHILD

Fill in the boxes or mark the appropriate choice with a X.

For office use only — Age: 0 5 s 1 Form no.: 1 5 0 8

Name of child: A A A A A A A A

Surname of child: B B B B B B

Date of measuring: (d d m m y) 2 8 0 7 2 0 0 0 **Date of birth:** (d d m m y y) 2 0 0 4 1 9 9 5

4 **Language:** Afrikaans 1 English 2 Zulu 3 Xhosa X Specify other: 5

5 **Gender:** Boy X Girl 2

PREPARATION

Fill the blocks with the correct numbers:

6 Weight 0 2 2 ,0

Supervisor Signature:

PHOTOGRAPHER (disc numbers)

Fill the blocks with the correct numbers:

7	DISC 1	1 1 5
8	DISC 2	0 0 0
9	Front view	0 1 4
10	Side view	0 1 5
11	Back view	0 1 6

TEAM 1

Fill the blocks with the correct numbers:

12	Neck base	3 1 ,5
13	Armhole	2 4 ,9
14	Elbow (**BENT**)	2 1 ,4
15	Knee (**BENT**)	2 6 ,0
16	Height	1 1 6 ,5
17	Nape to floor	0 9 6 ,4
18	Crutch to floor	5 2 ,0
19	Scye depth	0 8 6 ,5
20	Waist to floor	0 7 0 ,8
21	Hip to floor	0 5 6 ,7
22	Knee to floor	3 2 ,8
23	Ankle to floor	0 5 ,0
24	Nape to waist	2 6 ,0
25	Nape to shoulder	1 2 ,5
26	Stern to waist	2 6 ,5

TEAM 2

Fill the blocks with the correct numbers:

27	Head girth	5 5 ,7
28	Head arc	5 2 ,5
29	Cervical brow	4 4 ,0
30	Neck girth	2 7 ,0
31	Bust / Chest	5 9 ,0
32	Under bust (**GRL**)	0 0 ,0
33	Nape to bust point	2 3 ,0
34	Nape - u/bust (**GRL**)	0 0 ,0
35	Inter-nipple position	1 3 ,0
36	Across front	2 1 ,0
37	Shoulder circ.	0 7 0 ,0
38	Shoulder breadth	2 9 ,5
39	Across back	2 8 ,0
40	Waist	5 4 ,2
41	Hip	6 1 ,0

TEAM 3

Fill the blocks with the correct numbers:

42	Shldr - elbow (**STR**)	2 2 ,0
43	Shldr - wrist (**STR**)	3 8 ,0
44	Shldr - elbow (**BNT**)	2 4 ,0
45	Shldr - wrist (**BNT**)	4 0 ,0
46	Biceps (upper arm)	1 7 ,0
47	Elbow (**STR**)	1 7 ,5
48	Wrist	1 2 ,3
49	Thigh	3 5 ,0
50	Knee (**STR**)	2 6 ,0
51	Calf	2 3 ,4
52	Ankle	1 8 ,0
53	Instep & heel girth	2 5 ,0
54	Back neck	0 7 ,6
55	Hand	0 7 ,1
56	Crutch	5 0 ,0
57	Vertical trunk	1 0 8 ,5

APPENDIX 5c

Field worker contract

FIXED TERM CONTRACT OF APPOINTMENT

We have pleasure in offering you an appointment as **Field Worker: Measurer** on a fixed term contract basis reporting to the Researcher of the Children's Dummy Development Project.

1. COMMENCEMENT AND EMPLOYMENT PERIOD

You will be employed for a total of 59 days. Your first period of employment will commence on Monday, 2 May 2000 and will, subject to clause 2, remain in force for a fixed period of 44, days terminating on Friday, 20 September 2000 in the Western Cape. The second employment period will commence on Monday, 2 October 2000 and subject to clause 2, remain in force for a fixed period of 15 days, terminating on Friday 20 October 2000, in Gauteng.

2. PROBATIONARY PERIOD

Your employment will be subject to successful completion of the prescribed training period. During this period the trainers will assess whether you meet the standards required for your appointment. Upon satisfactory completion of this period, your appointment in terms of this agreement will be confirmed.

3. FUNCTIONS AND DUTIES

A description of your general duties is listed in the measuring guide. This job entails mainly the efficient, accurate and consistent measuring of children according to the guidelines.

4. REMUNERATION

Your daily rate of payment is R100 and the daily allowance of R25 will be deposited directly into your bank account on Fridays. You will not receive remuneration for public holidays, Saturdays or Sundays in the Western Cape. You will, however, receive an allowance on Saturdays and Sundays when working in Gauteng. All travel expenditures such as airfare, accommodation and transport will be covered on your behalf, as agreed prior to traveling, when in Gauteng.

5. HOURS OF WORK

Your standard working day for measuring from Monday to Friday is 5 hours (25 hours per week). Measuring centres need to be set up and dismantled before and after prescribed measuring hours.

You agree that your normal hours of work may be extended or amended from time to time to meet any existing or changing operational or similar requirements. You agree to work overtime as and when required, subject only to any statutory limits required from time to time by the relevant legislation. It should be noted, however, that payment for overtime will only proceed after you have completed your full normal weekly hours of work.

6. ATTENDANCE

As Measurer you agree to attend all days of measuring as listed above. You do understand the importance of consistency and will therefore be present at all times and on the days agreed for measuring, both in the Western Cape and in Gauteng.

7. EQUIPMENT

You are aware of the value of and accept full responsibility for the equipment in your care. If equipment in your care is broken, lost or stolen, you are personally responsible for its replacement of equal value.

8. PROCEDURES AND POLICIES

You are expected to comply with all rules and procedures of the project relating to health, safety, hygiene, security and discipline that are currently in force within the project or which may be introduced at a later stage. The rules and procedures are listed in the field worker manual.

9. TERMINATION

9.1 This agreement may be terminated in terms of clause 1 prior to the expiry of the agreement by either party on written notice to the other party of not less than:

9.1.1 one day if you have been employed for 16 day or less;

9.1.2 one week if you have been employed for more than 16 days;

9.2 This agreement may be summarily terminated on any grounds recognised in law as sufficient.

9.3 If you wish to terminate this agreement when in Gauteng, you are personally responsible for repaying the full travel and accommodation costs incurred on your behalf.

Should you agree with the above terms and conditions of employment, kindly sign the declaration hereunder.

Yours sincerely

Sanette van Huyssteen
Researcher

………………………………………………… ……… / ………. / 2000
EMPLOYEE SIGNATURE DATE OF ACCEPTANCE

Please print:
Name of field worker: ………………………………………………………………

Address of field worker: …………………………………………………………….

………………………………………………………………

………………………………………………………………

Contact number(s): ……………………………………………………………….

APPENDIX 6

Practical problems regarding project structure

The following practical problems and implications pertaining to measuring and data collection were identified through proper debriefing discussions between the researcher, field co-ordinator and fieldworkers on completion of the final study. These are related to:

Measuring centers

- Generally, facilities at nursery schools were very poor regarding the requirements for measuring and taking photographs. Rooms were very small and lighting was a problem.
- At times field workers were measuring at two or more schools on the same day. This was considered a waste of time, since only a few children were measured at each school. It was time consuming to move the measuring equipment between the centres.
- Field workers experienced problems at schools where teachers were less involved and were not present in the measuring centre. Calling the children from classes was time consuming in these instances.

Measuring outfits and gifts

- Although children's clothes were put in plastic bags while they were being measured, some clothing still got lost while in other cases children, mostly the older girls, did manage to take the measuring swimwear home.
- Children were very cold when dressed for measuring and waiting to be measured. Blankets were a great help to keep them warm.

- Panty liners for the swimwear were ineffective. The adhesive tape did not work effectively and the children did not understand how to put the liners into the garments.
- The health and hygiene of some children was questionable.
- A few of the smaller children were afraid, and in some instances they wet their pants.

Measuring scheduling

- It was recommended that the children should be measured during the summer months and not in winter.
- At times it was necessary for field workers to adjust the measuring sequence in order to keep all field workers occupied during each measuring session. This happened most often when older children were measured. Less help was needed with dressing and undressing and children understood the instructions given. This resulted in quicker "processing" at certain stages of the measuring sequence.
- Too many children were sometimes waiting in line to be measured. The number of waiting children reduced to ten, which was more workable.
- Preparation of the children and marking of landmarks were very time-consuming, causing huge bottlenecks and delays of the measuring process.
- Time was wasted when children, mostly the younger children, were crying. In some instances calming them was quite a problem.

Selection of sample

- The field co-ordinator found it difficult to pre-select children before measuring. The requirement was that children with physical disabilities should not be included. (If these children were, however, selected for measuring it was agreed to continue to measure them in order not to discriminate. The measurements and photographs of these children were then simply not included in the analysis.)

- Some parents were concerned about the photographs taken of the children and therefore did not allow their children to participate. Particular concerns were raised regarding child pornography and the protection of the child's identity, including photographs with their faces visible, and personal information.

Equipment

- Smaller children were afraid of the white gloves worn by the field workers.
- The surgical gloves affected some field worker's hands, causing skin rashes.
- Smaller children needed visual focus points to keep the correct stance during measuring and photographing.
- The safety pins on the tape measures damaged the white surgical gloves. Field workers eventually did not wear the gloves, but regularly wet their hands with the disinfection solution to clean them before measuring each child.

Photographs

- Some photographs were blurred due to distortion caused when people walked past the photographic area while photographs were taken.
- When there was a lot of movement next to the camera some photographs were out of focus.
- Positioning of the photographic equipment was problematic, since facilities and lighting were different at every school.

Field workers

- Field workers found three weeks away from home too long and they became bored during the measuring period in Gauteng.