Aspects of the involvement, confidence and knowledge of South African registered dietitians regarding genetics and nutritional genomics

by
Lizalet Oosthuizen

Thesis presented in partial fulfilment of the requirements for the degree of Master of Nutrition at the University of Stellenbosch

Supervisor: Me LM du Plessis
Co-supervisor: Me CE Naude
Statistician: Prof DG Nel
Faculty of Health Sciences
Department of Interdisciplinary Health Sciences
Division of Human Nutrition

March 2011

DECLARATION

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Date: March 2011

Signature:

ABSTRACT

Introduction: Nutritional genomics is a new and emerging field aimed at investigating the complex interactions between genetics and diet and the joint influence this has on disease prevention and health promotion. Research is accelerating at a rapid pace and although still in its infancy, it is important for registered dietitians (RDs) to be knowledgeable and keep abreast of these developments as it promises to revolutionize dietetic practice. International studies have demonstrated low confidence and involvement as well as poor knowledge of both genetics and nutritional genomics amongst RDs. To date no similar studies have been conducted amongst South African (SA) RDs.

Methods: A cross-sectional descriptive study was conducted using a national survey of 1881 dietitians registered with the Health Professions Council of South Africa (HPCSA). Data was collected using an existing and validated questionnaire as developed for use in a similar study amongst RDs in the United Kingdom (UK). The self-administered questionnaire consisted of 4 sections to assess the following aspects: i) involvement and confidence in activities relating to genetics and nutritional genomics ii) knowledge of genetics and nutritional genomics iii) factors associated with knowledge and iv) demographic information. The main method of questionnaire distribution was via email (70%) using the Association of Dietetics in South Africa (ADSA) distribution service and questionnaires were posted to those RDs not registered with ADSA (30%).

Results: The response rate was 15.2% (n = 279). Results showed low involvement in activities relating to genetics (n = 47, 17%) and nutritional genomics (n = 72, 25.8%). The majority of respondents indicated low confidence in performing activities relating to genetics (n = 161, 58.7%) and nutritional genomics (n = 148, 53.8%). However, a significant positive association was found between involvement and confidence for all activities ($p < 0.001$). The mean total knowledge score was 48.5 (±19%) and considered as low, with the mean genetics score of 58.5 (± 24%) being significantly higher than the nutritional genomics score of 31.9 (±23%), $p < 0.001$. Those respondents who reported involvement in discussing the genetic basis of a disease (p = 0.02);

providing guidance to patients with genetic disorders (p = 0.01); providing training or education on human genetics (p = 0.01) and discussing with patients how diet may interact with genes to influence risk (p = 0.03) also had higher total knowledge scores. Factors associated with knowledge were greater genetics content in university studies (p < 0.001); higher qualification (p = 0.01); participating in related continuous professional development (CPD) activities (p <0.001) and considering genetics of greater importance to dietetic practice (p = 0.03).

Conclusions: The results of this study indicate that there is overall low involvement, confidence and knowledge of genetics and nutritional genomics amongst SA RDs and this compares well with international studies. Recommendations therefore include the development of a competency framework for genetics and nutritional genomics for undergraduate dietetic education as well as CPD activities in order to provide the driving force for the development of this field in SA.

OPSOMMING

Inleiding: Voeding genomika is ‘n nuwe en ontwikkelende veld wat die komplekse interaksies tussen dieet en genetika bestudeer, asook die gesamentlike invloed wat dit op gesondheids-bevordering en siekte voorkoming het. Navorsing is vinnig besig om uit te brei en alhoewel dit nog in die begin fase is, is dit belangrik vir geregistreerde dieetkundiges (GDs) om op hoogte te bly van die nuutste ontwikkelinge, aangesien dit die potensiaal het om ‘n merkwaardige invloed op die dieetkunde praktyk te hê. Internationale studies het lae selfvertroue en betrokkenheid, asook lae kennis van genetika en voeding genomika onder GDs bevind. Daar is tans geen studies beskikbaar onder Suid Afrikaanse (SA) GDs nie.

Methodes: ‘n Dwarssit studie is onderneem deur gebruik te maak van ‘n nasionale opname van al 1881 dieetkundiges wat by die *Health Professions Council of South Africa (HPCSA)* geregistreer is. Data is ingesamel deur ‘n gevalideerde self-geadministreerde vraelys wat ook begruik is vir ’n eenderse studie onder dieetkundiges in die Vereenigde Koninkryk (VK). Dit het bestaan uit vier afdelings om die volgende aspekte te evalueer: i) betrokkenheid en selfvertroue in aktiwiteite te make met genetika en voeding genomika ii) kennis van genetika en voeding genomika iii) faktore wat met kennis geassosieer word asook iv) demografiese inligting. Die hoof metode van data insameling was deur middel van epos (70%) met behulp van die *Association for Dietetics in South Africa (ADSA)* se epos databasis. Vraelyste is aan diegene gepos wat nie geregistreer was by ADSA nie (30%).

Resultate: Vyftien persent (n = 279, 15.2%) van GDs het op die vraellys gereaggeer. Resultate het lae betrokkenheid in aktiwitiete met betrekking tot genetika (n = 47, 17%) en voeding genomika (n = 72, 25.8%) gewys. Die meerderheid van die deelnemers het lae selfvertroue gerapporteer in die uitvoering van aktiwiteite wat genetika (n = 161, 58.7%), asook voeding genomika (n = 148, 53.8%) behels. Daar was ‘n statistiese beduidende positiewe assosiasie tussen betrokkenheid en selfvertroue vir alle aktiwiteite ($p < 0.001$). Die gemiddelde kennis telling was 48.5 (±19%) wat as laag beskou kan word. Die gemiddelde kennis vir genetika van 58.5 (± 24%) was statisties

beduidend meer as die vir voeding genomika 31.9 (±23%), $p < 0.001$. Deelnemers wat betrokkenheid aangedui het in die bespreking van die genetiese basis van ‘n siekte ($p = 0.02$); raadgewing aan pasiënte met genetiese siektes ($p = 0.01$); lewering van opleiding met betrekking tot genetika ($p = 0.01$) asook die bespreking van die interaksie van dieet en genetika met pasiënte en die invloed hiervan op risiko ($p = 0.03$), het ook beduidende hoër totale kennis gehad. Faktore wat met kennis geassosieer word is die genetika inhoud in voorgraadse studies ($p < 0.001$), hoër kwalifikasies ($p = 0.01$), voorgesette professionele onderrig (VPO) ($p <0.001$) asook diegene wat genetika as belangrik beskou vir dieetkunde praktyk ($p = 0.03$).

Gevolgtrekking: Die resultate van hierdie studie wys dat daar oor die algemeen lae betrokkenheid, selfvertroue en kennis is van genetika en voeding genomika onder SA GDs. Dit vergelyk goed met international bevindinge. Aanbevelings is dat ‘n raamwerk vir die kennis van genetika asook voeding genomika ontwikkel word vir voorgraadse dieetkunde studies, asook die ontwikkeling van VPO aktiwiteite wat die dryfkrag sal voorsien vir die ontwikkeling van hierdie veld in SA.

ACKNOWLEDGEMENTS

I would like to thank the following people for making this research possible. Firstly, to my husband Christo, for his ongoing encouragement and support. To my mother, Rosa, to Deon and Natalie, thank you for your willing and valuable assistance with the distribution of the questionnaires, without your help I could not have completed this. To Roslyn, for your wise words and encouragement when I needed it most.

On a professional level, to both my study leaders Lisanne du Plessis and Celeste Naudé for their expert guidance and support on the execution of this study, I am truly grateful for all your time, effort and encouragement. To Janicke Visser, for assisting and advising me regarding the practical issues surrounding the study and encouraging me throughout.

To Professor Nel (statistician), for his patience as well as speedy analysis of the data, it is much appreciated.

I would also like to thank all the dietitians who participated in the study.

Dedication:

In memory of my dad, Eugene Frederik Neser

TABLE OF CONTENTS

	Declaration	ii
	Abstract	iv
	Opsomming	v
	Acknowledgements	vii
	Dedication	viii
	Table of contents	ix
	List of tables	xiv
	List of figures	xv
	List of appendices	xvi
	Abbreviations	xvii
	List of definitions	xviii
Chapter 1	LITERATURE STUDY	
1.1	Introduction	1
1.2	Research and practice	2
1.3	The potential benefits to dietetic practice	4
1.4	The potential challenges to RDs	4
1.4.1	Educational needs	5
1.4.2	Ethical considerations	6
1.4.3	Direct to consumer nutrigenetic testing and client acceptance	7
1.4.4	Functional foods based on genetic profiling	7
1.5	The current status of nutritional genomics in dietetic practice	8
1.6	Allied HCPs and genetics	8
1.7	Involvement, confidence and knowledge of RDs in other countries	8
1.8	Involvement, confidence and knowledge of SA RDs	10

1.9	Motivation for study	11
Chapter 2	METHODOLOGY	
2.1	Objectives	12
2.1.1	Research aim	12
2.2	Specific Objectives	12
2.3	Study design overview	12
2.4	Study population	12
2.4.1	Sample selection	12
2.4.2	Sample size	13
2.4.3	Inclusion criteria	13
2.4.4	Exclusion criteria	13
2.5	Data collection	13
2.5.1	Data collection tool: Questionnaire	13
2.5.2	Language	14
2.5.3	Questionnaire content	14
2.5.4	Content validity	16
2.5.5	Construct validity	16
2.5.6	Intra-rater reliability	16
2.6	Pilot study	16
2.6.1	Face validity	16
2.7	Distribution of questionnaires	17
2.7.1	Email	17
2.7.2	Postal	18
2.8	Cover letter	18
2.9	Incentive for participation	18

2.10	Anonymity of responses	18
Chapter 3	DATA ANALYSIS	
3.1.1	Confidential management of the questionnaire	20
3.1.2	Statistical analysis of the questionnaire	20
3.2	Ethics considerations	20
3.2.1	Ethics review committee	20
3.3	Assumptions and limitations	21
Chapter 4	RESULTS	
4.1	Response rate	22
4.2	Description of respondents	22
4.2.1	Qualifications	22
4.2.2	Patient groups	22
4.2.3	Current positions	23
4.2.4	Work settings	23
4.3	Involvement in activities	26
4.3.1	Genetics	26
4.3.2	Nutritional genomics	26
4.4	Confidence in activities	26
4.4.1	Genetics	27
4.4.2	Nutritional genomics	27
4.4.3	Relationship between involvement and confidence in all activities	27
4.5	Knowledge	29
4.5.1	Total knowledge	29
4.5.2	Genetics section	29
4.5.3	Nutritional genomics section	29
4.6	Relationship between knowledge and involvement	31

4.6.1	Genetics	31
4.6.2	Nutritional genomics	31
4.7	Relationship between knowledge and confidence	31
4.7.1	Genetics	32
4.7.2	Nutritional genomics	32
4.8	Factors associated with knowledge	34
4.8.1	Genetics	34
4.8.2	Nutritional genomics	34
4.8.3	Total knowledge	35
Chapter 5	DISCUSSION	
5.1	Involvement and confidence	38
5.1.1	Genetics	38
5.1.2	Nutritional genomics	39
5.2	Knowledge	39
5.2.1	Knowledge of genetics and nutritional genomics	39
5.2.2	The relationship between knowledge, involvement and confidence	40
5.3	Factors associated with knowledge	40
5.3.1	Genetics content of undergraduate studies	40
5.3.2	Continuous professional development activities	40
Chapter 6	CONCLUSION	
6.1	Conclusion	42
6.2	Recommendations	42
6.2.1	Development of a competency framework	42
6.2.2	CPD activities	43
6.2.3	Development of special interest groups	43
6.2.4	Postgraduate studies	43

6.2.5 Proposed further research 43

REFERENCES 44

LIST OF TABLES

Table 1	Involvement and confidence of respondents in activities relating to genetics and nutritional genomics	28
Table 2	Knowledge of respondents regarding genetics and nutritional genomics	30
Table 3	Respondents knowledge score compared to involvement and confidence in activities relating to genetics and nutritional genomics	33
Table 4	Respondents knowledge score comparing factors related to university education, practice experience, CPD and attitude towards genetics	36

LIST OF FIGURES

Figure 4.1	Qualifications of respondents	24
Figure 4.2	Number of respondents involved in patient consultations	24
Figure 4.3	Patient groups advised by respondents	24
Figure 4.4	Positions being held by respondents	25
Figure 4.5	Work settings of respondents	25

LIST OF APPENDICES

Appendix 1	Request for permission to use validated UK questionnaire and response by Kevin Whelan (email)	52
Appendix 2	Request for permission for questionnaire to be distributed via ADSA group email list	56
Appendix 3	Request for participation in Pilot study	59
Appendix 4	Pilot study: Comment sheet as sent via email	62
Appendix 5	Cover letter for email questionnaire: Request for participation	65
Appendix 6	Email reminder to complete questionnaire	68
Appendix 7	Cover letter for postal questionnaire: Request for participation	70
Appendix 8	Postal reminder to complete questionnaire	73
Appendix 9	Research Questionnaire	75

ABBREVIATIONS

ADSA	Association for Dietetics in South Africa
CSD	Community Service Dietitian
CPD	Continuing Professional Development
DNA	Deoxyribonucleic Acid
HCP	Health Care Professional
HuGEM	Human Genome Education Model
JADA	Journal of the American Dietetic Association
MTHFR	Methylene tetrahydrofolate reductase
NTD	Neural tube defects
NuGO	European Nutrigenomics Organization
RD	Registered Dietitian
RDA	Recommended Dietary Allowance
SA	South Africa
SNP	Single Nucleotide Polymorphism
UK	United Kingdom
USA	United States of America

LIST OF DEFINITIONS

Apolipoprotein	The protein component that combines with a lipid to form a lipoprotein.
Functional food	A modified food or food ingredient that provides a health benefit beyond that of the traditional nutrients that it contains.
Gene	The fundamental physical and functional unit of heredity, which carries information from one generation to the next.
Genetics	The science that forms the basis for understanding genomics and examines the mechanisms for the inheritance of specific traits as explained by genes.
Genomics	The study of the functions and interactions of all the genes in the genome, including their interactions with environmental factors.
Genotype	The complete genetic constitution of an organism or group, as determined by the specific combination and location of the genes on the chromosomes.
Homozygous	Possessing two identical forms of a particular gene, one inherited from each parent.
Human Genome Project	An international research project to map each human gene and to completely sequence human DNA.
Multifactorial	A pattern of inherited characteristics, such as physical traits or diseases, which results from the interaction of genes and the environment.
Nutrigenetic tests	Tests intended to provide information about an individual's responsiveness to a particular nutrient or diet and how this affects metabolism, health status and risk for disease.
Nutrigenetics	A field that aims to describe how normal variation in the sequence of base pairs in a gene alters an individual's response to diet and health

	and disease outcome.
Nutrigenomics	A field that focuses on the interaction between bioactive dietary components and genes, proteins and metabolites and how this in turn influences gene expression.
Nutritional genomics	An umbrella term that describes both nutrigenetics and nutrigenomics and describes the application of high throughput functional genomic technologies in nutrition research.
Phenotype	The complete observable characteristics of an organism or group, including anatomic, physiologic, biochemical, and behavioral traits, as determined by the interaction of genetic makeup and environmental factors.
Polymorphism	Having multiple alleles of a gene within a population, usually expressing different phenotypes.
Single Nucleotide Polymorphism	A variation in sequence between individuals caused by a change in a single nucleotide. This is responsible for most of the genetic variation between individuals.

CHAPTER 1

LITERATURE REVIEW

1.1 Introduction

Nutritional genomics is an emerging field that holds promise to revolutionize the practice of health care professionals (HCPs) and in particular those of registered dietitians (RDs). [1,2,3] The completion of the Human Genome Project in 2003 [4,5] and advances in genetic science and technology created new avenues of research in nutrition. Subsequent research has focused on the complex interactions between genes and diet and the joint influence this has on the prevention and outcome of multifactorial diseases such as cardio-vascular disease (CVD), diabetes, obesity, certain cancers and various inflammatory disorders. [6,7 8, 9,10,11,12, 13,14,15,16,17] Thus, in the future it is thought that RDs will be uniquely positioned to integrate new discoveries of diet and genetic interactions into practice by translating these scientific findings into practical dietary recommendations. [3,18,6,19]

Although research is still in its infancy and more evidence is required before findings can be applied in everyday dietetic practice, experts agree that it has the potential to significantly improve health outcomes and change the way we identify and manage patients with chronic diseases of lifestyle. [6,20,21,22] It will also invariably have an impact on practice, health care ethics and policy making. [3]

In order to understand the potential applications of this novel field in nutrition, the definitions and principles thereof need to be understood. [21,23] Nutritional genomics is used by some experts as an umbrella term to describe both nutrigenomics and nutrigenetics. Nutrigenomics describes the influence of certain biological food components on DNA structure and gene expression[6] and nutrigenetics on the other hand describes how normal variation in the sequence of base pairs can alter an individual's response to diet.[20] The conceptual basis for this new branch of genomic research can best be described by the following five principles as described by *Kaput et al*:

1) Common dietary chemicals act on the human genome, directly or indirectly, to alter gene expression or structure;
2) Under certain circumstances and in some individuals, diet can be a serious risk factor for a number of diseases;
3) Some diet regulated genes (and their normal, common variants) are susceptibility genes and likely to play a role in the onset, incidence, progression, an/or severity of chronic diseases;
4) The degree to which diet influences the balance between healthy and disease states may depend on an individual's genetic makeup;
5) Dietary interventions based on knowledge of nutritional requirement, nutrition status, and genotype can be used to prevent, mitigate, or cure chronic disease.[6]

1.2 Research and practice

To date, research in nutritional genomics has been conducted in two designs namely hypothesis-driven candidate gene approaches and genome wide association studies (GWAS). Candidate gene approaches aim to study how genetic predisposition, for example single nucleotide polymorphisms (SNPs) can influence or determine an individual's response to environmental factors, of which diet is a key component.[24] One of the most widely investigated diet-gene interactions is dietary fat intake with the ApoE genotype and the impact this has on CVD risk.[22,25,26] Studies have found that individuals carrying the ApoE4 genotype have a higher risk of CVD and usually higher LDL cholesterol levels, but also respond better to low fats diets with subsequent cholesterol lowering effects. These individuals have also been found to be more sensitive to total dietary fat and saturated fat intake.[8,11] However, the magnitude and significance of these associations are not consistent in all studies and more research regarding the influence of age, gender and other physiological factors on genotype penetrance is warranted.[22]

Several genes and alleles that influence nutrient utilization have also been identified. The well studied

polymorphism, in the methylene tetrahydrofolate reductase (MTHFR) gene is a good example. Homozygosity of the TT variant of the C677T SNP in the MTHFR gene results in reduced activity of the encoded enzyme, this has been shown to alter folate metabolism and increase homocysteine levels.[27] Individuals with this mutation have an increased risk for CVD and NTDs when folate status is low and may benefit from folate supplementation above the recommended dietary allowance (RDA).[13,28,29,30] Currently, this may be one of the best examples of a genetic variation that can influence RDA and demonstrate that genetic variation can modify nutrient requirements.[31] Other promising areas of investigation include obesity and diabetes, however further studies are needed to delineate this.[23,32] The role of green tea or soy polyphenols and their interaction with genes, receptor function and cancer risk is also under investigation.[33,34]

From these examples it is clear that the study of the human genome sequence and SNPs can reveal insights into health outcomes and disease susceptibility[35] but that the predictive accuracy of these SNPs in susceptibility genes remains limited when used in isolation. Diet and nutrition are key environmental factors and when interpreted together with genetic information provide a more powerful tool for the prediction of health and disease outcomes.[25] Studies also need to be interpreted in context as SNPs that matter in one population do not necessarily have an impact on another and recommendations need to be population or sub-population specific, taking environmental factors into account.[16,36,37,38]

A further promising application of nutritional genomics is in nutrition research. Scientists are now able to stratify subjects according to their genetic profiles and differentiate between responders and non responders in dietary intervention studies. By combining genetic and lifestyle information the overall health and disease risk assessment of intervention studies can be strengthened.[25]

There are numerous sizeable international centers focusing on advancing nutrigenomic research and

contributing to our understanding of its potential and application in clinical practice.[39] At present there is convincing data to suggest that individual response to diet is regulated by specific genetic genotypes,[6] however the magnitude of these associations differ between studies and further research is required.[26] The promise of personalized and targeted dietary prescriptions based on genetic profiling is certainly appealing but there is no doubt that we have a long way to go before it will become part of routine dietetic practice.[21,22,26,40,41]

1.3 The potential benefits to dietetic practice

There exists some uncertainty with regards to the potential impact advances in nutritional genomics will have on dietetic practice. *Joost et al* [42] describes three distinct scenarios where it will potentially benefit dietetics practice: Firstly, it can provide the RD with the necessary evidence to intervene early in the prevention of disease, before non-genetic biomarkers are available. Secondly, it can help to identify at risk sub-population groups and individuals, thus allowing for targeted intervention strategies and saving resources through advice to those who are most likely to benefit. Finally it is thought that by personalizing diets to an individual's genetic profile, there will be better compliance when compared to general dietary advice, affording greater benefit of nutritional advice for the individual. [11,22,42,43]

Kauwell et al predicts that at first only RDs with specialist training in nutritional genomics will apply it in practice but that it has the potential to become part of everyday dietetic practice. They go on to describe further advances in dietetic practice that will be driven by nutritional genomics and research:

1) Sophisticated software packages will be developed that integrate genetic profiling and tailored dietary advice, including meal plans, menus and recipes;
2) As a result of new research and dietary requirements based on genetic profiling, food composition databases will need expansion to include bioactive food components;
3) New diagnostic tests will need to be developed to assess nutritional status and the efficacy of

tailored nutritional prescriptions;

4) Dietary reference intakes will need to be adjusted to take into account genetic variability;
5) The food industry will need expansion in order for these dietary prescriptions to be translated into food choices.[44]

Tailored nutritional advice based on a careful family history; genetic profiling and disease prevention in the future may empower individuals to make the necessary changes to improve health outcomes. This can present exciting opportunities for RDs when the time arises by expanding the role and contribution of RDs to health care, as well as to expanding the scope of their practice.[3]

1.4 The potential challenges to RDs

Nutritional genomics research studies are ongoing and accelerating. The dietetic profession needs to stay abreast of these developments and prepare for the potential impact these findings may have on practice. This presents substantial challenges for the profession as described below:

1.4.1 Educational needs

In order to be prepared for the challenges ahead, RDs not only need to become familiar with basic genetic terminology, but also need to familiarize themselves with the terminology and science of nutritional genomics.[45] This involves the ability to understand how an individual's genetic composition influences food and nutrient requirements and to differentiate between genetic and environmental factors and the impact on disease when recommending dietary changes. RDs will also be required to work with individuals and families and advise them according to their genetic predispositions as well as function as part of an intra-professional team of health care practitioners and genetic specialists.[45,46]

These educational challenges highlight shortfalls in current undergraduate and post graduate training

for dietitians that need to be addressed. Timely investments into education and training can ensure a new foundation for the nutrition profession in the future as the field continues to advance.[47] It is proposed that by integrating human genetics and nutritional genomics education in undergraduate studies, educators can ensure that future professionals are prepared for this emerging field of nutrition.[41] Other avenues for qualified RDs with an interest in nutritional genomics is to pursue post graduate training in genetics or molecular sciences as well as attending continued professional development (CPD) activities regarding nutritional genomics.[41]

Rosen et al determined the CPD topics that are considered as most important to American RDs regarding nutritional genomics. Their findings indicated that RDs viewed foundational knowledge; application in practice and the means to communicate information to the public as important for CPD topics.[48] As a results, the American Dietetic Association (ADA) recommended the following steps to ensure competency for RDs: the inclusion of human genetics coursework in undergraduate studies with special emphasis on diet-gene interactions and subsequent dietetic registration testing; the forming of special interest groups on nutritional genomics and the encouragement of health care systems to recognize and reimburse RDs for individual counseling on diet-gene interactions when the time arises.[33]

1.4.2 Ethical considerations

The terminology and basic principles of nutritional genomics are not the only challenges that face RDs. Some of the other issues that need to be addressed include the ethical, legal and social implications of personalized nutrition as well as the possibility of discrimination based on genotype.[22,46] The cost of genetic testing is also being debated, as it could be argued that equal access to the benefits of personalized nutrition is crucial.[23] *Reilly et al* argues that RDs need to be prepared for when these challenges arise by developing a code of conduct concerning the proper use of genetic information. RDs will also require training on the ethical, legal and social implications of using

genotyping in practice in the future.[48,49] Consumer acceptability of genetic profiling is another key issue that needs to be addressed for the field to progress.[22,50]

1.4.3 Direct to consumer nutrigenetic testing and client acceptance

With the current boom in consumer empowerment, the general public are becoming more aware of their genetic predisposition though the media, the internet and advertising. Increasing numbers of companies are offering direct-to-consumer (DTC) nutrigenetic tests, mainly through the internet, with simultaneous nutritional advice and supplements. There are benefits and pitfalls to this approach as access to nutrigenetic tests can enhance patient autonomy and encourage individuals to take responsibility for health and behavior, but at the same time concerns have been raised over potential misleading and exaggerated claims made by some commercial companies.[51,52,53,54,55] The UK Human Genetics Commission has compiled a document setting out principles and standards for the provision of genetic tests amongst commercial providers. The aim is to promote high standards, ensure evidence based practice and protect consumers.[56] Similarly, in SA there is the need for a regulatory body to discourage the premature marketing of genotyping tests that have not been validated and to encourage good, evidence-based practice.[55] These issues tie in with the other ethical points discussed in section 1.4.2. Additionally, it is unclear how consumers will react to the information provided through DTC services. The availability of these tests may also result in individuals questioning HCPs regarding the interpretation of the data provided by testing companies.[53] In view of this, RDs can partner with these companies and become involved in translating test results into practical guidelines. This will involve being knowledgeable regarding the potential applications and pitfalls of DTC nutrigenetic tests and to encourage good practices amongst commercial companies.[40,42,44]

1.4.4 Functional foods based on genetic profiling

It is predicted that the food industry will respond to these new advances by developing specialized foods based on genetic profiling, thus allowing information on genetic predisposition to be translated

into food choices. These advances could be limited to the functional food arena and RDs will face an increased demand for information and guidance on the use of these products from consumers and clients.[23] RDs have a responsibility and opportunity to, in future, work together with the food industry to ensure that products developed for specific genotypes are credible and evidence based with realistic health claims.[57]

1.5 The current status of nutritional genomics in dietetic practice

Considerable research is needed before all of the diet-related genes are identified and matched to appropriate food choices and diets tailored to individual's particular gene variants can be developed.[57,58] At present only a limited number of well-characterized SNPs exist where tailored dietary advice may result in improved health outcomes.[57] One of the main risks related to genotype testing and screening is that recommendations and medical decisions can be based on inadequate data and that other important factors obtained from a more conservative approach may receive lower priority. For this reason, it is important for RDs to be adequately informed to differentiate between the risks and benefits of genetic testing for the individual and interprets results within context and to be realistic with regards to what is achievable through genetic profiling at the present time.[42]

1.6 Allied HCPs and genetics

According to international surveys conducted amongst HCPs, most are not ready to integrate genetics into practice and those who are already integrating it into practice are not particularly confident in doing so.[59,60] Studies amongst occupational therapists[61], speech and language therapists,[62] audiologists[63] and psychologists [64] also emphasize the important role that genetic education plays in preparing HCPs for the post genomics era.

1.7 Involvement, confidence and knowledge of RDs in other countries

Various studies have been undertaken to date to determine if RDs are prepared for the post-genomic

era. Despite the call for action to prepare RDs for the integration of nutritional genomics into practice, studies have found low involvement and confidence as well as low knowledge amongst RDs in the UK,[65] USA[48] and Europe.[66]

In 2000 the Human Genome Education model (HuGEM) survey aimed to measure the knowledge, education needs and priorities of allied HCPs in the USA regarding genetics. A total of 3600 members of six allied health care organizations were included in the survey.[59] This included dietitians, occupations therapists, physiotherapists, psychologists, social workers and speech and language therapists. The response rate was 57% and among the 362 dietitians included, there was overall low involvement and confidence in a series of activities pertaining to the application of genetics.[59]

Rosen et al conducted a study to measure the continuing education needs of American RDs regarding the application of nutritional genomics in clinical practice. A random sample of 2500 RDs was included and a response rate of 40% was reached. Their findings were similar to that of the HuGEM study, in that respondents had little previous exposure to nutritional genomics, had not applied it in practice within the previous year and had little confidence in applying it in clinical practice. RDs were however positive concerning the potential benefits of nutritional genomics for nutrition practice, but experienced barriers as a result of their limited background and knowledge. This study also found that there was a lack of professionals with the expertise to convey the information.[48]

The European Nutrigenomics Organization (NuGO) carried out a needs assessment of the knowledge, expectations and concerns of dietitians in Poland, Sweden, UK and the Netherlands regarding nutritional genomics.[66] The results showed variation in response between the different groups: Polish dietitians described it as relevant to dietetic practice; Swedish dietitians were of the opinion that dietitians should be more involved in the development process; UK dietitians were concerned about their client's reactions to nutritional genomics and there was low awareness of nutritional genomics

amongst Dutch dietitians.[66]

In a UK based study, *Whelan et al* assessed the involvement, confidence and knowledge of UK RDs relating to genetics and nutritional genomics as well as factors associated with knowledge. A questionnaire was sent to 600 randomly selected RDs resulting in a response rate of 65%. Their findings were similar to the USA study as involvement and confidence in genetics and nutritional genomics was found to be low and knowledge poor.[65,69] the factors most associated with superior knowledge were exposure to genetics in undergraduate studies and CPD activities relating to genetics and nutritional genomics.[69]

As a result measures are being put into place in these countries to ensure RDs will be prepared for the integration of nutritional genomic principles into practice. The USA is prioritizing the educational needs of RDs and a position paper is currently under review with the aim of identifying key issues that need to be addressed.[67] These measures include integration into undergraduate dietetic studies and offering post graduate education. As a result of the NuGO findings, web-based resources have been developed, available on the NuGO website, including articles regarding nutritional genomics for RDs and HCPs, as well as a training course.[68] The UK National Health Service is responding to the findings by *Whelan et al* by providing training for HCPs in genetics and nutritional genomics.[70] The revised British Dietetic Association pre-registration curriculum framework recommends that RDs should be able to demonstrate a broad knowledge and understanding of genetics as well as application in practice. This includes knowledge of the principles of genetics, nutrigenomics and nutrigenetics; the genetic basis of diseases and application in dietetic practice; the impact of nutrients on cellular mechanisms (including gene expression), and the contribution to diet related disease and management.[69,70]

1.8 Involvement, confidence and knowledge of SA RDs

There is currently no information available on the involvement, confidence and knowledge of SA RDs

with regard to genetics and nutritional genomics. In SA, nutritional genomics has been offered as one of the optional topics for the Masters degree in Nutrition at The University of Stellenbosch in Cape Town as well as the University of Pretoria in Gauteng and therefore has been at the forefront in terms of postgraduate education for RDs in this field.[71, 72]

1.9 MOTIVATION FOR STUDY

The dietetic profession and RDs need to stay up to date with the latest research and developments in order to provide the best standard of evidence-based nutritional care. The novel field of nutritional genomics presents a substantial challenge to the dietetic profession in this regard and there is a need to educate RDs on the basic principles of genetics and nutritional genomics, in line with current and future research and practice within this field.[47]

Due to the fact that there is currently no information available on the involvement, confidence and knowledge of SA RDs with regard to genetics and nutritional genomics, identifying and describing these factors will be of utmost importance in order to advance this field. This information could be used to define and address the educational needs of SA RDs regarding genetics and nutritional genomics in the future. It is believed that these are the first steps in preparing the dietetic profession in SA for the possible future integration of nutritional genomics into nutrition practice.

.

CHAPTER 2

METHODOLOGY

2.1 OBJECTIVES

2.1.1 Research aim

To investigate aspects of the present involvement, confidence and knowledge of SA RDs with regard to genetics and nutritional genomics.

2.2 Specific Objectives

- To determine whether there is a relationship between involvement and confidence in specific activities relating to genetics and nutritional genomics.
- To compare knowledge scores to involvement and confidence in activities relating to genetics and nutritional genomics.
- To investigate the factors associated with knowledge of genetics and nutritional genomics.
- To compare the results to those of a similar study conducted amongst UK RDs.[65]

2.3 STUDY DESIGN OVERVIEW

- **Study domain:** The study domain was mainly in the quantitative domain.
- **Study design:** Cross-sectional, descriptive study.
- **Study technique:** A self-administered national questionnaire was distributed via email and postal services.

2.4 STUDY POPULATION

2.4.1 Sample selection

A national survey was conducted and included all SA RDs registered with the Health Professional Council of South Africa (HPCSA) as well as all dietitians completing their compulsory community

service year. The HPCSA was contacted for a list of names and postal addresses of all RDs in SA for the year 2010, resulting in the inclusion of one thousand eight hundred and one (1881) RDs. It is mandatory for all practicing SA dietitians to be registered with the HPCSA and therefore this sample can be considered to be representative.

2.4.2 Sample size

The response sampling technique was used and all subjects who responded to the questionnaire within the specified time frame were included in the study.

2.4.3 Inclusion criteria

- All SA dietitians registered with the HPCSA, who obtained their dietetics qualification in SA.

2.4.4 Exclusion criteria

- Dietitians registered with the HPCSA who did not receive their dietetics qualification in SA.
- Dietitians involved in the pilot study.

2.5 DATA COLLECTION

2.5.1 Data collection tool: Questionnaire

An existing, validated questionnaire was used for the purposes of this study. The questionnaire was developed by *Whelan et al* and validated for use amongst UK RDs to assess their involvement, confidence and knowledge regarding genetics and nutritional genomics.[65] Permission was granted by the authors to apply the questionnaire to the present study[73] (Appendix 1), with the condition that copyright be acknowledged to King's College London by displaying the original logo at the bottom of each page of the questionnaire and the authors be acknowledged in all publications. Further conditions were that none of the questions be changed as it is copyrighted, however permission was granted to make changes to the demographic information section to make it applicable to the SA setting (Appendix 2).

2.5.2 Language

The questionnaire was only available in English. It is accepted that all SA RDs can read and understand English as this is also the official language that all correspondence is conducted in by both the HPCSA and ADSA.

2.5.3 Questionnaire content

Section 1: Involvement and Confidence

Respondents were asked to indicate their involvement in activities relating to genetics (seven activities) and nutritional genomics (four activities) within the last year. These activities were adapted by Whelan et al from the HuGEM survey [65] and rated using a dichotomous response set. Respondents were then asked to indicate their level of confidence in performing these activities, irrespective of whether they have been involved in the specific activity or not. A five point Likert scale was used to rate confidence (1 = very low confidence and 5 = very high confidence).

Section 2: Knowledge

The knowledge section of the questionnaire consisted of twelve multiple choice questions relating to genetics (eight questions) and nutritional genomics (four questions). Each of these questions consisted of four options as well as an option for "don't know". The eight genetics questions required respondents to identify basic genetic terminology.

The four questions relating to nutritional genomics required respondents to identify specific interactions between genetics, diet and disease. Respondents were asked to identify the correct definitions of "nutrigenetics"; diseases related with diet and genetics; correctly identify the gene linking dietary fat intake and CVD; and disorders associated with the MTHFR 677C→T polymorphism.

Section 3: Training in genetics

This section included questions on the level of training in genetics and clinical experience using categorical scales and a dichotomous response set. Respondents were asked to indicate their level of training in genetics whilst at university; if they had read any scientific literature or attended any meetings, study days or conferences relating to genetics and/or nutritional genomics within the last year and indicate on a five point scale how important they consider the understanding of genetics to be to dietetic practice.

Section 4: Factors affecting knowledge

Four domains were surveyed in order to investigate their effect on knowledge of genetics and nutritional genomics:

i) university education (highest qualification and genetic content) was measured using categorical scales;

ii) practice experience (years of experience and currently involved in advising patients) was measured using open ended responses and categorical scales;

iii) involvement in continuing professional development (reading scientific literature or attending conferences relating to genetics or nutritional genomics, currently studying for a qualification) was measured using open ended responses and categorical scales;

iv) attitude towards genetics (importance of genetics in clinical practice) was measured using a five- point Likert scale.

These domains were identified after extensive review of factors relating to knowledge of genetics in other professions.[69]

The following questions were adapted to be more applicable to the SA setting:

i) Grading system for dietitians: categories for community service dietitian; junior clinical dietitian, senior clinical dietitian and food service manager were included

ii) Work setting: a category for district general hospital was included

2.5.4 Content validity

The original questionnaire was tested for content validity. This was done by a survey of clinical and academic dietitians involved in a national genetics workshop (n = 4) and a statistician with expertise in questionnaire design. The content experts agreed that the sections were "relevant" or "very relevant" to the outcomes of the study.[65]

2.5.5 Construct validity

Construct validity of the knowledge sections was evaluated by comparing the knowledge score of a convenient sample of dietitians (n = 15) to that of doctorate level geneticists (n = 9). The total knowledge score was significantly higher for the doctorate level geneticists 87 (± 8%), when compared to the dietitians 57 (± 28%); $p = 0.001$.[65]

2.5.6 Intra-rater reliability

Intra-rater reliability was assessed by asking the same group of dietitians (n = 15) to complete the questionnaire again after 1 week and findings showed agreement of all four sections ranging from 60-100%.[65]

2.6 PILOT STUDY

2.6.1 Face validity

For this study the questionnaire (with adaptations where permitted) was piloted in a convenient sample of SA RDs to test its face validity for use in the SA setting. Ten Western Cape ADSA members, typical of the study population and representing a variety of practice fields were selected and contacted via email to request participation. An electronic copy of the cover letter and questionnaire was emailed to the group (Appendix 3). Respondents were asked to email their responses back after completion within three weeks of receiving it. The data obtained from the pilot

study was excluded from the main study.

Respondents who participated in the pilot study were asked to answer the following questions pertaining to the questionnaire: (Appendix 4)

- Was the cover letter explaining the research aim and requesting participation in the main study clear and understandable?
- Were the instructions on how to complete the questionnaire clear and understandable?
- Were the questions easy to understand?
- How long did it take to complete the questionnaire?
- Did you experience any difficulty in completing the questionnaire in its electronic format?
- Did you experience any difficulty in attaching the questionnaire and emailing it back to the email address given?

All respondents reported that the cover letter, instructions and questions were clear and understandable. There were no problems with opening or sending the questionnaire in its electronic format. It took most respondents an average of 10 – 15 minutes to complete the questionnaire.

2.7 DISTRIBUTION OF QUESTIONNAIRES

Questionnaires were distributed using email and postal services as described:

2.7.1 Email

The main method of questionnaire distribution was via email. This method was selected taking convenience, time and budgetary constraints into consideration. ADSA was contacted to obtain permission to distribute the questionnaire via their group email list (Appendix 2). For the year 2010, ADSA had a total of 1262 members (direct correspondence); this represents sixty seven percent (67%) of all dietitians registered with the HPCSA. It was therefore deemed an effective route to reach the majority of RDs in a cost effective manner. Each ADSA member received an email via the ADSA group notification service. This included a cover letter, a brief description of the study (Appendix 5)

and the four page questionnaire as an attachment (Appendix 9). To promote survey returns, one follow up email was sent three weeks after the initial email (Appendix 6). Furthermore, the questionnaire was available on the ADSA website for a total of 8 weeks for those who wished to access it after the initial send out.

2.7.2 Postal

For those RDs not registered with ADSA (33%), the questionnaire was sent via postal services. A personalized cover letter printed on University headed paper (Appendix 7) and a self-addressed, postage-paid envelope was included to promote survey returns. This is similar to the methods used by *Whelan et al*.[65,74] A follow-up reminders were sent 3 weeks after initial postage. The reminder included a modified request for participation as well as the ADSA website address with information on how to access and email the questionnaire back to the researcher, should they have misplaced or not have received the original questionnaire (Appendix 8). The time allocated for completion of both the email and postal questionnaires was 8 weeks.

2.8 Cover letter

An introductory cover letter was included with each questionnaire and adapted for email (Appendix 5) and postal (Appendix 8) send out. This explained the aim of the study, notification of ethics approval, time required for completion and clear instructions on how to complete and return the questionnaire. The respondents were assured of the confidentiality and anonymity of their responses.

2.9 Incentive for participation

In order to promote survey returns, an incentive for participation was used in the form of a lucky draw to win one of two retail “Woolworths” vouchers.

2.10 Anonymity of responses

Respondents who were contacted via post were asked to provide their HPCSA number should they wish to be entered into the draw. The HPCSA number was removed from the questionnaire upon receipt, assuring anonymity. The email addresses of those responding by email were de-linked from their responses upon receipt and were only used to contact the winners.

CHAPTER 3

DATA ANALYSIS

3.1.1 Confidential management of the questionnaire

The email responses were printed out when received and delinked from the email address. Both the email and postal responses were assigned a number so that it could be referred to again.

3.1.2 Statistical analysis of the questionnaire

All data was captured on a Microsoft Excel® spreadsheet after consultation with the statistician. Frequency distributions were used to describe the different levels of involvement and confidence for each activity. Similar to the study by Whelan et al [65], the scale in question 1 was collapsed from a 5 point to a 3 point Likert scale due to the very low frequencies of "very high confidence". Thus only 3 options were available being "low", "moderate" and "high" confidence. This was done to facilitate comparison between subsample groups using the x^2 test. The mean knowledge score for the 12 multiple choice questions was compared between sample sub groups using the independent samples t tests or one-way ANOVA, as appropriate. Tukey's post hoc correction was used to detect sub group differences where appropriate. Continuous data are represented as mean ± SD and categorical data are presented as *n* (%), unless otherwise stated. All tests were two tailed and considered statistically significant where $p \leq 0.05$.

3.2 ETHICS CONSIDERATIONS

3.2.1 Ethics review committee

The original protocol was approved by the Committee for Human Research, Faculty of Health Sciences, Stellenbosch University project reference number: N07/05/107.

3.3 ASSUMPTIONS AND LIMITATIONS

- **Assumptions:** The assumptions made in this study were

1) Respondents will respond truthfully
2) All respondents read, understand and interpret the questions correctly

- **Limitations :** The response rate is dependent on a variety of factors such as
    - Respondent's interest in the research topic. This would have been a fairly unknown topic to most SA RDs as was evident in previous studies, RDs could have perceived it as not being relevant to their practice and thus not participated.
    - The postal distribution is dependent on the reliability of the postal services in SA.
    - Email distribution was only possible through the ADSA group email service due to confidentiality issues. The researcher was therefore unable to contact each participant individually. The "mass" distribution method could have been deemed impersonal by some respondents and thus may not have had the intended impact.

CHAPTER 4

RESULTS

4.1 RESPONSE RATE

A total of 1881 questionnaires were sent out via email and post combined. A total of 320 questionnaires were returned (actual response rate of 17%); however twenty five postal questionnaires and sixteen email questionnaires were undelivered, resulting in a final study population of 1840 and the inclusion of 279 questionnaires (final response rate of 15.2%). A total of 1262 questionnaires were emailed to ADSA members (67% of all RDs) via the ADSA group email system and 147 were returned (email response rate 11.6%). Of the 619 questionnaires that were physically posted, 132 were returned (postal response rate 21.3%). Out of all the returned questionnaires 6 were incomplete but could still be used for analysis. The majority of respondents (*n* = 265, 95%) responded to the first send out.

4.2 DESCRIPTION OF RESPONDENTS

4.2.1 Qualifications

A total of thirty three respondents (11.8%) held a master's degree in nutrition and four (1.4%) a doctorate degree in nutrition. Fifty six respondents (20%) indicated that they are currently completing a further qualification. Twenty five respondents (9%) indicated that they are undertaking a master's degree in nutrition and seven (2.5%) a PhD in nutrition (Figure 4.1).

4.2.2 Patient groups

The majority of respondents (*n* = 215, 77%) were directly involved in advising patients (Figure 4.2). The most common areas of practice (not mutually exclusive) were diabetes (*n* = 184, 66%), obesity (*n* = 137, 49%), Human Immunodeficiency Virus (HIV) (*n* = 119, 43%), paediatrics (*n* = 107, 38%) and CVD (*n* = 103, 37%) (Figure 4.3).

4.2.3 Current positions

The most common positions held were in private practice (*n* = 71, 25.5%), senior clinical positions (*n* = 43, 15.4%) and dietitians completing their compulsory community service year (*n* = 39, 14%) (Figure 4.4).

4.2.4 Work settings

Thirty two percent of respondents (*n* = 89) were self-employed, with twenty nine percent working in district general hospitals (*n* = 80, 28.7%) and less than 2% (*n* = 5) working in private hospitals (Figure 4.5).

Figure 4.1 Post graduate qualifications of respondents

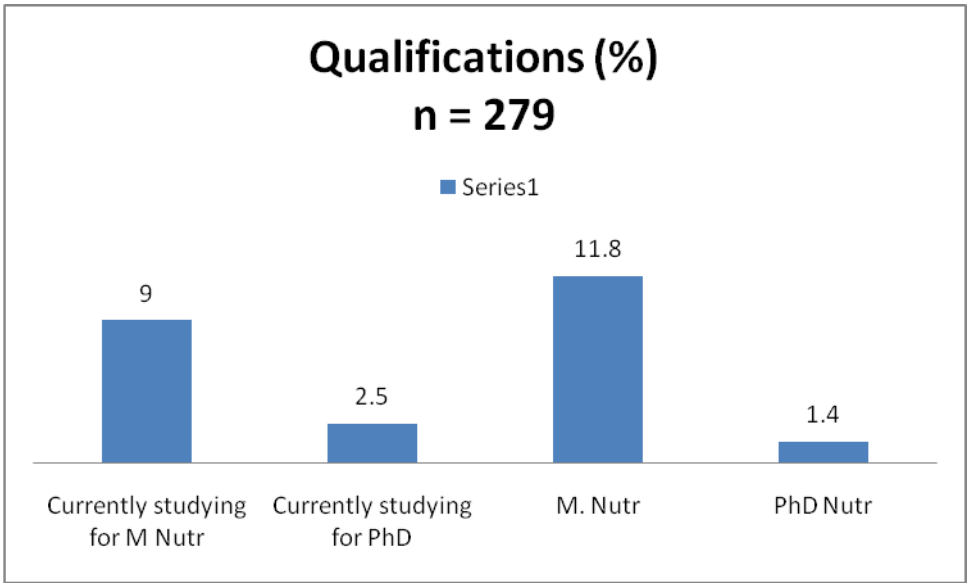


Figure 4.2 Number of respondents involved in patient consultations

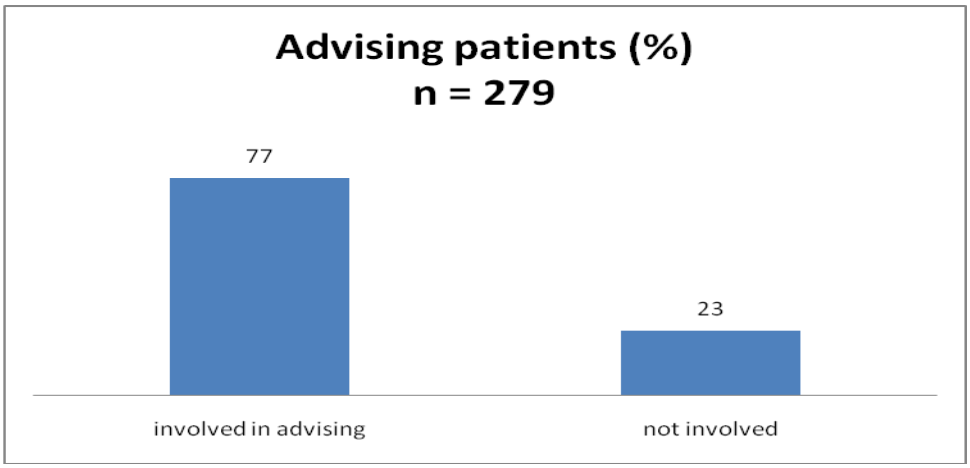


Figure 4.3 Patient groups advised by respondents

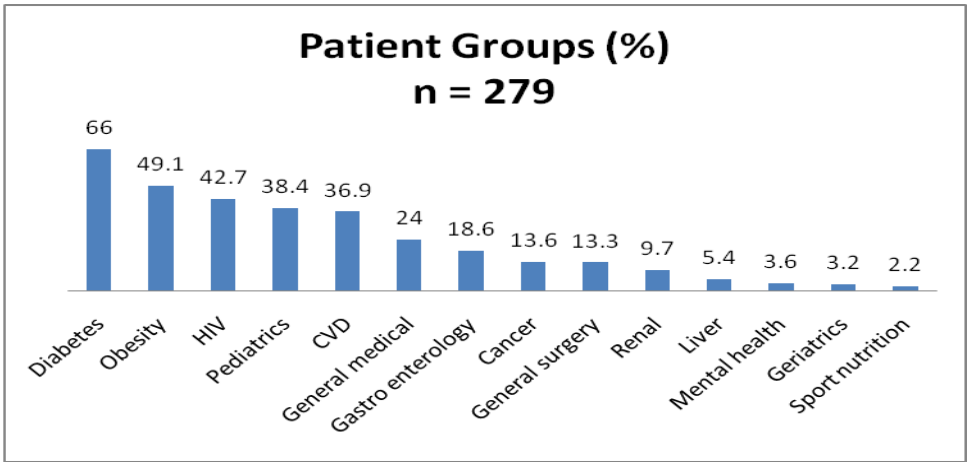


Figure 4.4 Positions held by respondents

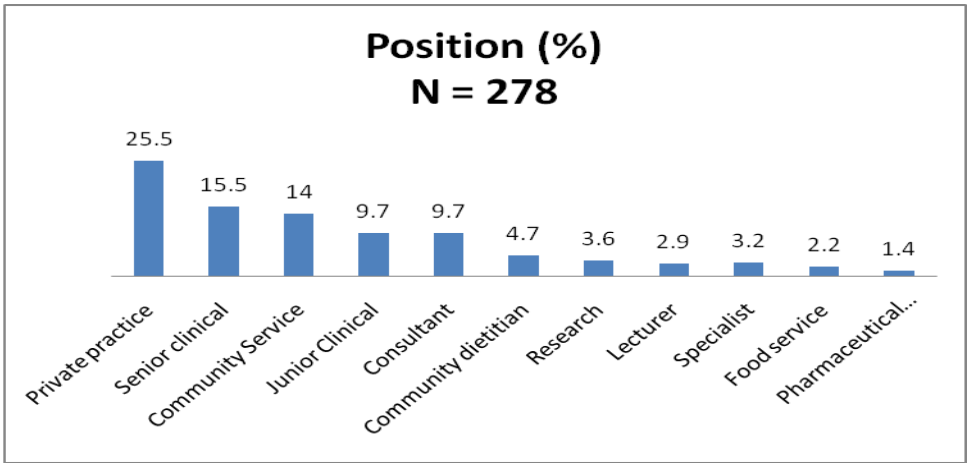
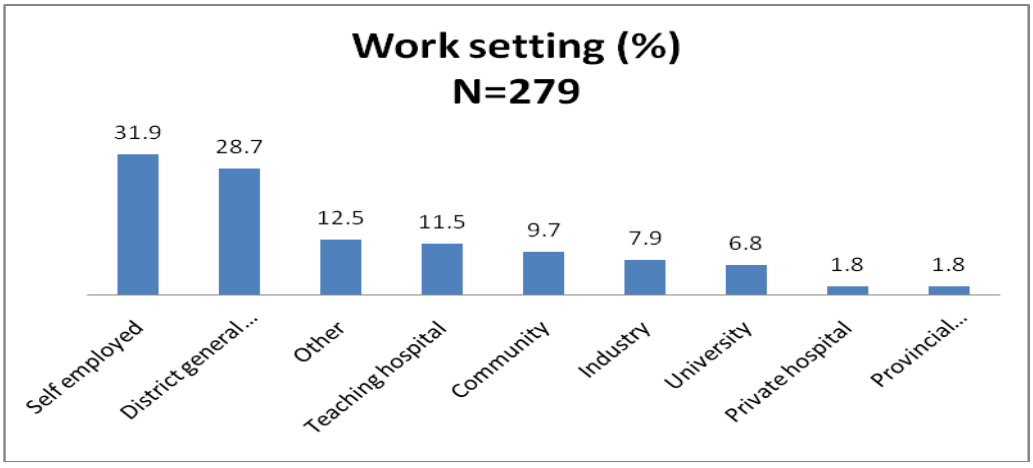


Figure 4.5 Work settings of respondents



4.3 INVOLVEMENT IN ACTIVITIES

Respondents were asked to indicate whether or not they had been involved in a series of activities relating to genetics and nutritional genomics within the last year. The results show that forty seven (17%) were involved in the 7 activities relating to genetics and seventy two (25.8%) out of 279 respondents were involved in the 4 activities relating to nutritional genomics.

4.3.1 **Genetics** (*n* = 279)

The genetic activity that respondents were most involved in was ***"discussing the genetic basis of a disease with patients"*** (*n* = 106, 38%) and the lowest involvement was for ***"obtaining written informed consent to release genetic information to a third party"***, with only 2% (*n* = 5) of respondents involved in this activity (Table 1).

4.3.2 **Nutritional genomics** (*n* = 279)

The activity that respondents were most involved in was **"*discussing with patients the basis for a disease that has both a dietary and genetic component"***, (*n* = 132, 48%). The activity with the lowest involvement was for ***"providing training and education to students or other health care professionals on diseases that have both a dietary and genetic component"***, with only eleven percent (*n* = 31) of respondents indicating that they were involved in this activity (Table 1).

4.4 CONFIDENCE IN ACTIVITIES

Respondents were asked to rate their confidence in each activity irrespective of whether they were involved in the activity or not. An average of 58.7% (*n* = 161) indicated *"low confidence"* in activities relating to genetics and 53.8% (*n* = 148) indicated *"low confidence"* for activities relating to nutritional genomics. There was a wide variation in the involvement and confidence of respondents in different activities as specified below:

4.4.1 **Genetics** (*n* = 274)

The highest average confidence score was for the ***"taking genetic information as part of a family or disease history"***, with twenty nine percent of respondents reporting high confidence (*n* = 78) in this activity and the lowest average confidence score was for ***"providing training or education to students or other HCP's on human genetics"***, with 78.1% (*n* = 214) reporting "low confidence" for this activity (Table 1).

4.4.2 **Nutritional genomics** (*n* = 275)

Similar to the involvement section, respondents were most confident in **"*discussing with patients the basis for a disease that has both a dietary and genetic component*"** (*n* = 91, 33%) and least confident in ***"providing training and education to students or other health care professionals on diseases that have both a dietary and genetic component"***, with sixty seven percent (*n* = 184) of respondents indicating "low confidence" for this activity (Table 1).

4.4.3 **Relationship between involvement and confidence in all activities**

Respondents who were involved in a specific activity were more confident in undertaking it; this was the case for all activities ($p < 0.001$).

Table 1: Involvement and confidence of respondents in activities relating to genetics and nutritional genomics

		Involvement			Confidence						
		Total responses	Involved		Total responses	Low		Moderate		High	
	Activity		n	%		n	%	n	%	n	%
Genetics	Taking genetic information as part of a family or disease history	279	100	35.8	274	121	44.2	75	27.4	78	28.5
	Discussing the genetic basis of a disease with patients	279	106	38.0	274	128	46.7	78	28.5	68	24.8
	Referring patients for genetic counselling	279	17	6.1	274	146	53.3	68	24.8	60	21.9
	Providing guidance to patients with genetic disorders about what impact it may have on their future development	279	49	17.6	274	164	59.9	57	20.8	53	19.3
	Providing counselling to patients regarding genetic disorders	279	51	18.3	274	170	62.0	57	20.8	47	16.8
	Obtaining written informed consent to release genetic information to a third party	279	5	1.8	274	182	66.4	51	18.6	41	15.0
	Providing training or education to students or other HCP's on human genetics	279	10	3.6	274	214	78.1	30	10.9	30	10.9
Diet and genetics	Discussing with patients the basis of a disease that has both a genetic and dietary component	278	132	47.5	274	88	32	95	34.7	91	33.2
	Advising patients where to access information relating to a disease with both a dietary and genetic component	279	54	19.4	275	138	50.2	64	23.3	73	26.5
	Discussing with patients how diet may interact with genes to influence the risk for disease	279	89	31.9	274	130	47.4	81	29.6	63	23
	Providing training or education to students or other HCP's on diseases that have both a dietary and genetic component	279	31	11.1	276	184	66.7	50	18.1	42	15.2

4.5 KNOWLEDGE

4.5.1 Total knowledge

The mean total knowledge score was 48.5 (±19%). The knowledge score for the genetics section was 58.5 (± 24%) and for the nutritional genomics section was 31.2 (±23%). The difference between the two sections was statistically significant ($p < 0.001$) (Table 2).

4.5.2 Genetics section

A wide difference was found between the percentage of correct answers for each question with the majority (*n* = 247, 88.5%) of respondents correctly identifying the definition of a ***"chromosome"***; and two thirds (*n* = 183, 65.6%) correctly defining a ***"mutation"***. The lowest score was for correctly defining a ***"polymorphism"*** (*n* = 75, 26.9%). Almost half (*n* = 151, 45.9%) of respondents were unable to correctly identify the definition of a "gene" (Table 2).

4.5.3 Nutritional genomics section

The lowest score here was 6.8% (*n* = 19) for correctly identifying disorders associated with the MTHFR 677T→T polymorphism. More than half (*n* = 166, 59.5%) of respondents were able to correctly identify the definition for ***"nutrigenetics"*** and thirty percent of respondents (*n* = 83) were able to identify diseases related to diet and genetics. Approximately one fifth (*n* = 60, 21.5%) of respondents were able to identify the gene linking dietary fat and CVD (Table 2).

Table 2: Knowledge of respondents regarding genetics and nutritional genomics

	Correct answers	
Question type	**N**	**%(SD)**
GENETICS		
"gene"	151	54.1(49.9)
"chromosome"	247	88.5 (31.9)
"allele"	103	37.0(48.3)
"genotype"	190	68.1(46.7)
"phenotype"	151	54.1(49.9)
"polymorphism"	75	26.9(44.4)
"mutation"	183	65.6(47.6)
"PCR"	172	61.6(48.7)
Mean		58.5(23.6)
NUTRITIONAL GENOMICS		
"nutrigenetics"	166	59.5(45.8)
Genetics, diet and disease	83	29.7(41.2)
Dietary fat and CVD	60	21.5(25.2)
MTHFR 677T→T polymorphism	19	6.8(23.6)
Mean		31.9(23.2)
Total knowledge score		48.5(19.2)

4.6 RELATIONSHIP BETWEEN KNOWLEDGE AND INVOLVEMENT

The total knowledge score was compared between respondents who were and those who were not involved in each activity relating to genetics and nutritional genomics (Table 3). For four out of the eleven activities those who indicated involvement had higher total knowledge scores as discussed below.

4.6.1 Genetics

The total knowledge score was significantly higher for those who were involved in the following three genetic activities: ***"discussing the genetic basis of a disease with patients"*** (50.8 (± 19.8%) *v.* 46 (± 17.7%), Mann-Whitney U p = 0.02); ***"providing guidance to patients with genetic disorders about what impact it may have on their future development"*** (55.3 (±18.4%) *v.* 46.2 (±18.4%), Mann-Whitney U p = 0.01); ***"providing training or education to students or other HCP's on human genetics"*** **(**65 (± 29%) *v.* 47.1 (± 18%), Mann-Whitney U p = 0.01).

4.6.2 Nutritional genomics

The total knowledge score was significantly higher for those respondents who reported involvement in ***"discussing with patients how diet may interact with genes to influence the risk for disease"*** (51.4 (± 20.1%) *v.* 46 (±17.7%), Mann-Whitney U p = 0.03).

4.7 RELATIONSHIP BETWEEN KNOWLEDGE AND CONFIDENCE

The total knowledge score was compared between respondents who reported *"low", "medium"* and *"high"* confidence for each of the eleven activities (Table 3). For five out of the eleven activities those who reported higher confidence had a higher total knowledge scores as reported below:

4.7.1 Genetics

Respondents who reported higher confidence in the following three genetic activities also had higher total knowledge scores ***"discussing the genetic basis of a disease with patients"*** (Kruskal Wallis p = 0.03), ***"providing guidance to patients with genetic disorders about what impact it may have on their future development"*** (Kruskal Wallis p = 0.013) and ***"providing counselling to patients regarding genetic disorders"*** (Kruskal Wallis p = 0.005).

4.7.2 Nutritional genomics

Respondents who reported higher confidence in the following two activities also had higher total knowledge scores: ***"discussing with patients the basis of a disease that has both a genetic and dietary component"*** (Kruskal Wallis p = 0.036), ***"discussing with patients how diet may interact with genes to influence the risk for disease"*** (Kruskal Wallis p = 0.007).

Table 3: Respondents' knowledge score compared to involvement and confidence in activities relating to genetics and nutritional genomics

		KNOWLEDGE SCORE %					KNOWLEDGE SCORE %						
		Involved		Not involved			Low confidence		Moderate Confidence		High Confidence		
	Activities	**Mean**	**SD**	**Mean**	**SD**	**P-value (t-test)**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**P valu (Anova)**
Genetics	Taking genetic information as part of a family or disease history	47.8	18.6	47.8	19.9	0.92[a]	45.5	17.6	48.8	18.3	51.2	20.0	0.12 [b]
	Discussing the genetic basis of a disease with patients	50.8	19.8	46.0	17.7	0.03[a]	45.0	17.2	49.1	18.5	52.2	20.6	0.04[b]
	Referring patients for genetic counselling	52.9	18.2	47.5	24.5	0.6[a]	46.2	17.4	48.5	18.6	51.7	21.0	0.21[b]
	Providing guidance to patients with genetic disorders about what impact it may have on their future development	55.3	18.4	46.2	18.4	< 0.01[a]	45.3	17.2	52.8	20.1	51.1	19.9	0.02[b]
	Providing counselling to patients regarding genetic disorders	52.0	20.1	46.9	18.2	0.11[a]	45.6	17.3	54.7	19	49.0	21	<0.01 [b]
	Obtaining written informed consent to release genetic information to a third party	63.3	28	47.5	18.4	0.21[a]	46.5	16.6	48.2	21.7	54.3	22	0.04 [b]
	Providing training or education to students or other HCP's on human genetics	65.0	29	47.1	18	0.01[a]	46.7	17.6	52.8	19.5	52.2	23.9	0.17[b]
Nutritional genomics	Discussing with patients the basis of a disease that has both a genetic and dietary component	48.3	19	47.6	18.2	0.91[a]	43.8	16.5	49.4	19	50.5	19.6	0.03[b]
	Advising patients where to access information relating to a disease with both a dietary and genetic component	49.4	19.7	47.4	18.4	0.51[a]	45.6	17.1	50.6	18.6	50.0	21	0.11[b]
	Discussing with patients how diet may interact with genes to influence the risk for disease	51.4	20.1	46.0	17.7	0.02[a]	44.4	17.6	50.3	16.1	52.5	22.2	< 0.01[b]
	Providing training or education to students or other HCP's on diseases that have both a dietary and genetic component	52.1	22.2	47.2	18.2	0.23[a]	46.3	17.4	50.8	20	51.6	21.3	0.14[b]

[a] Mann-Whitney U test

[b] Kruskal Wallis test, significance, when $p < 0.05$

4.8 FACTORS ASSOCIATED WITH KNOWLEDGE

4.8.1 Genetics

The knowledge score for the genetics section was not significantly higher for those with higher qualifications (p = 0.1). However, greater genetic content in undergraduate studies was associated with higher knowledge scores (p = 0.001) and Tukey's post hoc correction revealed significant differences between those with ***"no genetics content"*** and those who ***"took a course unit relating entirely to genetics"*** (51.8(±24.7%) *v.* (70 (±21.2%), Kruskall Wallis p = 0.008) as well as between those who had ***"no genetics content"*** and those who ***"took a degree in genetics"*** (51.8(±24.7%) *v.* 87.5 (±12.5%), Kruskall Wallis p = 0.04). There was no difference in knowledge of genetics between those who reported ***"no genetics content"*** and those who had ***"some genetic content"*** in undergraduate studies (52.1 (±24.8%) *v.* 58.2 (±22%), Kruskall Wallis p = 0.16). Knowledge in genetics was also significantly higher for those who had ***"read scientific literature, attended meetings, study days or conferences that included some material relating to genetics or diet and genetics***" (53.2 (±23.9%) *v.* 65.4 (±22.8%), Mann-Whitney U p < 0.001) within the last year, compared to those who had not (Table 4).

4.8.2 Nutritional genomics

Knowledge of nutritional genomics was higher for respondents with higher qualifications (p = 0.02), however, this was only significant between those with Bachelor's/postgraduate dietetics degree and a Master's degree (28 (±22.6%) *v.* 40.3 (±23.8%), Kruskall Wallis p = 0.01). Knowledge was also higher for those with greater genetic content in university studies (p < 0.001), with sub-group analysis showing a significant difference between those with an ***"entire degree in genetics"*** (83.3 (±14%) and all other categories (p < 0.001). These included those who reported ***"no genetic content"*** (83.3 (±14%) v. 26.4 (±23.3%), Kruskall Wallis p = <0.001); ***"some genetic content"*** (83.3 (±14%) v. 30.4 (±21.5%), Kruskall Wallis p = <0.001) and those respondents who took a ***"course unit relating to genetics"*** **(**83.3 (±14%) v. 28.8 (±23.3%), Kruskall Wallis p < 0.001). Similar to the genetics section,

knowledge scores was significantly higher for those who had ***"read scientific literature, attended meetings, study days or conferences that included some material relating to genetics or diet and genetics***" 36 (±24.1%) *v.* 26.3 (±21.8%), Mann-Whitney U $p < 0.001$) in the last year (Table 4).

4.8.3 Total knowledge

The total knowledge score was significantly higher for those respondents who held a higher qualification ($p = 0.01$), but this was only true between those with a Bachelor's/postgraduate dietetics degree and a Master's degree (46.8 (±18.1%) *v.* 57.3 (±20.5%), $p < 0.001$). Total knowledge score was also significantly higher for those who reported greater genetics content in university studies ($p < 0.001$). Tukey's sub-group analysis showed a significant difference between those with an ***"entire degree in genetics"*** and all other categories, these included those who reported ***"no genetic content"*** (86.1 (±12.7%) *v.* 43.6 (±19.1%), Kruskall Wallis $p < 0.001$); ***"some genetic content"*** (86.1 (±12.7%) *v.* 49.0(±17%), Kruskall Wallis $p = 0.002$) and those respondents who took a ***"course unit relating to genetics"*** (86.1 (±12.7%) *v.* 56 (±15.7%), Kruskall Wallis $p = 0.04$). The total knowledge score was higher for those who had ***"read scientific literature, attended meetings, study days or conferences that included some material relating to genetics or diet and genetics***" in the last year, when compared to those who did not (44.3 (±17.6%) *v.* 55.6 (±18.6%), Mann-Whitney U $p < 0.001$) and for those who considered genetics of greater importance to dietetic practice ($p = 0.03$). Surprisingly, the total knowledge score was significantly higher for those who were ***"not currently involved in advising patients"***, compared to those who were directly involved in advising patients (52.2 (±21.8%) *v.* 46.5 (±17.7%), Mann-Whitney U $p = 0.03$) (Table 4).

Table 4: Knowledge score comparing factors relating to university education, practice experience, CPD activities and attitude towards genetics

Knowledge score in %, mean (SD)							
Factors	**N (%)**	**Genetics**	**P**	**Diet and genetics**	**P**	**Total knowledge**	**P**
Highest qualification							
BsC dietetics /honours degree	244(87.5)	56.1(23)	0.1[b]	28 (22.6)*	0.02[b]	46.8 (18.1) *	0.01[b]
Masters	31(11.1)	65.7(24.4)		40.3 (23.8)*		57.3 (20.5) *	
Doctorate	4(1.4)	53.1(36)		25(20.4)		43.8 (17.2)	
Genetics content of university education							
No genetics	104 (37.3)	52.1(24.8)*†	0.001[a]	26.4 (23.3) †	0.003[a]	43.6 (19.1)	<0.001[a]
Some genetics within course	152 (54.4)	58.2(22)		30.4 (21.5)*		49.0(17) †	
Course unit in genetics	20(7.1)	70 (21.2)*		28.8 (23.3)Ω		56 (15.7)*	
Entire degree in genetics	3 (1)	87.5(12.5) †		83.3 (14)* † Ω		86.1 (12.7) *† Ω	
Years in practice							
< 5 years	124(44)	59(21.3)	0.2[a]	26.8(21)	0.09[a]	47.4(20.4)	0.68[a]
≥ 5 years	154(55)	55.1(25.1)		31.5(25)		48.3(16.4)	
Currently involved in advising patients							
No	63 (22.5)	61.3(26)	0.11[a]	34(24)	0.06[a]	52.2(21.8)*	0.034[a]
Yes	216(77.4)	55.7(22.7)		28(23)		46.5(17.7)*	
Reading literature or attending conferences on genetics or nutritional genomics							
No	190(68.1)	53.2(24) *	<0.001[a]	26.3 (21.8) *	<0.001[a]	44.3 (17.6)*	<0.001[a]
Yes	89(31.8)	65.4(23) *		36 (24.1) *		55.6 (18.6)*	
Currently studying for a qualification							
No	223(80)	55.9(22.9)	0.08[a]	28.8(22.2)	0.4[a]	46.9(17.6)	0.07[a]
Yes	56 (20)	62(25.6)		31.7(25.9)		52(21.8)	
Importance of genetics for dietetic practice							
Not at all	-	-	0.06[b]	-	0.42[b]	-	0.03[b]
Not very	7(2.5)	44.6(20.2)		17.9 (18.9)		35.7(19.1)	
Somewhat	37(13.3)	54.4(20.6)		29.1 (17.2)		45.9 (15.3)	
Important	124(44.4)	58.7(23.9)		29.0(21.5)		48.8 (17.8)	
Very important	110(39.4)	57.6(23.7)		30.9(27)		48.7(20.6)	

[a] When comparing two scores, the *p*-values are a result of an independent t-test (Mann-Whitney)

[b] When comparing three or more scores, the P-values are the result of an ANOVA (Kruskal Wallis)

Scores with the same superscript are significantly different from each other following an ANOVA with the Tukey's post hoc correction.

Results statistically significant, where $p < 0.05$

CHAPTER 5

DISCUSSION

In this study a national questionnaire-based survey was performed to measure aspects of the involvement, confidence and knowledge of SA RDs regarding genetics and nutritional genomics. Results revealed that 17% of SA RDs are involved in activities relating to genetics and 25.8% in nutritional genomics, which can be regarded as low involvement when considering similar surveys.[59,65] Confidence in activities involving both genetics and nutritional genomics were also reported as "low" by the survey scale used, in more than half of SA RDs. Knowledge scores were poor with respondents answering less than half of the questions correctly. These findings should however be interpreted within the context of the low response rate for this survey.

The response rate for this study was 15.2%. The main method for questionnaire distribution was through the ADSA group email as described in section 2.7.1. Previous studies amongst RDs that used email as the main questionnaire distribution method show a response rate of 19%[74] and 23%[75] respectively. To put the response rate of this study into perspective, a statistical report was requested of ADSA's monthly email distribution, which showed that on average only 36% of RDs open their ADSA emails (direct correspondence with ADSA administration office). Therefore, theoretically speaking of those RDs who did read their ADSA email, 32% responded to the questionnaire. Despite the obvious drawbacks of distributing this survey via the ADSA group email; it was deemed an effective way to reach a large number of RDs when considering financial, time and practical constraints. The response rate was low for the postal questionnaires despite efforts to increase response rate as recommended by *Edwards et al* by including a personalised cover letter on University headed paper and a postage paid envelope.[74]

The response rate does however not compare favourably to the UK study by *Whelan et al* where a response rate of 65% was reached. Possible explanations for the discrepancy in response rate could be

that that their main method of questionnaire distribution was solely via postal services, eliminating the drawbacks of email distribution as discussed; another explanation could be the greater interest in this field in the developed world where RDs would have had more exposure to nutritional genomics.

As described in the methodology, section 2.5.1, a validated, existing questionnaire as developed by *Whelan et al* was used.[65] It was deemed important to place the results within an international context and draw some comparisons between these two studies. However, due to the low response rate of this study as well as some differences in the profile of the respondents, direct comparisons will only be made where it was judged to be appropriate.

There was a marked difference between the study demographics of these two study populations with the majority of the SA respondents being self employed (*n* = 89, 31.9 %), compared to only (*n* = 23, 6%) of the UK respondents. The majority of UK respondents worked in teaching hospitals (n = 229, 59%), compared to only (*n* = 32, 11.9%) of SA respondents. A total of (*n* = 337, 89 %) of the UK respondents were involved in advising patients compared to (*n* = 215, 77%) of SA respondents. However, the most common patient groups these two groups had worked with in the past year were very similar, with the majority of SA and UK respondents indicating diabetes and obesity as the most common patient groups.

5.1 INVOLVEMENT AND CONFIDENCE

5.1.1 Genetics

The low involvement and confidence in genetic activities could possibly be explained by the perceived lack of emphasis placed on these skills in undergraduate dietetic studies as more than a third (37.3%) of SA respondents indicated that they had *"no genetics"* in their undergraduate studies, compared to 45% in the UK study.[65] However, the majority of both SA and UK respondents indicated that their undergraduate studies contained *"some genetic content"*. Although this could be influenced

by the ability of respondents to accurately recall the content of their undergraduate studies, this confirms the low level of genetic content of undergraduate dietetic studies in SA and corresponds well with international findings.[48,57,65]

5.1.2 Nutritional genomics

Respondents indicated greater involvement and confidence in performing activities relating to nutritional genomics, when compared to genetic activities. Surprisingly, 48% of SA and 51% of UK respondents indicated that they were not involved in ***"discussing with patients the basis of a disease that has both a genetic and dietary component"*** despite the survey results showing that the majority of respondents for both groups are involved in advising on diabetes, obesity and CVD which are all multifactorial diseases.

5.2 KNOWLEDGE

5.2.1 Knowledge of genetics and nutritional genomics

The limitation of a smaller subset of questions aiming to assess total knowledge score is that it cannot possibly represent the totality of knowledge relating the genetics and nutritional genomics, as highlighted by McCarthy *et al.*[69] However, the total knowledge score for the genetics section was markedly higher than that of the nutritional genomics section. The reason for this could be that genetics is a topic that RDs would be more familiar with due to some exposure in undergraduate studies, as more than half of respondents indicated that they had *"some genetic"* content in their undergraduate studies. However, nutritional genomics is a relativity new topic that has only recently been incorporated into some undergraduate dietetic studies in SA. The poor knowledge in both categories corresponds well with UK RDs [65,69] as well as the USA based HuGEM study[59] as discussed in the literature review in section 1.7.

5.2.2 The relationship between knowledge, involvement and confidence

In this study it was found that a higher total knowledge of genetic and nutritional genomics was positively associated with having more genetic content in undergraduate dietetic training; partaking in CPD activities relating to genetics and/or nutritional genomics and considering genetics to be important to the dietetic profession as discussed below.

5.3 FACTORS ASSOCIATED WITH KNOWLEDGE

5.3.1 Genetics content of undergraduate studies

More genetic content in undergraduate studies was associated with higher total knowledge scores amongst SA and UK RDs. Interestingly, in this study there was no significant difference in the knowledge scores of those who reported ***"no genetic content"*** in undergraduate studies and those who reported ***"some genetic content"***. But there was a significant difference between the latter and those who ***"took a course unit relating entirely to genetics"***. This highlights that ***"some"*** genetics in undergraduate studies does not translate into markedly higher knowledge, but that fundamental knowledge and core competencies in genetics need to be established. From the results it is evident that incorporating genetics into undergraduate dietetic curricula is crucial to provide the foundational basis for understanding nutritional genomics. Some argue that including genetics in the undergraduate dietetic curriculum may not be practical due to an already crowded curriculum and lack of faculty expertise.[76] But, the low knowledge, confidence and involvement in these activities can pose considerable challenges to RDs and educators in future if not addressed [65] and use of nutritional genomics becomes a part of routine evidence-based dietetic practice. Steps to ensure competency need to be taken order to keep the profession aligned with research progress.

5.3.2 Continuous professional development activities

The minority of respondents (31.9%) had read literature or attended conferences relating to genetics or nutritional genomics within the last year. Yet, most respondents indicated that they considered

genetics to be *"important"* to clinical practice. Respondents with a Master's degree in Nutrition, who read literature or attended meetings on genetics and/or nutritional genomics within the last year and who had higher genetics content within their undergraduate studies, on average had higher total knowledge scores compared with those who did not. This was also true for the UK study and demonstrates the importance of incorporating genetics into undergraduate dietetic studies as well as participating in continuing education activities.

The average profile of respondents was self-employed, private practicing RDs and they would be the first to be faced with client's questions about personalised nutrition.[3] The poor knowledge of SA RDs regarding genetics and nutritional genomics is of concern, and highlights the importance of education strategies to keep RDs abreast of new developments. This will ensure that once nutritional genotyping becomes evidence-based practice, it can be harnessed by well prepared RDs and incorporated into dietetic practice.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSION

According to international surveys, most HCPs are not ready to integrate genetics into their clinical practice [77,78,79,80] and it would appear that RDs are not the exception. In line with these findings, this study shows that SA RDs currently have low involvement, confidence and knowledge in both genetics and nutritional genomics. Undergraduate and postgraduate exposure to these topics is associated with better knowledge. Nutritional genomics is an important emerging field with the potential to become an essential part of dietetic practice in future and it is crucial that these new principles are integrated into dietetic training programs.

6.2 RECOMMENDATIONS:

6.2.1 Development of a competency framework

It is imperative for the dietetic profession in SA to recognise the importance of preparing RDs for the post genomics era and the future integration of nutritional genomics and principles into practice. The first step would be the development of a competency framework for genetics and nutritional genomics for the dietetic profession. Basic knowledge of genetics needs to be included as a prerequisite for dietetic registration. This would involve the revision of the preregistration framework for undergraduate dietitians. Ideally the responsibility should be taken by each educational institution involved in the training of dietitians and the integration of genetics into dietetic training should be made a priority. Strategies should also be implemented to develop professional learning plans that increases the future understanding of nutritional genomics and related areas as new research becomes available.

6.2.2 CPD activities

Nutritional genomics is a fast developing field and staying current with research is important for this field to move forward in SA. The number of publications and seminars related to nutritional genomics has greatly increased in the past several years and results from this study demonstrate the importance of continued education in genetics and nutritional genomics. Therefore, should they wish to be part of these new developments, it is imperative for RDs to partake in independent learning activities to remain abreast of relevant research developments and findings.

6.2.3 Development of special interest groups

A call to action is needed for RDs to assume leadership roles in developing CPD activities specifically for RDs regarding nutritional genomics. This can ideally be done through a special interest group for those with an interest in nutritional genomics. Those who already have the skills and education should ideally put themselves forward to educate other RDs on these topics and make resources available in the form of online forums, workshops and relevant literature.

6.2.4 Postgraduate studies

RDs who wish to become well versed in nutritional genomics will need to undertake additional training to master the core competencies of genetics and nutritional genomics. It is recommended that RDs do so by completing a graduate degree with a genetic and/or molecular component.[68]

6.2.5 Proposed further research

An important factor to consider in addition to the readiness of dietetic professionals to incorporate genetics and nutritional genomics into practice is the readiness of the consumer to embrace these new concepts of health care based on genetic profiling. This can provide useful measurements of the attitude towards personalized nutrition. Further to the results of this study the reassessment of the involvement, confidence and practices of SA RDs will be warranted as this field continues to mature.

REFERENCES:

1. Gillies PJ. Nutrigenomics: The rubicon of molecular nutrition. Journal of the American Dietetic Association. 2003;103:S50-S55.
2. Carol JC, Rideout JL, Wilson BJ et al. Genetic education for primary care providers. Improving knowledge, attitudes and confidence. Canadian Family Physician. 2009; 55: 92-99
3. De Busk RM. Diet-related disease, nutritional genomics and food and nutrition professionals. Journal of the American Dietetic Association. 2009;109:410-413.
4. Venter JC, Adams MD, Myers EW et al. The sequence of Human Genome. Science. 2001; 291:1304–1351.
5. McPherson JD, Marra M, Hillier L et al. A physical map of the human genome. Nature. 2001; 409:934–941.
6. Kaput J. Diet-disease Gene interactions. Nutrition. 2004;20:26-31.
7. Kotze MJ, Badenhorst CH. Chronic disease risk management: combining genetic testing with medical nutrition therapy. South African Family Practice. 2005;47: 43–44.
8. Loktionov A. Common gene polymorphisms and nutrition: Emerging links with pathogenesis of multifactorial chronic diseases (Review). The Journal of Nutritional Biochemistry. 2003; 14:426-451.
9. Scholtz CL, Odendaal HJ, Thiart R et al. Analysis of two mutations in the MTHFR gene associated with mild hyperhomocysteinaemia--heterogeneous distribution in the South African population. South African Medical Journal. 2002;92:464-467.
10. Loktionov A, Scollen S, McKeown N et al. Gene-nutrient interactions: dietary behavior associated with high coronary heart disease risk particularly effects serum LDL cholesterol and apolipoprotein E epsilon4 –carrying free living individuals. British Journal of Nutrition. 2000; 84:885-890.
11. Ordovas JM. Nutrigenetics, plasma lipids, and cardiovascular risk. Journal of the American Dietetic Association. 2006; 106:1074-1081.

12. Chiu S, Diament AL, Fisher JS et al. Gene-gene epistasis and gene-environment interactions influence diabetes and obesity. In: Kaput J, Rodriguez RL, editors. Nutritional genomics: discovering the path to personalized nutrition. Hoboken, NJ: John Wiley & Sons Inc. 2006; 135-137.
13. Voutilainen S, Rissanen TH, Virtanen J et al. Low dietary folate intake is associated with an excess incidence of acute coronary events: The Kuopio Ischemic Heart Disease Risk Factor Study. Circulation. 2001;103:2674–2680.
14. Firmann M, Mayor V, Vidal PM et al. The CoLaus study: a population-based study to investigate the epidemiology and genetic determinants of cardiovascular risk factors and metabolic syndrome. BMC Cardiovascular Disorders. 2008;8:6.
15. Siffert WG. Protein polymorphisms in hypertension, atherosclerosis, and diabetes. Annual Reviews in Medicine. 2005;56:17–28.
16. Lyssenko V, Jonsson A, Almgren P et al. Clinical risk factors, DNA variants, and the development of type 2 diabetes. New England Journal of Medicine. 2008;359:2220–2232.
17. Kornman KS, Martha P, Duff G. Genetic Variations in inflammation: A practical nutrigenomics opportunity. Nutrition, disease and the genome. 2004;20:44-49.
18. Labadarios D, Meguid MM. Nutrigenomics: Unraveling man's constitution in relation to food. Nutrition. 2004;20:2-3.
19. Keku OT, Rakhra-Burris T, Millikanet R. Gene testing: What the health professional needs to know. American Society for Nutrigenomics. 2003;3754S-3757S.
20. Gibney MJ. Nutrigenomics in human nutrition – an overview. South African Journal of Clinical Nutrition. 2005;18:11–18.
21. Stover PJ. Nutritional genomics. Physiology Genomics. 2004;16:161-165.
22. Rimbach G, Minihane AM. Nutrition Society silver medal lecture. Nutrigenetics and personalized nutrition: how far have we progressed and are we likely to get there? Proceedings of the Nutrition Society. 2009;68:162-172.

23. Ryan-Harsman M. Nutritional genomics and dietetic professional practice. Canadian Journal of Dietetic Practice and Research. 2008;69:177-182.
24. Kaput J, Rodriquez RL. Nutritional genomics: the next frontier in the postgenomic era. Physiological Genomics. 2004; 16:166-177.
25. Kussman M, Krause L, Siffert W. Nutrigenomics: where are we with genetic and epigenetic markers for disposition and susceptibility? Nutrition Reviews. 2010;68:S38–S47.
26. Ordovas JM. Genotype-Phenotype associations: Modulation by diet and obesity. Obesity. 2008;16:40-46.
27. Klerk M, Verhoef P, Clarke R et al. MTHFR studies collaboration group. MTHFR 677C-T polymorphism and risk of coronary heart disease: A meta analysis. Journal of the American Medical Association. 2002;288:2023-2031.
28. Guenther BD, Sheppard CA, Tran P, Rozen R et al. The structure and properties of methylenetetrahydrofolate reductase from Escherichia coli suggest how folate ameliorates human hyperhomocysteinemia. Nature Structural Biology. 1999;6:359–365.
29. Reyes-Engel A, Munoz E, Gaitan MJ et al. Implication on the human fertility of the 677C to T and 1298A to C polymorphisms of the MTHFR gene: Consequences of a possible genetic selection. Molecular Human Reproduction. 2002; 8:952–957.
30. Tikly M. Two mutations in the MTHFR gene associated with mild hyperhomocysteinemia. South African Medical Journal. 2003; 91:161-162.
31. Stover P. Influence of human genetic variation on nutritional requirements. American Journal of Clinical Nutrition.2006;83:S432-436.
32. Kaput J, Dawson K. Complexity of type 2 diabetes mellitus data sets emerging from nutrigenomic research: A case for dimensionality reduction? Mutation research. 2007;622:19-32.

33. Guo S, Sonenshein G. Green tea polyphenols and cancer prevention. In Kaput J, Rodriguez RL, Editors. Nutritional genomics: discovering the path to personalized nutrition. Hoboken, NJ: John Wiley & Sons Inc; 2006. pp 177-194.
34. Barnes S, Allison DB, Page GP et al. Genistein and polyphenols in the study of cancer prevention: chemistry, biology, statistics, and experimental design. In Kaput J, Rodriguez RL, editors. Nutritional genomics: Discovering the path to personalized nutrition. Hoboken, NJ: John Wiley & Sons Inc; 2006. pp 305-324.
35. Manolio TA. Cohort studies and the genetics of complex disease. Nature Genetics. 2009;41:5-6.
36. Zeggini E, Weedon MN, Lindgren CM, et al. Replication of genome-wide association signals in UK samples reveals risk loci for type 2 diabetes. Science. 2007;316:1336–1341.
37. Maher B. Personal genomes: the case of the missing heritability. Nature. 2008;456:18–21.
38. Meigs JB, Shrader P, Sullivan LM et al. Genotype score in addition to common risk factors for prediction of type 2 diabetes. New England Journal of Medicine. 2008;359:2208–2219.
39. Boehl T. Emerging science raises questions: What to tell your clients about nutritional genomics. Journal of the American dietetic association. 2007;107:1094-1096.
40. Afman L, Muller M. Nutrigenomics: From molecular nutrition to prevention of disease. Journal of the American Dietetic Association. 2006;106:569 – 576.
41. Stover P, Caudill MA. Genetic and epigenetic contributions to human nutrition and health. Managing genome-diet interactions. Journal of the American Dietetic Association. 2008;108:1480-1487.
42. Joost HG, Gibney MJ, Cashman KD et al. Personalised Nutrition: status and perspectives. British Journal of Nutrition. 2007;98:26-31.
43. King J. Nutritional genomics: interview by Deborah Shattuck. Journal of the American Dietetic Association. 2003;103:16-18.

44. Kauwell GPA. Epigenetics: What it is and how it can affect dietetics practice. Journal of the American Dietetic Association. 2008;108:1056–1059.
45. Gilbride J. Genetics: Brave new world. Journal of the American Dietetic Association. 2000;100:996.
46. Gilbride J, Camp K. Preparation and needs for genetics education in dietetics. Topical Clinical Nutrition. 2004;19:316-323.
47. Zeisel SH. Nutrigenomics and metabolomics will change clinical nutrition and public health practice: insights from studies on dietary requirements for choline. American Journal of Clinical Nutrition. 2007;86:542-548.
48. Roosen R, Earthman C, Marquart L et al. Continuing education needs of registered dietitians regarding nutrigenomics. Journal of the American Dietetic Association. 2006;8:1242-1245.
49. Reilly P, DeBusk RM. Ethical and legal issues in nutritional genomics. Journal of the American Dietetic Association. 2008;108:36–40.
50. DeBusk RM. Ethical and Legal Issues in Nutritional Genomics. Journal of the American Dietetic Association. 2008;108:36-40.
51. DeBusk RM, Fogarhty PC, Ordovas J et al. Nutritional genomics in practice: Where do we begin? Journal of the American Dietetic Association. 2005;105:589-598.
52. Janssens CJW. A critical appraisal of the scientific basis of commercial genomic profiles used to assess health risks and personalize health interventions. American Journal of Human Genetics. 2008;82:593–599.
53. Caulfield T. Nutrigenomics Patents and Commercialization: Old Wine in a New Bottle? OMICS. A Journal of Integrative Biology. 2009;13:63-69.
54. Oliver D. The Future of Nutrigenomics – From the Lab to the Dining Room. Palo Alto, CA: Institute for the Future; 2005.
55. Ries NM, Castle D. Nutrigenomics and Ethics Interface: Direct-to-consumer Services and Commercial aspects. A Journal of Integrative Biology. 2008,12:245-250.

56. The Human Genetics Commission. A common framework of principles for direct-to-consumer genetic testing services. (Online) (accessed 2011, January 22); Available: http://www.bshg.org.uk/Principles.pdf.
57. Ferguson LR. Nutrigenomics approaches to functional foods. Journal of the American Dietetic Association. 2009;109:452-458.
58. Pajovic BS. Nutrigenomics. Genetika. 2008;40:74-76.
59. Lapham EV, Kozma C, Weiss JO et al. The gap between practice and genetics education of health professionals: HuGEM survey results. Genetics in medicine. 2000;2:226-231.
60. Christianson CA, McWalter MK, Steinberg Warren N. Assessment of allied health graduates preparation to integrate genetic knowledge and skills into clinical practice. Journal of Allied Health. 2005;34:138-144.
61. Kyler P, Thomas JM. Implications of the Human Genome Project for occupational therapy. American Journal of Occupational Therapy. 2000;2:CE1-CE8.
62. Chermak GD, Wagner-Bitz CJ. Survey of speech and language pathologists' and audiologists' knowledge of clinical genetics. American Speech-Language and Hearing Association. 1993;5:39-45.
63. Pelletier S, Dorval M. Predictive genetic testing raises new professional challenges for psychologists. Canadian Psychology. 2004;45:16-30.
64. Patenaude AF, Guttmacher AE, Collins FS: Genetic testing and psychology. American Psychology. 2002;57:271-282.
65. Whelan K, McCarthy S, Pufulete M. Genetics and diet-gene interactions: involvement, confidence and knowledge of dietitians. British Journal of Nutrition. 2008;99:23-28.
66. Dieticians current knowledge, expectations and concerns towards nutrigenomics. (Online) (accessed 2009, November 14); Available: http://www.nugo.org/everyone/28182.
67. American Dietetic Association position paper nutrigenomics. (Online) (accessed 2010, July 1); Available: http://www.eatright.org/positions/.

68. De Busk RM. Information for Dietitians. (Online) (accessed 2010, January 5); Available: http://www.nugo.org/everyone/28182.
69. McCarthy S; Pufulete M and Whelan K. Factors associated with knowledge of genetics and nutritional genomics among dietitians. Journal of Human Nutrition and Dietetics. 2008;32:547-554.
70. Genetics education: National genetics education and development centre. (Online) (accessed 2010, July 30); Available: http://www.geneticseducation.nhs.uk/about-us.aspx.
71. Postgraduate degree programme: Magister in dietetics. (Online) (accessed 2011, January 22); Available: http://web.up.ac.za/default.asp?ipkCategoryID=4768&language=0.
72. De Busk, RM. Nutritional genomics and the nutrigenomics practitioner. (Online) (accessed 2008, January 1); Available: http://www.nugo.org/stakeholders.
73. Whelan K. Permission the use validated questionnaire. (E-mail communication); 2009, May 5.
74. Edwards P, Roberts I, Clarke M et al. Methods to increase response rates to postal questionnaires. British Medical Journal. 2002;324:1183-1185.
75. Whitehead K, Langley-Evans SC, Tischler V et al. Communication skills for behaviour change in dietetic consultations. Journal of Human Nutrition and Dietetics. 2009;22:493-500.
76. Weil SD, Lafferty L, Keim KS et al. Registered dietitian prescriptive practices in hospitals. Journal of the American Dietetic Association. 2008;108:1688-1692.
77. Vickery CE, Cotuga N. Incorporating genetics into dietetics curricula remains a challenge. Journal of the American Dietetic Association. 2005;105:583-588.
78. Harris R, Challen K, Benjamin C et al. Genetic education strategies for non-genetics health care professionals. Community Genetics. 2006;9:224–226.
79. Addressing genetics delivering health: Report to the Welcome Trust and the Department of Health (Online) (accessed 2010, August 30); Available: http://www.wellcome.ac.uk/stellent/groups/corporatesite/@policy_communications/documents/web_document/wtd003179.pdf.

80. Baars MJH, Scherpier AJJA, Schuwirth LW et al. Deficiency of knowledge of genetics and genetic tests among general practitioners, gynecologists, and pediatricians: a global problem. Genetics Medicine. 2005;7:605-610.

APPENDIX 1

REQUEST FOR PERMISSION TO USE VALIDATED UK QUESTIONNAIRE AND RESPONSE BY KEVIN WHELAN (AS PER EMAIL)

Dear Kevin Whelan, Sarah McCarthy and Maria Pufulete

Re: Genetics and diet-gene interactions: involvement, confidence and knowledge of dietitians (British Journal of Nutrition (2008), 99, 23-29)

I am a registered dietitian from Human Nutrition, Faculty of Health Sciences, University of Stellenbosch, South Africa. I am currently completing my master's degree in Nutrition and have successfully completed a post graduate course in nutritional genomics.

I have developed a keen interest in this field and believe that it is holds great potential for nutrition research and application in dietetic practice. I have read your above mentioned article with much interest. The field of nutritional genomics is emerging in our country and for this reason I have decided to do an assessment as to the current level of knowledge, attitudes and practices of South African dietitians with regard to nutritional genomics.

I would like to enquire if you would grant me permission to use your questionnaire, and adapt and validate it for the South African setting. I will most certainly give the necessary acknowledgement in the protocol as well as any publications following the research.

Your assistance will be greatly appreciated.

Yours sincerely,

Lizalet Oosthuizen

Researcher and RD

lizoosthuizen@yahoo.com

RESPONSE BY KEVIN WHELAN

Dear Lizalet

Please find the questionnaire attached. You will see that the questionnaire is copyrighted by King's College London - I have spoken to our legal people here and changing the content of the questionnaire is legally difficult!

However we do recognize that you will have to change some of the information on it. We are happy for you to change some of the wording of the questionnaire in section 4 to make it relevant to the SA dietetic profession (e.g. grading of dietitians, roles etc), but would like the body of the questionnaire (ie the actual questions and their responses, particularly in section 1, 2, 3) to remain the same. They have requested that the copyright symbol for King's remains at the bottom of each page of the questionnaire - although of course we are happy for you to remove the King's logo on the first page!

I hope this is OK - let me know if you need further clarification. Regarding publication - we would request that you acknowledge the three authors for the use of the questionnaire: Kevin Whelan, Sarah McCarthy, Maria Pufulete, and that you cite the two papers we have published relating to it (I've also attached these for your info):

McCarthy S, Pufulete M, Whelan K. Factors associated with knowledge of genetics and nutritional genomics among dietitians. J Hum Nutr Diet. 2008 Dec; 21(6): 547-54.

Whelan K, McCarthy S, Pufulete M. Genetics and diet--gene interactions: involvement, confidence and knowledge of dietitians. Br J Nutr. 2008 Jan; 99(1):23-8.

Good luck with your survey, if I can be of any help then please do let me know. We went to quite lengthy measures to ensure a good response rate - if you need any more details that aren't included in the papers then let me know.

Best wishes

Dr Kevin Whelan

Lecturer in Nutritional Sciences

Department of Nutrition and Dietetics

School of Biomedical and Health Sciences

King's College London

4.06 Franklin Wilkins Building

150 Stamford Street

London

SE1 9NH

United Kingdom

Tel: +44 (0)20 78 48 38 58

Fax: +44 (0)20 78 48 41 95

Email: kevin.whelan@kcl.ac.uk

APPENDIX 2

REQUEST FOR PERMISSION FOR QUESTIONNAIRE TO BE DISTRIBUTED VIA ADSA GROUP EMAIL LIST

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Dear ADSA President: Rene Smalberger

RE: Request for assistance with research

I am contacting you with regard to a research project that is currently in progress at the University of Stellenbosch as part of a Master's degree in Nutrition. This is a national study specifically aimed at South African (SA) dietitians. The aim of the study is to measure the current involvement, confidence and knowledge of SA dietitians regarding genetics and nutritional genomics by means of a questionnaire. This research study has received ethics approval from the Committee for Human Research, Faculty of Health Sciences, Stellenbosch University (Project number: N07/05/107).

I kindly request your assistance in 3 regards:

Firstly, for the survey material to be distributed via your ADSA group email to all ADSA members. The survey material will consist of a request for participation and a 4 page questionnaire as an attachment. The request for participation will clearly state that participation is entirely voluntary and anonymous. Respondents will be asked to download the questionnaire and email it back to the researcher after completion. Thus, ADSA will not receive any emails.

Secondly, I kindly request a follow up reminder to be sent 3 weeks after the initial, as this method has been demonstrated to increase response rate.

Thirdly and lastly, I kindly request of you to please send me only the HPCSA numbers of all ADSA members. This information will be treated as strictly confidential. I am requesting this information in order to cross reference the HPCSA numbers of the ADSA members with the complete list of

registered dietitians as obtained from the HPCSA head office. This will enable me to determine which dietitians are not ADSA members and will thus not receive the questionnaire via email. These dietitians will then receive a questionnaire by post. As this is a national study, all SA dietitians need to be included. I will only use the HPCSA numbers for the purpose of excluding ADSA members from receiving a postal questionnaire. The names and postal addresses of ADSA members will thus not be known to the researcher, therefore assuring complete anonymity.

I truly value your assistance in this regard as research amongst SA dietitians is important to bring us to the forefront of nutrition research and the international dietetic community. Similar research studies have been conducted among dietitians in the UK, USA and Europe and for comparison purposes it would be valuable to know where we as SA dietitians stand with regard to the research topic.

Should any further information be required, please do not hesitate to contact me.

Yours sincerely,

The researcher
Lizalet Oosthuizen
Researcher and RD (SA)
lizoosthuizen@yahoo.com

APPENDIX 3

REQUEST FOR PARTICIPATION IN PILOT STUDY

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Request for participation in Pilot Study conducted by University of Stellenbosch as part of Master's degree in Nutrition.

Dear (Name of dietitian)

Your permission is kindly requested to partake in this pilot study. You are one of 10 South African (SA) dietitians conveniently selected to represent all major practicing fields in dietetics.

This research has received ethics approval from the Committee for Human Research, Faculty of Health Sciences, Stellenbosch University (Project number: N07/05/107).

What is the aim of the study?

Nutritional genomics is a new and promising field, holding great opportunities for dietetic practice. It focuses on the interaction between genes and diet and the joint influence this has on disease management and prevention. This clearly holds significance for the dietetic profession.

Therefore the aim of the study is to determine the current involvement, confidence and knowledge of all registered SA dietitians regarding genetics and nutritional genomics by means of a questionnaire.

The findings will be compared to similar studies conducted amongst dietitians in the UK to determine where SA dietitians stand with regard to the international dietetic community. This is the first study of its kind conducted in SA. Studies aimed at SA dietitians are crucial to keep us at the forefront of nutrition research and developments.

What is the aim of the pilot study?

You will be asked to complete the short questionnaire and then answer 5 questions regarding the user-friendliness (face validity) thereof. Even if you are not entirely familiar with the research topic, your contribution will be of great importance and we urge you to participate. We only request 15-20 minutes of your time. On completion of this study, we will circulate an updated email to all participants on project findings and any publications arising from this study.

What do I need to do to participate?

Participation in entirely voluntary, anonymous and strictly confidential. By completing this questionnaire you are consenting to partake in the pilot study. **Important:** Although your response will be received by email, your address will be de-linked from your response upon receipt, ensuring anonymity. You will be asked NOT to participate in the main study: The final questionnaire will be sent via the ADSA group email.

Follow these 5 steps:

1. Please find attached the cover letter and questionnaire. This is the proposed version to be sent out in the main study.
2. Complete the questionnaire. At the end of the questionnaire there is a comment sheet. This contains 4 short questions for you to comment on the face validity or "user-friendliness" of the questionnaire.
3. Once completed, save it to your computer as "nutrition research".
4. Then attach it and email it back to the researcher at nutrition.research1@gmail.com
5. We kindly request that you return the completed questionnaire by the 16th of March 2010.
6. Should you have any problems in attaching the questionnaire, you can copy the entire questionnaire and paste it into a new message.

Thank you in advance for your participation,

Lizalet Oosthuizen RD(SA)

APPEDDIX 4

PILOT STUDY: COMMENT SHEET AS SENT VIA EMAIL

Comment Sheet

Please answer the following questions in order to evaluate the Face Validity (user-friendliness) of the questionnaire

How to answer:
Put the letter "X" next to your answer and if asked to provide a written answer, type it in - there is no limit on the amount of words.

1. Please comment on the Cover letter (request for participation):			
Was the cover letter explaining the research aim and requesting participation in the main study clear and understandable?			
Yes		**No**	
If you indicated "No", please state why and suggestions for improvement...			
2. Please comment on the questionnaire instructions:			
Were the instructions on how to complete the questionnaire clear and understandable?			
Yes		**No**	
If you indicated "No", please state why and suggestions for improvement...			
3. Please comment on the questionnaire content and time taken to complete:			
Were the questions easy to understand?			
Yes		**No**	
If you indicated "No", please state which questions were difficult to understand and why...			

How long did it take you to complete the questionnaire? (Not evaluation sheet)								
< 10 min		**10-15min**		**15-20min**		**>20min**		
4. Please comment on completing the questionnaire in electronic format:								
Did you experience any difficulty in completing the questionnaire in its electronic format?								
Yes				**No**				
If "yes" please explain if what difficulties you had...								
5. Did you experience any difficulty in attaching the questionnaire and emailing it back to the address given?								
Yes				**No**				
If "yes" please explain if what difficulties you had...								

Any additional comments? I would be grateful for any suggestions that would help to improve the questionnaire:

Thank you sincerely for taking the time to evaluate the face validity of this research questionnaire.

Please email the completed questionnaire and comment sheet as an attachment to: nutrition.research1@gmail.com

Please do not hesitate to contact me at the above address should you have any queries.

Yours sincerely,

Lizalet Oosthuizen RD(SA)

APPENDIX 5

COVER LETTER FOR EMAIL QUESTIONNAIRE: REQUEST FOR PARICIPATION IN MAIN STUDY

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

South African Registered Dietitians and Nutritional Genomics: A National Study

Dear Colleague,

Research amongst South African dietitians is crucial to advance our profession and to stay at the forefront of the international dietetic community. Therefore your participation is kindly requested in this National Research Study that is currently underway at the University of Stellenbosch as part of a Master's degree in nutrition. We only request 8-10 minutes of your time to complete the attached 4 page questionnaire.

What is the study about?

With the completion of the Human Genome Project in 2003 the study of diet-gene interactions has become a hot topic in nutrition, promising the transition from generic nutritional recommendations to more personalized nutritional prescriptions. This field is known as nutritional genomics and clearly holds exciting opportunities for dietitians. Various international studies have been conducted in the USA, UK and Europe to determine what dietitians know and want to know about nutritional genomics as well as what this means for the dietetic profession.

Now it is time for South African dietitians to have our say:

This National Research Study aims to measure the confidence, involvement and knowledge of SA dietitians regarding genetics and nutritional genomics by means of a questionnaire. This questionnaire was used in a study amongst UK dietitians (*Whelan et al 2008*) and results will help to determine where SA dietitians stand with regard to the international dietetic community.

For this study to be representative of all SA dietitians it is crucial to get your opinion, even if you are not familiar with the topic, or if it is not relevant to your practice. All SA dietitians registered with the

HPCSA have been contacted by either post or email and this research project has received ethics approval from the Committee for Human Research, Faculty of Health Sciences, Stellenbosch University.

Because we value your time and input, each respondent will be entered into a prize draw to win one of two R1000 Woolworth's vouchers

Participation in entirely voluntary and strictly confidential and although your response will be received via email, your email address will be de-linked from your response upon receipt ensuring anonymity.

How to complete and return the questionnaire: Follow these 5 steps:

1. Open the attached questionnaire and follow the easy instructions to complete it.
2. Once completed, save to your computer as "nutrition research".
3. Now compose a new email and attach your completed questionnaire.
4. Return it to the researcher at nutrition.research1@gmail.com.
5. Although you will have received this e-mail from ADSA, please DO NOT return it to ADSA.

Should you have any problems in attaching the questionnaire, you can copy the entire questionnaire and paste it into a new message, or alternatively you can contact the researcher at the above email address for a postal copy.

Please return the completed questionnaire before or on the 20th of May 2010

Please do not hesitate to contact me with any queries at nutrition.research1@gmail.com

Yours Sincerely,

Lizalet Oosthuizen RD(SA)

APPENDIX 6

EMAIL REMINDER TO COMPLETE QUESTIONNAIRE

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Reminder to complete questionnaire: South African Registered Dietitians and Nutritional Genomics: A National Study

Dear Colleague,

Research amongst South African dietitians is crucial to advance our profession and stay at the forefront of the international dietetic community.

Therefore this is a kind reminder to please complete and return the 4 page questionnaire

All dietitians registered with the HPCSA have been contacted via email or post. For this study to be representative of all SA dietitians it is crucial to get your opinion, even if you are not familiar with the topic, or if it is not relevant to your practice.

Please be so kind as to respond by the 20th of May.

All respondents will be entered into a prize draw to win one of two R1000 Woolworth's vouchers.

- You can access the questionnaire on the ADSA website by selecting this link www.adsa.org.za - click on "Nutrition Links" on the ADSA homepage and then choose "Nutrition Research". Here you will find the questionnaire and easy instructions on how to complete and email it back to the researcher.
- Should you require a hard copy, you can email me at nutrition.research1@gmail.com and I will gladly post one on to you.
- Thank you for taking the time to complete this questionnaire, I look forward to your response.

Yours Sincerely,

Lizalet Oosthuizen RD(SA)

APPENDIX 7

COVER LETTER FOR POSTALAL QUESTIONNAIRE: REQUEST FOR PARTICIPATION IN MAIN STUDY

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

South African Registered Dietitians and Nutritional Genomics: A National Study

Dear (name of dietitian)

Research amongst South African dietitians is crucial to advance our profession and stay at the forefront of the international dietetic community. Therefore your participation in this National Research Study will be much appreciated and we only request 8-10 minutes of your time to complete the included questionnaire.

What is the study about?

With the completion of the Human Genome Project in 2003 the study of diet-gene interactions has become a hot topic in nutrition, promising the transition from generic nutritional recommendations to more personalized nutritional prescriptions. This field is known as nutritional genomics and clearly holds exciting opportunities for dietitians. Various international studies have been conducted in the USA, UK and Europe to determine what dietitians know and want to know about nutritional genomics as well as what this means for the dietetic profession.

Now it is time for South African dietitians to have our say:

This National Research Study aims to measure the confidence, involvement and knowledge of SA dietitians regarding genetics and nutritional genomics by means of a questionnaire. This questionnaire was used in a study amongst UK dietitians (*Whelan et al 2008*) and results will help to determine where SA dietitians stand with regard to the international dietetic community.

For this study to be representative of all SA dietitians it is crucial to get your opinion, even if you are not familiar with the topic, or if it is not relevant to your practice. All SA dietitians registered with the HPCSA have been contacted by either post or email and this research project has received ethics

approval from the Committee for Human Research, Faculty of Health Sciences, Stellenbosch University.

Because we value your time and input, each respondent will be entered into a prize draw to win one of two R1000 Woolworth's vouchers

How to enter the Prize Draw:

- If you wish to be entered, please provide your DT number where indicated at the bottom of the questionnaire. Your DT number will be separated from the questionnaire upon receipt and not be linked to your response. The DT numbers will only be used to contact the winners.

How to complete the questionnaire:

- The 2 page questionnaire (printed on both sides) is included.
- Complete all questions by following the easy instructions.
- Once completed, return to the researcher in the postage paid envelope.
- Please return the completed questionnaire before 10 May 2010.
- All responses will be treated as confidential and anonymous.

Thank you for taking the time to complete this questionnaire, I look forward to your response.

Yours Sincerely,

Lizalet Oosthuizen RD(SA)

APPENDIX 8

POSTAL REMINDER TO COMPLETE QUESTIONNAIRE

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Reminder to complete questionnaire: South African Registered Dietitians and Nutritional Genomics: A National Study

Dear Colleague,

Research amongst South African dietitians is crucial to advance our profession and stay at the forefront of the international dietetic community.

Therefore this is a kind reminder to please complete and return the 4 page questionnaire, as posted on to you on the 10th of April 2010.

All dietitians registered with the HPCSA have been contacted via email or post and for this study to be representative of all SA dietitians it is crucial to get your opinion, even if you are not familiar with the topic, or if it is not relevant to your practice.

The closing date has been postponed to the 20th of May and all respondents will be entered into a prize draw to win one of two R1000 Woolworths vouchers.

If you did not receive a questionnaire or have misplaced it, you can access the complete questionnaire on the ADSA website: www.adsa.org.za - click on "nutrition links" and select "nutrition research". Here you will find the easy instructions on how to complete and email the questionnaire back to the researcher. Should you require a hard copy, you can email me at nutrition.research1@gmail.com and I will gladly post it on to you.

Thank you for taking the time to complete this questionnaire, I look forward to your response.

Yours Sincerely,

Lizalet Oosthuizen RD(SA)

APPENDIX 9

RESEARCH QUESTIONNAIRE

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

SECTION 1 - Registered Dietitians involvement and confidence in genetics

We would like to know whether in the past year you have been involved in the practices described below (please tick 'yes' or 'no'). Then, irrespective of whether you have been involved in them or not, we would like to know how much confidence you have, or would have, in doing them using the scoring system below.

1 = Very low confidence	*2 = Low confidence*	*3 = Average confidence*	*4 = High confidence*	*5 = Very high confidence*

	Have you been involved in this in the past year? (*please tick*)	**How much confidence do you have, or would you have, in doing this? (*please circle*)**				
1. Taking genetic information as part of a family or disease history	☐ Yes ☐ No	1	2	3	4	5
2. Discussing the genetic basis of a disease with patients	☐ Yes ☐ No	1	2	3	4	5
3. Referring a patient for genetic counseling	☐ Yes ☐ No	1	2	3	4	5
4. Providing guidance to patients with genetic disorders about what impact it may have on their future development	☐ Yes ☐ No	1	2	3	4	5
5. Providing counselling to patients regarding genetic disorders	☐ Yes ☐ No	1	2	3	4	5
6. Obtaining written informed consent to release genetic information to a third party	☐ Yes ☐ No	1	2	3	4	5
7. Discussing with patients the basis of a disease that has both a dietary and a genetic component	☐ Yes ☐ No	1	2	3	4	5
8. Advising patients where to access information relating to a disease with both a dietary and genetic component	☐ Yes ☐ No	1	2	3	4	5
9. Discussing with patients how diet may interact with genes to influence the risk of disease	☐ Yes ☐ No	1	2	3	4	5
10. Providing training or education to students or other health professionals on human genetics	☐ Yes ☐ No	1	2	3	4	5
11. Providing training and education to students or other health professionals on diseases that have both a dietary and genetic component	☐ Yes ☐ No	1	2	3	4	5

SECTION 2 - Registered Dietitians knowledge about genetics

Below are a series of multiple choice questions. Please tick the answer you think is correct. If you do not know the answer please tick 'Don't know' rather than guessing. Remember that we want to know what YOU think. Please do not ask others for the answer or look it up in a book or on the internet.

1. A 'gene' is: ☐ An alteration in DNA that results in disease ☐ The protein produced from DNA ☐ A short sequence of DNA ☐ A DNA sequence that codes for a protein ☐ Don't know	**2. A 'chromosome' is:** ☐ A self-replicating genetic structure within cells ☐ An abnormality occurring in DNA ☐ A gene ☐ A gene that causes a disease ☐ Don't know
3. An 'allele' is: ☐ A single stranded piece of DNA ☐ One of a set of alternative forms of a gene ☐ A gene ☐ Part of the nucleus where DNA is stored ☐ Don't know	**4. 'Genotype' is:** ☐ The genetic information in an organism ☐ The effect of the genetic code on proteins ☐ The type of DNA in genes ☐ Any genetic disorder ☐ Don't know
5. 'Phenotype' is: ☐ The genetic alteration responsible for PKU ☐ A trait resulting from the genetic code ☐ A type of gene that is expressed ☐ A trait resulting from genes that do not code ☐ Don't know	**6. A 'polymorphism' is:** ☐ The range of genes in one human ☐ The changes in DNA during a cell cycle ☐ A mutating gene ☐ Variation in DNA sequence between individuals ☐ Don't know
7. A 'mutation' is: ☐ Apoptosis ☐ A change in DNA sequence ☐ A change in DNA between generations ☐ A change in DNA that results in disease ☐ Don't know	**8. 'PCR' means:** ☐ Promotion of cell replication ☐ Polymorphism control region ☐ Polymerase chain reaction ☐ Penetrance of cancer risk ☐ Don't know
9. 'Nutrigenetics' is: ☐ The effect of diet on how genes work ☐ How genes affect what we eat ☐ The effect of genes on the response to diet ☐ Passing nutritional diseases to the offspring ☐ Don't know	**10. Which of the following is FALSE? 'Genetic defects can…'** ☐ Increase food intake ☐ Increase the risk of diverticular disease ☐ Decrease nutrient absorption ☐ Increase the risk of Crohn's disease ☐ Don't know
11. Which of the following defects interact with DIETARY FAT intake to influence the risk of cardiovascular disease? ☐ CBS 844ins68 ☐ Angiotensinogen M235T ☐ ApoE2/E2 ☐ MS 2756A→G ☐ Don't know	**12. What condition is NOT associated with the methylene-tetrahydrofolate reductase (MTHFR) 677C→T defect?** ☐ Cardiovascular disease ☐ Colorectal cancer ☐ Type 1 diabetes mellitus ☐ Neural tube defects ☐ Don't know

SECTION 3 – Training of Registered Dietitians in genetics

We would like to know the extent of training that you have had in genetics, both before and after qualifying as a Registered Dietitian.

1. Tick the phrase below that most accurately describes your training in genetics whilst at university

   □ I didn't cover any material relating to genetics
   □ I took a course unit that included some genetics
   □ I took a course unit relating entirely to genetics
   □ I took a degree relating entirely to genetics

2. In the past year, have you read any scientific literature (e.g. journal articles, books), attended any meetings, study days or conferences that included some material relating to **genetics** or **diet and genetics**? (*please tick*)

   Genetics
   □ Scientific literature, if so how many in the past year ……..
   □ Meetings / study days / conferences, if so how many in the past year ……..

   Diet and genetics
   □ Scientific literature, if so how many in the past year ……..
   □ Meetings / study days / conferences if so how many in the past year ……..

3. In your opinion, how important is an understanding of genetics to the practice of dietetics? Please consider the profession as a whole, rather than just your own area of speciality *(please circle).*

Not important at all	*Not very important*	*Somewhat important*	*Important*	*Very important*

SECTION 4 – About you

We would like to know a little bit about you, your career and your training.

1. What year did you qualify as a Registered Dietitian? …….

2. How many years have you worked as a Registered Dietitian? .....

3. When you qualified as a Registered Dietitian did you do so by an undergraduate degree (e.g. BSc) or a postgraduate diploma/MSc? *(please tick)*

   □ Undergraduate degree
   □ PG Diploma/MSc, if so what was your undergraduate degree in? ……..

4. When you qualified as a Registered Dietitian, was this at a university in South Africa?

□ Yes	□ No, which country was it in?…….

5. Which of the following qualifications do you hold? *(you may tick more than one box)*

- ☐ A bachelor's degree (e.g. BSc)
- ☐ A masters degree (e.g. MSc)
- ☐ A doctorate degree (e.g. PhD)
- ☐ Other (please specify) ……

Are you currently studying for a qualification? *(please tick)*

☐ No	☐ Yes, please specify ……

Are you currently practising as a Registered Dietitian? This includes clinical practice, management, research, education or industry *(please tick).*

☐ No, if no go to 11	☐ Yes

Are you currently involved in advising patients or clients as a Registered Dietitian? *(please tick)*

☐ No, if no go to 11	☐ Yes

What patient groups in the past year did you most frequently work with? (you may tick up to four)

☐ Cancer	☐ General medical	☐ Liver	☐ Renal
☐ Cardiovascular	☐ General surgical	☐ Mental health	☐ Other ……
☐ Diabetes	☐ Geriatrics	☐ Obesity	☐ Other ……
☐ Gastroenterology	☐ HIV and AIDS	☐ Paediatrics	☐ Other ……

What is your current position? *(please tick all that apply)*

☐ Community service dietitian	☐ Junior Clinical dietitian	☐ Research dietitian	☐ Consultant dietitian
☐ Community Dietitian	☐ Senior Clinical dietitian	☐ Private practice dietitian	☐ Other …….
	☐ Specialist dietitian		

Where do you work? *(you may tick more than one)*

☐ Teaching hospital	☐ Industry	☐ Other ……
☐ District general hospital	☐ Self-employed	
☐ Community	☐ University	

Thank you very much for completing this questionnaire