Urinary Incontinence in Adolescent Gymnasts

By

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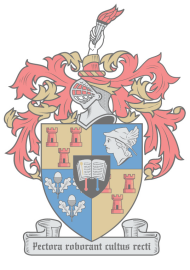

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DECLARATION

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ABSTRACT

Introduction

Urinary incontinence (UI) affects women of all ages, but its presence in adolescence is associated with UI in later life. While pregnancy and parity have a strenuous and even damaging effect on the urogenital system, they are not risk factors in adolescence. In South Africa, the prevalence of adolescent UI is unknown and investigations into the particular risk factors are required.

Prevalence rates of incontinence in young athletes are concerning. Stress urinary incontinence (SUI) is the most common form of UI. Great variation in the prevalence of SUI in nulliparous athletes has been reported. High-impact sports, in particular gymnastics and ballet, have the highest prevalence rates. Connective tissue disorders have been associated with SUI in adults and nulliparous females. Normally, gymnasts and ballerinas regard general joint hypermobility (GJH) as an asset due to the enhanced flexibility it affords them, but it may also place the athletes' musculoskeletal system under strain, resulting in early fatigue. The investigation into a nulliparous adolescent gymnastic population is needed to identify early risk factors.

The aim of this thesis is to describe the prevalence, severity and risk factors of SUI in the female adolescent population and to determine if GJH is a risk factor for SUI in an adolescent gymnastic population.

Methodology

We used a structured literature review to summarise the prevalence rates of UI in females, adolescents, and nulliparous sportswomen. Search engines included Google Scholar, PubMed, CINAHL and Science Direct.

An analytical cross-sectional design was used to describe the prevalence and risk factors of SUI in an adolescent gymnastic population. Twenty-four gymnastic clubs were randomly selected from the fifty-five gymnastic clubs in the Cape Metropole. The female adolescent gymnasts, between the ages of 11 and 19 years, voluntarily participated. The participants completed an Incontinence Severity Index, a self-compiled questionnaire, and one practical hypermobility assessment.

Results

The literature review reported on the UI prevalence in adolescence, pathology of SUI, risk factors for SUI in adolescence and pelvic floor muscle (PFM) function in a nulliparous

sporting population. It revealed that the prevalence of SUI in a non-sporting adolescent population ranged from 7.2%-22%. Prevalence rates in a nulliparous sporting population vary greatly (0%-80%) and depend on the type of sports that females participate in. Gymnastics and ballet have the highest prevalence rates and acquire the most flexibility to excel in the sport. Risk factors in adolescence are high-impact exercise, obesity, cystic fibrosis, neurological disturbances, childhood enuresis and constipation. Connective tissue disorders, like benign joint hypermobility syndrome (BJHS), and decreased collagen content are possible risks factors of SUI in adult and nulliparous populations. Connective tissue laxity may affect the pelvic floor muscles (PFMs) and decrease urogenital support even more. GJH is a phenomenon in otherwise normal subjects, which result in joints moving more than the normal range due to a lack of connective tissue support. This hypothesised connective tissue involvement in SUI, prompted this primary study.

The primary study investigated seven gymnastic clubs, which includes sixty-seven female gymnasts that agreed to participate. The prevalence of SUI was 35.82% (95% CI [24.74%–48.53%]) and urge urinary incontinence (UUI) was 8.96% (95%CI [3.69%–19.12%]). The incontinent gymnasts were older (p=0.02). Race (p=0.50) and body mass index (BMI) (p=0.53) was not associated with SUI. The average number of gymnastic training days, hours, years and levels did not influence the presence of incontinence. Participants are eight times (OR 8 95% CI [1.91-33.60]) more likely to develop SUI when involved in trampoline gymnastics than in other gymnasts. Most participants experienced SUI when jumping (p≤0.001). The Incontinence Severity Index (ISI) used in this study, is sensitive enough to distinguish between incontinence and continence in this adolescent group (p≤0.001). It is also sensitive enough to distinguish the severity amongst different types of incontinence [SUI (p<0.001), mixed urinary incontinence (MUI) (p=0.002), and UUI (p=0.026)]. Twenty-five (38.8%) gymnasts were classified with GJH according to the Beighton score with a cut off of 5/9 (GJH5). The presence of hypermobility (GHJ5) did not differ with age (p=0.227), BMI (p=0.274), race (p=0.70) or gymnastic discipline. Regular ligament injuries are three times more common (OR 3.09 95 % CI [1.11–8.56]) in GJH5 participants than participants that are not hypermobile. A stepwise backward logistic regression (r^2=0.554) demonstrated that adolescent gymnasts that present with a history of regular ligament sprains (OR=4.58), are older (OR=1.41), participate in trampoline (OR=33.76) and train for two to three hours daily (OR=57.99) were more likely to present with SUI.

Conclusion

The prevalence of SUI in the adolescent population varies greatly. Risk factors in adolescence are high-impact exercise, obesity, cystic fibrosis, neurological disturbances,

childhood enuresis and constipation. More than a third of the adolescent gymnasts included in the primary study presented with SUI and/or GJH. While GJH was not associated with the development of SUI in this group of adolescent gymnasts, the potential involvement of connective tissue laxity in SUI should be explored in future studies. Older trampolinists, who train for two to three hours daily and have regular ligament or joint injuries, are more likely to develop SUI. This data can now be used by health care professionals and coaches to identify adolescent gymnasts at risk and refer appropriately.

OPSOMMING

Inleiding

Urinêre inkontinensie raak vroue van alle ouderdomme, maar die teenwoordigheid tydens adolessensie word geassosieer met inkontinensie as ‘n volwassene. Alhoewel swangerskap en pariteit alom bekend is vir ‘n skadelike effek op die urogenitale stelsel, word dit nie gesien as risiko faktore in adolessente nie. Urinêre inkontinensie in Suid-Afrikaanse adolessente is nog onbekend en die betrokke risiko faktore moet ondersoek word.

Die prevalensie van inkontinensie is kommerwekkend in jong atlete. Druklek is die algemeenste vorm van inkontinensie. Groot variasie in druklek prevalensie word in nullipareuse atlete gerapporteer. Hoë impak sport en in besondere gimnastiek en ballet het die hoogste prevalensie. Bindweefselsiektes word geassosieer met druklek in volwassenes en nullipareuse vrouens. Hipermobiliteit word as ‘n aanwins in gimnastiek en ballet beskou aangesien dit ekstra soepelheid verskaf, maar dit kan die muskuloskeletale systeem onder meer druk plaas en lei tot vroeë spier uitputting. Vroeë risiko faktore moet in adolessent gimnastiek populasie ondersoek word.

Die doel van die tesis is om die prevalensie,intensiteit en risiko faktore van urinêre inkontinensie in 'n adolessente bevolking te beskryf en om te bepaal of algemene hipermobiliteit ‘n risiko faktor vir die ontwikkeling van druklek is in ‘n adolessent gimnastiek populasie.

Metode

Die literatuur oorsig sluit veelvuldige soek terme in om urinêre inkontinensie in adolessensie te ondersoek. Soekenjins sluit Google Scholar, Pubmed, CINAHL en Science Direct in.

‘n Analitiese deursnit ontwerp was gebruik om die prevalensie en risiko faktore in ‘n adolessent gimastiek populasie te beskryf. Vier en twintig gimnastiek klubs was lukraak gekies uit die vyf en vyftig gimnastiek klubs in die Kaapse Metropool. Die vroulike adolessente gimnaste, tussen die ouderdomme van 11 en 19 jaar, het vrywillig deelgeneem. Die deelnemers het 'n Inkontinensie Erns Index, 'n self saamgestelde vraelys en een praktiese laksheidsevaluasie voltooi.

Resultate

Die literatuur oorsig doen verslag oor die prevalensie van urinêre inkontinensie in adolessensie, die patologie van druklek, die risiko faktore vir druklek in adolessensie en

bekkenvloer spier funksie in 'n nullipareusse sport bevolking. Die prevalensie van druklek in 'n nie-sport adolessente bevolking wissel van 7.2-22%. In 'n nullipareusse sport bevolking wissel die prevalensie grootliks (0%-80%) en word dit bepaal deur die sportsoort. Gimnastiek en ballet het die hoogste prevalensie van urinêre inkontinensie, maar die deelnemers is ook die soepelste. Hoë impak oefening, vetsug, sistiese fibrose, neurologiese versteurings, urinêre inkontinensie tydens kinderjare en hardlywigheid is onder andere as risiko faktore in adolessensie beskryf. Bindweefselsiektes, soos benigne hypermobiliteit sindroom, en 'n verminderde kollageen inhoud hou verband met druklek in volwasse en nullipareusse vrouens en dien as moontlike risiko faktore. Die bindweefsel laksiteit kan ook ‘n negatiewe invloed op die bekkenvloer spiere hê en urogenitale ondersteuning verswak. Algemene hipermobiliteit is 'n verskynsel in andersins normale kandidate, wat meer as die normale gewrigsomvang toelaat. Die hipotese dat bindweefsel laksheid dalk betrokke is by druklek was die aansporing vir die primêre studie.

Die primêre studie ondersoek sewe gimnastiek klubs wat sewe en sestig vroulike gimnaste insluit. Die prevalensie van druklek was 35.82% (95% CI [24.74–48.53%]) en dranglek was 8.96% (95% CI [3.69–19.12%]). Die inkontinente gimnaste was ouer (p=0.02). Ras (p=0.50) en die liggaamsmassa index (LMI) (p=0.53) was nie geassosieer met druklek nie. Die gemiddelde aantal gimnastiek oefen dae, -ure, -jaar en vlakke het nie die teenwoordigheid van inkontinensie beïnvloed nie. Gimnaste wat deelneem aan trampolien is ag keer (OR 8 95% CI [1.91-33.60]) meer geneig om druklek te ontwikkel as ander gimnaste. Die meeste deelnemers ervaar druklek wanneer hulle spring (p≤0.001). Die inkontinensie erns indeks wat in hierdie studie gebruik word, is sensitief genoeg om te onderskei tussen inkontinent en kontinent (p≤0.001). Dit is ook sensitief genoeg om te onderskei in die erns van verskillende tipes inkontinensie [druklek (p<0.001), gemengde inkontinensie (p=0.002), en dranglek (p=0.026)]. Vyf en twintig (38.8%) gimnaste word geklassifiseer as hipermobiel volgens die Beighton telling met 'n af sny punt van 5/9 (GJH5). Die teenwoordigheid van hipermobiliteit (GHJ5) word nie geassosieer met ouderdom (p=0.227), LMI (p=0.274), ras (p=0.70) of verskillende tipes gimnastiek nie. Gereelde ligament beserings is drie keer meer algemeen (OR 3.09 95 % CI [1.11–8.56]) in GJH5 deelnemers as deelnemers wat nie hypermobile is nie. 'n Stapsgewyse agtertoe logistieke regressie (r^2=0.554) demonstreer dat vroulike adolessent gimnaste met 'n geskiedenis van gereelde ligament verstuitings (OR=4.58), ouer is (OR=1.41), aan trampolien deelneem (OR=33.76) en vir twee tot drie ure daagliks oefen (OR=57.99) meer geneig is om druklek te he.

Gevolgtrekking

Daar is baie variasie in die prevalensie van druklek in die adolessent populasie. Risiko faktore in adolessensie is hoë impak oefeninge, vetsug, sistiese fibrose, neurologiese versteurings, lek van uriene tydens kinderjare en hardlywigheid. Meer as'n derde van die adolessent gimnaste in die primêre studie het druklek en/of algemene hipermobiliteit gehad. Algemene hipermobiliteit was nie geassosieer met druklek in hierdie groep gimnaste nie. Die effek wat bindweefsel laksheid op druklek het moet in toekomstige studies ondersoek word. Ouer gimnaste wat aan trampolien deelneem, vir 2-3 ure per dag oefen en gereelde ligament of gewrigsbesering het, is meer geneig tot druklek. Hierdie informasie kan benuttig word deur gesondheidswerkers en afrigters om sodoeende adolessent gimnaste, wat 'n risiko het om druklek te ontwikkel, te identifiseer.

DEDICATION

Dedicated to Ouma Ans and Ouma Rosa

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ABBREVIATIONS

ADL	Activities of daily living
ATFP	Arcus tendinous fasciae pelvis
BJHS	Benign joint hypermobility syndrome
BMI	Body mass index
CI	Confidence interval
CTGA	Cape Town Gymnastics Association
GJH	General joint hypermobility
GJH4	General joint hypermobility classified by a 4/9 Beighton cut-off score
GJH5	General joint hypermobility classified by a 5/9 Beighton cut-off score
GSUI	Genuine stress urinary incontinence
HIFIT	High impact frequent intensity training
IAP	Intra-Abdominal Pressure
IC	Iliococcygeus
ICIQ-SF	International Consultation on Incontinence Questionnaire Short Form
ICS	International Continence Society
ISI	Incontinence Severity Index
LA	Levator Ani
MUI	Mixed Urinary Incontinence
MRI	Magnetic resonance imaging
MVC	Maximum voluntary contraction
OR	Odds ratio
PC	Pubococcygeus
PF	Pelvic floor

PFM(s)	Pelvic floor muscle(s)
PFMRx	Pelvic floor muscle treatment
PI	Primary investigator
RA	Research assistant
ROM	Range of movement
SAFSUI	Severe adolescent female stress urinary incontinence
SUI	Stress Urinary Incontinence
SUI-C	Stress Urinary Incontinence with coughing and sneezing
SUI-G	Stress Urinary Incontinence with gymnastics training
UI	Urinary Incontinence
UK	United Kingdom
UL	Urinary leakage
UUI	Urge Urinary Incontinence
US	Ultrasound
USCS	Urethral sphincteric closure system
USS	Urethral support system
VO2 max	Volume oxygen maximum (maximum oxygen uptake)
VRP	Vaginal resting pressure
WCGA	Western Cape Gymnastics Association

GLOSSARY OF TERMS

DEFINITIONS

Arcus tendineus fascia pelvis: are tensile structures located bilaterally on either side of the urethra and vagina.

Beighton score: A scoring system for measurement of hypermobility revised by Beighton et al in1969 form the Carter and Wilkinson scoring system.

Benign joint hypermobility syndrome: joint laxity which is associated with musculoskeletal complaints.

Endopelvic fascia: is a dense, fibrous connective tissue layer that surrounds the vagina and attaches to the arcus tendineus fascia pelvis.

Enuresis: any involuntary loss of urine.

General joint hypermobility: is an isolated finding in otherwise normal subjects. The joint are unduly lax and the range of motion is in excess of the accepted normal in most of the joints examined.

Incontinence Severity Index: is a tool to quantify the severity of incontinence. It has two questions of “how much” and “how often” urine loss is experienced. Severity is described according to slight, moderate, severe and very severe categories.

Mixed urinary incontinence: involuntary leakage associated with urgency and also with exertion, effort, sneezing and coughing.

Nulliparous: not given birth

Parous: having given birth

Pubocervical fascia: the fasciae between the bladder, cervix and the vagina.

Stress urinary incontinence: involuntary leakage on effort or exertion, or on sneezing or coughing.

Urinary incontinence: involuntary leakage of urine.

Urge urinary incontinence: involuntary leakage accompanied by or immediately proceeded by urgency.

CHAPTER 1:

URINARY INCONTINENCE IN ADOLESCENT GYMNASTS

1.1 INTRODUCTION AND BACKGROUND

Urinary Incontinence (UI) remains an embarrassing problem and women rarely consult a doctor to address this problem. These women do not seek help which leads to not necessarily having the correct information about treatment options.(1–3) They live with the misconception that UI and specifically SUI is the norm in later life. Stress urinary incontinence (SUI) is the most common form of UI amongst women.(4,5) SUI impacts negatively on their quality of life and they continue to suffer in silence by using urinary pads, restricting fluid intake, limiting exercise and avoid socialising.(3) Awareness about UI and available treatment options need to be created at a young age. Pelvic floor muscle (PFM) exercise programmes have been effective in addressing urinary symptoms.(6–9) Annually, the health care system in the United States of America spends more than $12 billion on the management and treatment of SUI, (10) indicating the severity of this problem. Conservative treatment and incontinence products also have a financial burden on the patient.(10)

Predictors and risk factors for SUI in females have been described in the literature. The presence of incontinence during adolescence is an indicator of UI in later life.(11–13) Other risk factors for the development of UI include obesity, chronic respiratory problems, high-impact exercise, connective tissue disorders and neurological disturbances.(14)

Little knowledge is available on the long-term effect of strenuous physical activities on the prevalence of UI.(11) During the competitive years, high-impact sportswomen have reported 13% UI prevalence; while participants in medium impact reported 10.7% and the low impact 5.3%. In later life, the UI prevalence of aforementioned athletes was reported as 36.1%, 36.9%, and 36.8 % respectively.(11) Taking part in sports did not increase the UI prevalence in later life, but if the athletic group experienced UI during the competitive years, this was an indicator for UI in later life.(11) The severity of UI was not investigated. Another study also found that the participation in high-impact sport did not predispose females to a higher rate of UI (12) compared to non-athletes. High-impact athletes were also more likely to report incontinence during their training years than low impact athletes. Both of these studies were done retrospectively and could influence the results. Uncertainty exists around the presence of UI in teenage years.

Many females take part in competitive sport and the competition is fierce. Due to the increased pressure to outperform the competitors, the female athlete struggles with a

number of health problems.(15–17) The presence and severity of UI can lead to the abandonment of a favourite sport, or change the way of doing sport.(18)

Connective tissue disorders, like benign joint hypermobility syndrome (BJHS) and a lack of support from connective tissue in the pelvis bowel, have been described as risk factors in the development of SUI in adults.(1,25-27,28) In children diagnosed with joint hypermobility, aged five to 12 years, UI was more prevalent in the general joint hypermobility (GJH) group than in non-hypermobile controls.(19) Whether GJH is related to incontinence is not clear.

The aim of this thesis is to describe the prevalence, severity and risk factors of SUI in the female adolescent population and to determine if GJH is a risk factor for SUI in the female adolescent gymnastic population. This information can provide health care providers and coaches with more facts about incontinence in adolescence and create more awareness about this embarrassing illness in order for adolescents to seek help.

1.2 STUDY CONTEXT

This study describes UI in adolescent gymnasts and explores the hypothesis of GJH as a risk factor in SUI. A literature study and primary study aids in the description and hypothesis testing. The literature review helps to formulate the connection between GJH and SUI and serves as the basis for the primary study. It also emphasises the need for investigating the adolescent sporting population.

1.3 THESIS OVERVIEW

This thesis was written in article format and consists of four chapters (Figure 1.1).

Chapter One includes the thesis introduction and background, study context and thesis outline.

Chapter Two is the literature review that summarises the known prevalence rates of urinary incontinence in females, adolescents, and nulliparous sportswomen. It describes the pathophysiology of stress urinary incontinence and pelvic floor function in nulliparous sportswomen. GJH and the association with stress urinary incontinence are discussed.

Chapter Three is the primary study. This chapter will be submitted for publication in the International Urogynaecology Journal (Addendum A01) and the title, “Stress urinary incontinence in female adolescent gymnasts and the presence of general joint hypermobility.”

Chapter Four comprises the general thesis discussion, the literature contributions, implications, strengths and limitations, recommendations and the conclusion.

One complete reference list is presented at the end of the thesis. Upon journal submission, individual chapter references will be compiled.

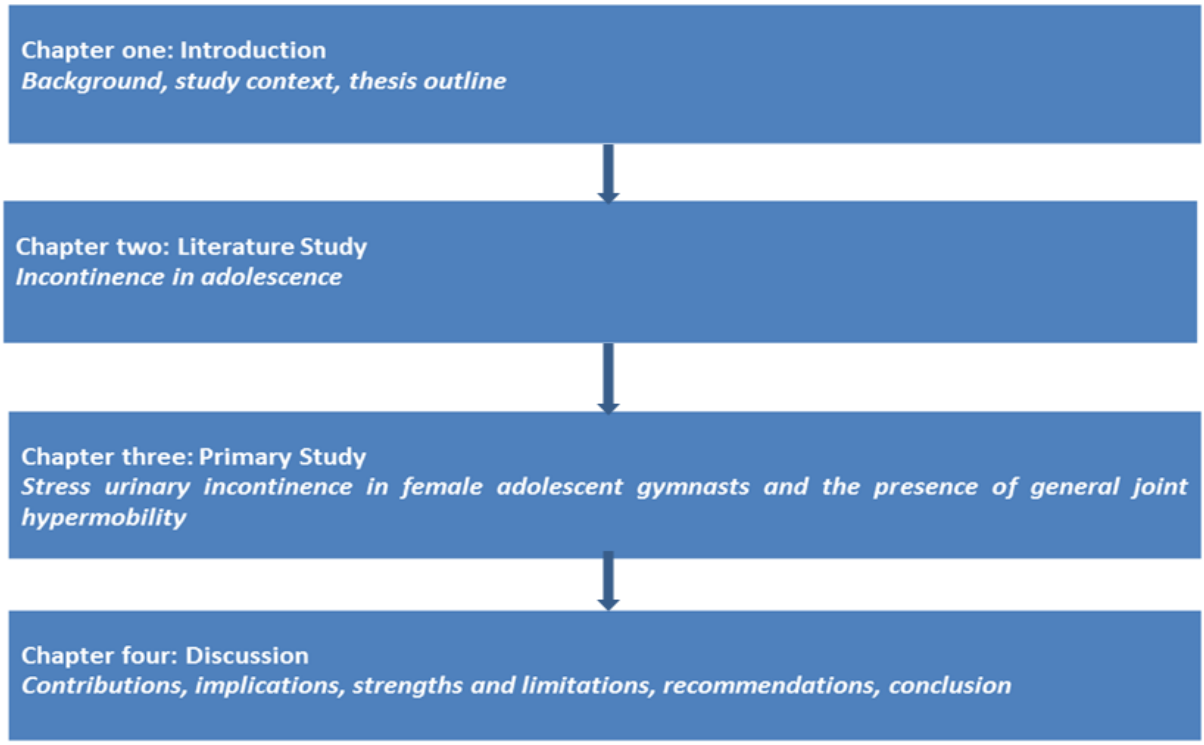

Figure 1.1: Thesis overview

CHAPTER 2:

INCONTINENCE IN ADOLESCENCE

2.1 A REVIEW OF THE LITERATURE

2.1.1 BACKGROUND

In South Africa urinary incontinence (UI) affects 35% of the adult population, of which stress urinary incontinence (SUI) is the greatest problem.(20,21) Many risk factors have been investigated and described to explain UI in later life. The presence of UI in adolescence, despite the reason for the UI, is a strong predictor of incontinence in later years.(11) Adults and adolescents under-reported UI for a fear of embarrassment and tend not to seek help.(2,3)

2.1.2 PREVALENCE OF UI

UI is prevalent in 10% to 55% of female adults.(6) SUI is the most common form in the adult population.(22) Due to a growing concern of the burden of this disease, SUI in a nulliparous population (in particular nulliparous athletes) has been under investigation in recent years.(1,6,23–27) Prevalence rates vary depending on the type of incontinence and population being studied.

In a review of UI prevalence in specifically non-athletic nulliparous females (adolescent to middle-aged), prevalence ranged from 1% to 42.2%. Amongst the incontinent participants, SUI ranged from 12.5% to 79%. Urge urinary incontinence (UUI) ranged from 15.6% to 41.6% and mixed urinary incontinence (MUI) varied between 8.3% and 50% amongst nulliparous UI sufferers.(27) Although only nulliparous females were included, there were large age differences in some of the reviewed studies, which could explain the wide prevalence ranges. Another factor that could influence reported prevalence was the multiple countries and ethnicities that were included.

Nulliparous athletes also present with variation in UI prevalence ranging from 0% in golf players to 80% in athletes participating in trampoline.(1,23,28–32) The different types of sport and associated impact during training could explain the variation in results.

A study of 4332 Belgian school children aged 10-14 years described any urinary leakage during the day as daytime wetting, to distinguish it from nocturnal enuresis (night time wetting). More than eight percent (8.8%) of adolescent girls experienced UI amongst other symptoms. These participants' parents completed the questionnaires of 41 questions at home, without help from investigators.(33) Another school-based study of 1176 adolescents

in the United Kingdom (UK), investigated urinary symptoms at age 11-12 years and again at age 15-16 years. These children were supervised while completing the questionnaires themselves. Daytime wetting prevalence in female participants was 16.6% at age 11-12 years and decreased to 4.7% at age 15-16 years.(34) These two studies have different ethnicities and reporters of urinary symptoms which may explain the differences in results.

SUI prevalence, in general adolescent populations, was reported as 15%-22% and UUI 16%-17%.(35,36) A recent Italian publication of UI in adolescent and nulliparous females reported much lower prevalence rates. Self-reported prevalence included 12.4% UI, 7.2% SUI, 3.4% UUI and 1.9% MUI.(27) The aforementioned results were based on an online survey and seeing as UI is under-reported (3,6,14) it may be that participants with UI decided not to participate.

A study based in the United Kingdom (UK) reported that only 126 of the 528 urinary incontinent adolescent participants sought medical treatment.(33) The stigma associated with incontinence seems to affect adolescents' help-seeking behaviour. Incontinence is a stressful event for children and Bakker (33) hypothesised that if treatment of urinary problems starts at an earlier age, there is a greater chance of improvement.

SUI occurrence of high school and university female athletes, aged 14-21 years, was 28%. In the participants with SUI, 26% had UUI symptoms.(1) More than 90% were unfamiliar with PFM exercises and have never reported their problem to anyone.(1) Unfortunately, there was only a 15.6% return rate of questionnaires and this does not make these results generalisable. In another study involving high school athletes, with a mean age of 19.9 years (SD 3.3 years), UI prevalence was 28% during participation of sports.(30) Forty percent (40%) reported that symptoms developed during their high school attendance and 17% reported symptoms in primary school.(30)

2.1.3 PATHOPHYSIOLOGY OF SUI

To obtain bladder control, a child has to conquer several developmental stages. Firstly, the bladder has to be able to hold more urine in order to decrease the number of voids per day. Initiation and inhibiting of urinary flow and control over PFMs are needed. Maturation of the nervous system results in better communication and coordination of specific peripheral parts of the central nervous system.(33) Problems achieving these milestones lead to inappropriate voiding, increased frequency in childhood and early adolescence (33) and a risk factor for developing SUI in adolescence.(37)

SUI is a known complication after vaginal deliveries and birth-related injuries due to injuries to the muscular, neural and connective tissue structures of the pelvic floor.(4,5) These

injuries decrease urethral support and function, leading to SUI.(38,39) Young athletes are mostly nulliparous and suffer from SUI without exposure to labour. It is important to be familiar with the anatomy and physiology of the urogenital system, to be able to understand which structures are involved in the development of SUI, especially if childbirth has been ruled out.

The stress continence system anatomically consists of the urethral sphincteric closure system (USCS) and urethral support system (USS).(39) These systems have an active and a passive functioning at rest and during increased intra-abdominal pressure (IAP). Continence is maintained when the urethral closure pressure is higher than bladder pressure.(39) The urethral sphincter closure system maintains sustainable passive pressure in the urethra at rest. This pressure is determined by slow twitch striated and smooth muscle fibres and a sturdy mucosal-vascular core.(40–42)

All the extrinsic structures to the urethra provide a supportive layer. The anterior vagina, endopelvic fascia, arcus tendinous fasciae pelvis (ATFP) and the PFMs form the urethral support system.(6,39) The endopelvic fascia is a thick connective tissue layer that enfolds the vagina and attaches to the ATFP. The pubocervical fascia is located between the bladder and cervix, supporting the vagina, and assumed to be part of the supportive layer to the bladder.(43) The pubocervical fascia gives tensile strength to the vagina. The hypothesis that a lax vaginal wall contributes to SUI symptoms was tested by investigating the collagen content of the fascial tissue of the pubocervical fascia in patients operated on for genuine stress urinary incontinence (GSUI) and cystocele.(43) The results revealed a decrease in collagen content of the pubocervical fascia in incontinent females, but the collagen solubility or collagenase activity was no different in incontinent women and the controls that were operated on for cystocele. Incontinent women were compared with women that have bladder-vaginal prolapse. Women suffering with prolapse already have a decreased collagen content of the para-urethral ligaments compared to women that do not have prolapse.(44) It might have been better to have compared the incontinent women's collagen content to controls without UI or prolapse.

The Levator Ani (LA) portion of the PFMs consist of the pubococcygeus (PC), puborectalis (PR) and iliococcygeus (IC) muscles and attach to the fibrous ATFP.(39–41) In a passive state, the PFMs support the urethra by functioning at low levels of tone. It fulfils an active role by activating in anticipation of load.(45,46)

The endopelvic fascia and the LA muscles support the urethra functionally during periods of increased IAP. PFMs should co-activate with transverse abdominus and increase the

urethral pressure by tensing the endopelvic fascia and facilitate a co-contraction of the striated urethral sphincter muscles.(46,47) The urethra is compressed against the firm supportive layer under the bladder neck during increased IAP.(48) This decelerates the downward movement of the proximal urethra.(39,45) A correct PFM contraction further compresses the urethra in the opposite direction towards the pubic symphysis.(38) Effective muscle contraction and support protects the connective tissue from stress and elongation.(39)

The urethral function can be compared to an attempt to stop the flow of water in a garden hose by stepping on it. If the hose rests on a sturdy surface, stepping on it will narrow and close the lumen of the hose. If the hose rests on a compliant surface like a trampoline, stepping on it will deform the compliant surface and not close the lumen of the hose. Therefore there will be a delay in ceasing the flow of water.(39,41)

Muscle strength depends on the thickness and volume of the muscle fibres and a total number of firing neural motor units. Other factors that influence muscle strength are the joint angle, the relationship between muscle length and tension, the relationship between velocity and force and a metabolic component.(6) A muscle needs to be anchored well to function optimally.(48) Connective tissue sheaths around skeletal muscle provide the tensile strength of the muscle and aids in the loading of a muscle. A strength training regime attempts to improve these factors.(49) The aforementioned general muscle strength and function description is also applicable to PFM function in the pelvis. Intensive PFM training increases the structural support within the pelvis, stiffens the connective tissue and increases the motor firing, thus preventing pelvic floor (PF) decent during increased IAP.(49)

The LA muscle is a mixture of slow-twitch and fast-twitch fibres. Seventy percent (70%) of the peri-urethral fibres are slow-twitch and responsible for the maintenance of tone in the LA muscle and support the viscera during rest. The fast-twitch fibres are activated during a sudden increase in IAP and can only hold the muscle contraction for a short time.(38)

If the PFMs contracted individually, contraction would happen in a different direction due to muscle fibre alignment. Instead, the muscles function together to form one movement. The PFM contract against suspensory ligaments in three different directions.(48) The contraction is described as a squeeze and upward lift around the anus, vagina and urethra.(6) If the ligaments are lax, then optimal muscle function is not possible.(48)

The Knack, a PFM contraction that is activated by the cough reflex, compresses the urethra and urogenital structures in continent women. This reflex activation is not observed in SUI suffers. During an increase in IAP, the urethra and supportive structures were displaced

twice as far, with twice the velocity in incontinent women.(8) The reason for this displacement may be because of an underlying connective tissue problem or even laxity.

2.1.4 RISK FACTORS

Known risk factors for UI in adult females include age, parity, obesity, diabetes, stroke, smoking, depression, other urinary symptoms, high-impact physical activities, oestrogen deficiency, urogenital surgeries and certain psychotropic medication.(14) Injuries to the PF caused by pregnancy and vaginal deliveries are not risk factors in a nulliparous population.(24,35,50) Known risk factors of developing SUI in the adolescent population include obesity or high BMI, lung disease such as cystic fibrosis, neurological disturbances like spina bifida, childhood enuresis, constipation and athletic activities or high-impact exercise.(4,27,37,51,52) Another factor that have been associated with SUI in young nulliparous athletes are the inability to interrupt micturition.(23,25)

Obesity in children and adolescents has doubled over the past few decades.(53) UI is present in more than 12% of obese teenagers.(53) One of the management strategies of obesity requires the individual to participate in a training program (53) and improve on fitness as exercisers have a lower body mass index (BMI) than non-exercisers.(54)

Sports participation requires regular training that challenges the fitness threshold of each individual.(54) Numerous problems have developed in the female athlete. Irregular menstrual cycles, eating disorders, injuries, stress fractures and incontinence are increasing.(15,16,55) Athletes may even modify their technique or abandon the sport due to incontinence.(18,56) In the 70's only one in 27 girls took part in sports. Nowadays, one in three girls plays sports. This requires females to be stronger, fitter and more competitive than ever before.(55) UI could be a reason to demotivate further participation in sport.(3,4)

UI in sport has been under investigation over the past three decades. Great variation of UI prevalence rates are seen in different types of sport.(28,30) Women that participate in high-impact, frequent intensity training (HIFIT) are eight times more likely to suffer from incontinence (57) than sedentary women.(56,58) High-impact sports include repetitive jumping or landing and high-intensity training. Sports such as gymnastics, running, aerobics, netball, squash, tennis and basketball fall in this category. Gymnastics and ballet have the highest prevalence of SUI, followed by ball sports and long distance running.(28,30) Swimming and golf have the lowest UI prevalence.(30,49) The most popular activities to elicit incontinence episodes are running and jumping.(1,30) Trampoline is a division of gymnastics which has reported high UI prevalence of up to 80% during training. Results indicate that incontinent trampolinists only experienced UI during physical activity and not

during coughing, sneezing or laughing.(23) Elite trampolinists were compared to a recreational group, which train at lower levels.(24) Incontinent trampolinists were significantly older, trained for longer hours with more regular intervals and were unable to interrupt the urine flow.(24) High-intensity frequent interval training (HIFIT) athletes have greater bladder neck descent, larger hiatal areas on Valsalva manoeuvres and thicker pubovisceral muscles than non-athletes.(59) An increased risk of prolapse development and SUI symptoms are hypothesised, but minimal HIFIT athletes had SUI complaints. It has been hypothesised that the thicker musculature in the HIFIT group could support the urethral sphincter better and decrease SUI symptoms.

Young nulliparous women that report SUI only during athletic participation and not during activities of daily living (ADL), has prompted the use of a new term “athletic incontinence”.(60) Araujo et al. designed a schematic representation of the complex pathophysiology of “athletic incontinence” (Figure 2.1).(60)

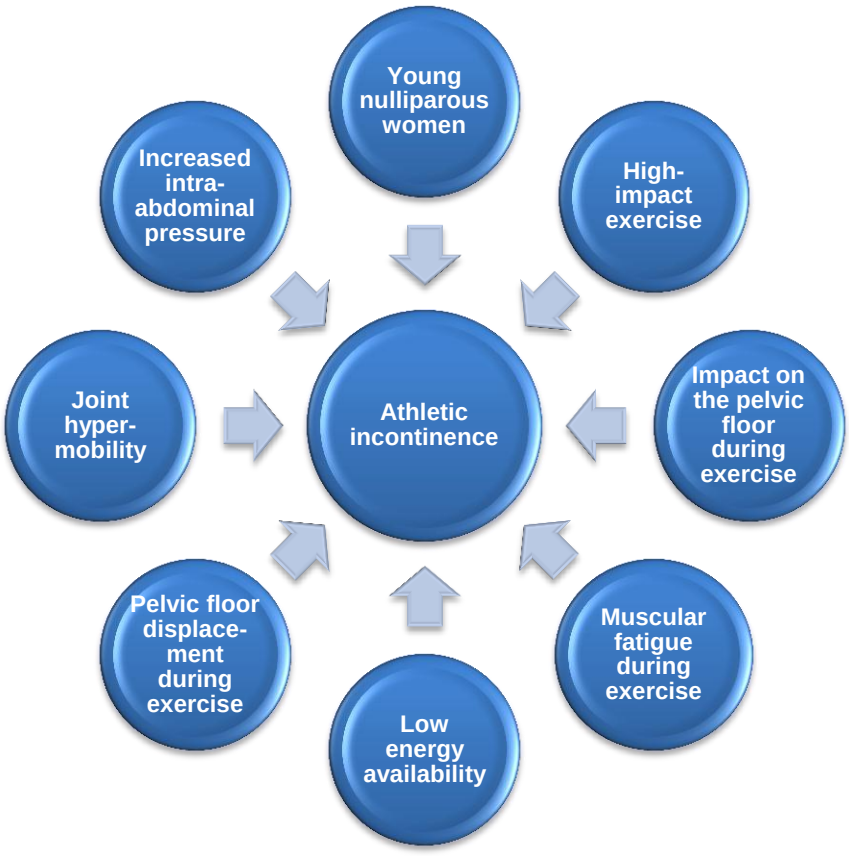

Figure 2.1: Pathophysiology of athletic incontinence adapted from Araujo.(60)

2.1.4.1 General joint hypermobility: a potential risk factor in adolescence

Connective tissue deficiency in the urogenital system has been hypothesised as the underlying reason for SUI in multiple studies.(6,39,41,43) Therefore, it is worth exploring the general laxity presence in females who suffer from SUI. BJHS and GJH has been described as possible risk factors in the development of incontinence in adults.(61–63) Hypermobility has been recognised especially in isolated SUI sufferers without an obvious cause.(64) In the UK, women with BJHS have a UI prevalence of 68%.(61–63)

GJH prevalence varies across race, gender and age (65) but the highest prevalence is found in females and young children.(66,67) Joint laxity decreases with age, (68) but females demonstrated more laxity during puberty than males. Hormonal changes during puberty seem to affect males and females differently.(69) Female laxity plateaued post-puberty.(70) Children have higher hypermobility scores than adults, but there is still no consensus regarding the cut-off score in children.(68) GJH prevalence in adolescents is 11.7%.(67) In an athletic adolescent group prevalence was 12.9%.(71) Female adolescent athletes demonstrated an increase in hypermobility compared to males during puberty. Prevalence also varies depending on the diagnostic tool used.(68) Clinical features of BJHS in children and adolescents are joint swelling, back pain, joint sprains, foot pain, anterior knee pain, dislocations, growing pains, sleep disturbances, joint stiffness, musculoskeletal pain and pain amplification.(72)

The classification of GJH differs from BJHS. GJH is the presence of more than normal joint movement and is normally hereditary.(73) GJH is diagnosed with a hypermobility criterion, the nine-point Beighton score. The BHJS is the identification of GJH with associated musculoskeletal symptoms. BJHS is diagnosed by the Brighton criteria.(66) GJH and BJHS are independent of inflammatory, neurological, and congenital or connective tissue disorders like Ehlers-Danlos or Marfan syndrome.(74) Hypermobility was originally described according to the five-point Carter and Wilkinson score developed in 1964. In 1973 a South African, P. Beighton, modified it to a nine-point scale. It is deemed a valid instrument for primary school children, adolescents and adults.(75,76) Intra-rater and interrater reliability for the overall Beighton scoring of zero to nine were 69% and 51% when using a goniometer and doing passive measurements in females aged 15-45 years.(70) A strict protocol was followed. Although the Beighton is found to be a valid and reliable diagnostic tool, the discrepancy in the cut-off score and misuse of the standardised protocol creates variable results in the literature that is incomparable to each other. There is a discrepancy between the dominant and non-dominant sides. The non-dominant side is usually more mobile, which may add to inconsistency if only one side of the body is measured. The original standardised

cut-off score for hypermobility of the Beighton score is 4/9 in adults but varies amongst studies.(68,76) In children under the age of 12 years, it is suggested that a cut-off score of 7/9 is used.(75) The cut-off score in adolescence is still undecided

The Beighton score categories for hypermobility in an adult population aged 15-45 years are (0-2) normal mobility, (3-4) increased mobility and (5-9) hypermobility. The intra-rater and interrater reliability for the category scores were 81% and 89%.(70) A standardised Beighton score protocol for children aged six years to 12 years was compiled in 2011.(75) Laxity is described according to three categories for children aged six to twelve years. Categories are classified as (0-4) normal ROM, (5-6) increased ROM, (7-9) hypermobile.(75) A cut-off score of 7/9 is recommended in Caucasian children six to 12 years.(75) The categories of the Beighton score in children differ from the categories used in adulthood, due to the higher value of the cut-off score in children. The cut-off score and categories in adolescence are still unclear.

The basic pathophysiology of GJH and BJHS is due to an underlying abnormality in collagen where the ratio of type III to type I collagen is increased.(76) This means that the fascia and collagen enriched tissue is more stretchable, and that the musculoskeletal system could also be affected. Type I collagen is the most common collagen in the human body. It is high in tensile strength and found in connective tissue of tendon, ligament, joint capsule, skin and nerve receptors. Type III collagen is found in the same tissue, but not in such abundance. BJHS and GJH sufferers have an increased amount of type III collagen.(61)

Joint stability requires functional active and passive structures to help protect the joint against injuries.(69) Ligaments, joint capsules and joint surface provide the passive support and muscles with the active component.(69) Adolescents are three times more likely to develop joint pain if GJH was present during childhood.(68)

Various case studies have reported a link between GJH and UI in young females.(51,64) A 20-year-old nulliparous female with MUI and constipation revealed that she used 10 incontinence pads daily. Video-urodynamics revealed that during a cough, the descent of the bladder base and hypermobility of the bladder neck led to stress incontinence. The patient was classified as hypermobile with a 7/9 Beighton score (64). The pubocervical fasciae (between bladder and vagina) of incontinent nulliparous women, has a diminished collagen content and may be the reason for weakness of the support of the bladder neck.(43)

A 15-year-old adolescent female with severe adolescent female stress urinary incontinence (SAFSUI) was investigated. SAFSUI is defined as: ”female adolescents between the ages of 12 and 17 years complaining of involuntary loss of urine multiple times each day during

normal activities or sneezing or coughing rather than during sporting activities".(51) Extensive ultrasound and other investigations were done, and revealed bladder neck descent accompanied with SUI. Diagnostic studies for urethral sphincter deficiency were not done. Numerous treatment options were unsuccessful, and surgery was performed inserting a sub-urethral synthetic tape. The connective tissue in the pelvis bowel, at the site of the lower urinary tract, was less stiff than deemed normal for an adult female.(51) Hypermobility testing was not done, and no mention of a hereditary connective tissue disorder was made.

Thirty-eight percent of nulliparous young female physical education students with a mean age of 19.9 years reported SUI. These students exercise at least 3 times per week as part of their curriculum. They participated in a 4-step study on UI. An interview, a clinical PF exam, urodynamics testing during exercise and needle electromyographic assessment of PFMs and the striated urethral wall muscles were included.(26) Age, BMI and PFM strength were not associated with SUI. BJHS was present in four of the seven SUI cases, but not in the asymptomatic control group. Needle electromyography determined that urethral sphincteric incompetence was associated with SUI.(26) The presence of hypermobility in the symptomatic group is worth further investigation. Urethral mobility, bladder neck decent and urogenital prolapse is associated with decreased connective tissue support (41) and not urethral sphincteric dysfunction, but connective tissue is present in the urethral sphincters and could possibly influence the functioning of the sphincter during increased pressure.(40,77)

Nulliparous athletes with a mean age of 28.5 years that participate in high-impact sport have thicker LA muscles and greater bladder neck descent on magnetic resonance imaging (MRI) than nulliparous women that do not exercise.(59) In this particular study three of 22 participants were classified as hypermobile (59), but a Beighton cut-off score of 6/9 was used instead of the validated 4/9. The number of hypermobile participants may have been higher.

In 1984 GJH prevalence in ballet dancers was 9.5%.(78) A study in 2004 reported prevalence results of 74%-94% (79) and in 2014 Sanches reported 57% (73). All three studies used 4/9 as the cut-off score for hypermobility according to the Beighton score. This dramatic difference may be due to growing requirements of the sport and stronger competition to perform well. Females that are naturally more flexible perform better and continue with participation in dance. Following a standardised Beighton protocol and using a goniometer for joint measurements may also influence the results.

Flexibility is a necessity in ballet (80), but the benefits of hypermobility remain unclear. Due to the demand on the muscular system, hypermobility could be regarded as a liability.(81) More dynamic processes are required to maintain joint stability in GJH dancers. GJH presence has been associated with musculoskeletal complaints, which included pain and fatigue, and lower physical fitness when ballet dancers with GJH were compared to ballet dancers without GJH.(73) The group of ballet dancers (with and without GJH) were also compared with the general public and even if GJH was present, the ballet dancers were still stronger than the controls from the general public.(73) This also states that although GJH is present with the possibility of joint pain, it is still better to continue with an exercise programme.(82) Therefore GJH may influence muscle function by increasing musculoskeletal complaints like pain and fatigue. PFMs may then re-act the same in the presence of GJH.

2.1.5 PELVIC FLOOR MUSCLE FUNCTION IN NULLIPAROUS ATHLETES

PFM function, strength and flexibility are difficult to assess in adolescents. Internal assessments are not traditionally performed in females that are not sexually active. Therefore, limited information is available about adolescent PFM function. The closest population to compare with is nulliparous young females.

Factors involved in the mechanism of SUI include: urethral function, urethrovaginal support and an increase in bladder pressure e.g. a cough or strenuous activity.(40) The urethral function is influenced by the yearly loss of 1%-10% of striated muscle fibre in the urethra of females, (39,40,77) which explains SUI in later life but not in younger years. Urethrovaginal support includes the visceral components, connective tissue and supportive PF musculature. Minimal damage to the PF and urogenital structures is expected in a nulliparous population. High-impact sport increases IAP and bladder pressure, which leads to an alteration in PF morphology and function.(59)

In studies of continent versus incontinent and nulliparous versus parous females, cross-sectional areas of PFMs were measured with MRI. PFMs measurements were thicker in the continent and nulliparous participants than in incontinent and parous participants.(83,84) It is expected that continent, nulliparous participants should have more muscle girth, power and effective muscle function than the symptomatic comparison groups. Two theories exist about the effect of impact on PFM support. The PFM is stimulated by regular impact and strengthens as a result of regular muscle contraction, or the chronic impact weakens and stretches the PFMs and connective tissue.(6) MRI investigations revealed that athletes also presented with higher diameter measurements of PFM than non-athletes.(59,84) This confirms the theory that impact through sport could contribute to muscle strength.

Pubovesical thickness was measured on MRI of the continent and incontinent football players. Incontinent footballers produced thicker pubovisceral (pubococcygeus) muscle measurements than continent football players. There was no difference in muscle power or PFM displacement during a contraction.(85) Thicker muscle mass is associated with increased muscle power, (49) but this football sample concludes a different hypothesis. Although there is a difference in muscle thickness, muscle power is similar in the two athletic groups. This may suggest that SUI is associated with a decrease in muscle reaction time, rather than decreased power. Maybe the pubovisceral muscle tries to compensate for the delayed reaction time by increasing muscle tone. This could create a shorter, less flexible muscle over a prolonged period. Footballers and athletes also had a discrepancy between the left and right muscles.(84,85) Computer simulation was used to assess the displacement of the PFMs during a contraction, but computer reproduction of the female pelvis still needs some refinement in future studies and could be the reason why no difference was observed between the two groups.(85) Displacement and translation of PFMs gives a better indication of function and urethral support, not muscle power. It also gives insight into muscle contractibility and flexibility. Ultrasound investigation is frequently used for this investigation.

Athletes are more frequently exposed to increases in IAP than sedentary women and need more PFM strength in order to support the urethra.(49) PFM exercises have been proven effective treatment in SUI.(7,38,49) Treatment may be effective as: 1) women learn to consciously use their PFM before and during increased IAP or 2) strengthening improves muscle volume creating more support or 3) abdominal muscle training indirectly adds to PFM strength.(49) PFM contraction can consciously be used pre- or during increased IAP. This is termed “The Knack”.(8,49) The Knack is a technique to support the urethral sphincter and bladder neck thus reducing SUI.(6,8)

An eight-week pelvic floor muscle treatment (PFMRx) protocol had a significant improvement in vaginal resting pressure (VRP), maximum voluntary contraction (MVC) and UI severity scores of nulliparous sports students with UI symptoms.(7) The best treatment programme for PFM rehabilitation is still undecided and needs to be a custom design for the patient’s needs.

Nulliparous young women (mean age 24 years) who suffer from SUI present with PFM fatigue during physical exercise.(86) Exercises like pilates, which do not specifically include PFM exercises, do not decrease the effect of SUI.(9) The contraction of large group muscles like the gluteal, hip adductors and abdominals creates a co-contraction of the PFM and can be used in conjunction with PFM contraction to aid in rehabilitation.(49) We argue that PFM

in athletes needs to be stronger with greater endurance than normal to counteract the increased IAP created during exercise.

Most athletes still do not leak urine, despite vertical ground forces being as high as 14 times bodyweight during physical activities.(49) It is possibly due to inherited and individual differences of anatomy, connective tissue, muscle function and neural input that cause some athletes to have UI.(6) The investigation into nulliparous athletic incontinence may benefit from more detailed assessment tools, to evaluate the all different dynamics involved in order to form a better diagnosis.

2.1.5.1 Computer simulation of a jump

Manual, internal PF assessment is a challenge in adolescence. Other diagnostic tools, like ultrasound imaging, are used. These assessments can become costly. It is necessary to explore less invasive and effective assessment tools.

It is important to not add stress and discomfort to investigations in adolescents who present with an embarrassing problem. Transperineal ultrasound was recommended in adolescents who are virgins and have no history of tampon usage.(51)

Several computer simulation models have been developed to study incontinence. Computer simulation is an advanced modelling tool used to evaluate the dynamics of the internal pelvic floor, especially during athletic activities.(87) High-resolution reconstructed MR-images are used to investigate processes that are difficult to observe with traditional techniques. Investigations are based on a healthy example; in this case, a pelvic model of a healthy nulliparous young female and then modifications and simulations are made by the computer.(87)

Jumping is the activity reported by sportswomen to induce SUI.(23,30,88) The effect of a jump on the female pelvis was simulated by the computer.(89) Analysis of the biomechanical responses of the pelvis during jumping revealed a difference between the anterior and the posterior part of the pelvis. The computer simulation revealed that the displacement of the posterior pelvis (sacrum, ilium and pelvic diaphragm) was much larger than the anterior pelvis (pubis, ischium and urogenital diaphragm). This difference caused the opening and slight funnelling of the urethra which relates to UI. An increase in jump height, not bladder volume, was associated with greater urine volume loss.(89)

In another computer study of SUI, the urethral mobility and PF deformation was assessed during a jump-land and during a Valsalva manoeuvre in a standard, supine PF assessment position.(87) Simulating weakening and strengthening of the LA muscles, the effect on

urethral mobility was assessed. Urethral mobility was only slightly altered by different degrees of LA muscle support. Pelvic structures moved in an antero-posterior direction during a jump-land demonstration and infero-posterior during a Valsalva manoeuvre. The IAP created during a Valsalva is less than during a jump-land simulation. The limited effect on urethral mobility with tightening and weakening of the LA muscle, the different direction of PF deformation during a jump-land and Valsalva and a difference in IAP between jump-land and Valsalva should be considered when routine PF assessments are done in a Valsalva position. When clinical assessments are done in active sporting women, these factors should be considered.

In search of new treatment strategies for SUI, Delancey (40) investigated the causal factors of SUI; urethral mobility and urethral sphincter function. Urethral mobility has been associated with SUI, but in this study maximal urethral closure pressure and not urethral support was the predominant factor associated with SUI.(40) Computer simulation also found that urethral hypermobility has less impact on the presentation of SUI and it is rather the urethral sphincteric system that is unable to handle increased load from IAP during a jump-land. The pressure thus exceeds the capability of the urethral sphincteric closure system. It may explain why most athletes only leak during athletic participation and not during ADLs.(39,87)

The effects of high-impact sports on the PF structures have been investigated. The effect of the constant increased IAP adds strain to the urogenital system and often creates incontinence. Although adolescent athletes in the various sports are exposed to the same increased pressure and loading, some athletes leak urine while most are still continent. Which factors distinguish these continent and incontinent athletes, in the same environment, from each other? Gymnastics and ballet have the highest flexibility requirements and also the highest incontinence prevalence. The constant reference to connective tissue deficiency in SUI raises the question of a potential link between the presence of a general connective tissue laxity and SUI. There is also an associated muscle weakness in the presence of joint laxity that could create less support of the urogenital system. These factors initiated my research question: “Does general joint hypermobility predispose female adolescent gymnasts to stress urinary incontinence?”

CHAPTER 3:

STRESS URINARY INCONTINENCE IN ADOLESCENT GYMNASTS AND THE PRESENCE OF GENERAL JOINT HYPERMOBILITY

3.1 INTRODUCTION

Great variation in the prevalence of SUI in nulliparous athletes has been reported. Prevalence varies from 0% to 80%.(1,12,23,24,28,30,32) Gymnasts and ballet dancers have the highest prevalence.(23,28) Although sportswomen presenting with SUI often report incontinence during their teenage years, (6) UI in adolescence athletes has not been widely described in the literature. In a generalised adolescent population SUI prevalence is 7.2%-22% and UUI 3.4%-17%.(27,35,36) Prevalence rates of SUI in adolescent athletes in South Africa are unknown.

SUI is demonstrated due to dysfunctional anatomical structures, which can be divided into a sphincter and support system. The urethral sphincters and bladder neck maintain the closure pressure of the urethra. The urethra is compressed against the firm supportive system, between urethra and vagina, during periods of increased IAP. The urethral wall and the support system include layers of connective tissue.(39) It has been hypothesised that high-impact training could result in connective tissue or muscle biomechanical insufficiency, which can increase bladder neck mobility.(59,90,91) Bø (12) hypothesised that strenuous activity may promote incontinence in women who are already at risk, like those with BJHS, which is a connective tissue phenomenon associated with GJH.(63)

Women in the UK diagnosed with BJHS have a higher prevalence of UI than women without BJHS.(63) GJH is a hereditary connective tissue condition and not acquired. It is an entity on its own, free from inflammatory, neurological or congenital disorders.(67) Joint hypermobility potentially has different forms of clinical presentation in young people.(72) The ratio of Type I to Type III collagen is increased in hypermobility syndromes. Type I collagen is the most common form of collagen found in the body and has high tensile strength. Type III is the thinner, more elastic type found in the vascular system, skin, and lungs. Hypermobility patients have an increased presence of Type III collagen throughout the body.(59,61)

The reported prevalence of GJH varies depending on the age, gender, race and hypermobility assessment tools used.(79,80,92,93) Adolescent hypermobility prevalence range from 11.7%-13.4% (65,67,71) to 27.5%–53%.(75,93,94) The reported variation is ascribed to the Beighton score protocol used and what measure was used as the cut-off

score. Gymnasts and ballerinas regard GJH as an asset due to the enhanced flexibility it affords them, and have a tendency to perform well in the sport.(59)

Numerous conditions unique to the sport of gymnastics have been linked to SUI. Repetitive high-impact activities have been associated with higher incidence of SUI.(56,58) The association is understandable as the maximum vertical ground reaction force is three to four times bodyweight during running, five to 12 times for jumping, nine times in landing from a front somersault and 14 times for landing a double-back somersault.(95)

Physically fit women raise their IAP more than sedentary women and it is debatable if the impact of strenuous forces on the PFMs might: 1) strengthen the PFMs or 2) weaken and stretch the PFMs.(6,26,49) Many women do not demonstrate an effective simultaneous or pre-contraction of the PFM during increased abdominal pressure. In nulliparous women, this may be due to hereditary weak connective tissue or PFM dysfunction.(6) Mechanisms of force absorption in the body may be a potential reason for SUI.(12) It has been hypothesised that changes to the PFM can occur as a result of high-impact sport which may result in SUI. Changes include PFM fatigue, a change in collagen content and perineal connective tissue damage by repetitive increased abdominal pressure.(22,86,88) Women presenting with SUI symptoms have demonstrated weaker PFM strength than women without SUI. (86)

In addition to repetitive high-impact activities, actual jump heights (89) and training volume have also been associated with incontinence severity.(88) The gold standard manner of measuring incontinence severity is by pad-weighing. The ISI and ICIQ-SF are questionnaires that have been validated against the gold standard testing.(96) Incontinence severity was self-classified in young nulliparous trampolinists as “moderate” by using the ICIQ-SF.(88) In a young nulliparous group of trampolinists, the average leakage was measured at 28 g during a training session.(23) Another nulliparous group, matched for sport, experienced an average of 12 g of UI after 45 min of strenuous exercise. The ISI severity categories were compared against the gold standard test. Slight incontinence equalled 6 g of UI in the pad, moderate incontinence 23 g, severe 52 g and very severe 122 g.(97) It seems that most trampolinists experienced moderate incontinence. No severity has been determined for gymnasts in South Africa.

Taking part in sports forms part of a healthy lifestyle and more than 40% of high school girls are actively participating in sport. Although SUI is present in young women, more than 90% never report the symptoms.(1) Describing the potential risk factors for the development of SUI in the young active population could create awareness about SUI and present information on the available treatment.

Considering all these factors, the aim of this paper is thus to describe the prevalence, severity and risk factors of SUI in the female adolescent gymnastic population and to determine if GJH is a risk factor for SUI.

3.2 METHODOLOGY

3.2.1 STUDY DESIGN

An analytical cross-sectional study design was performed.

3.2.2 RESEARCH SETTING

The Western Cape Gymnastic Association (WCGA) is the governing body of gymnastics in the Western Cape and serves its five geographical areas. The Cape Town District is managed by the Cape Town Gymnastics Association (CTGA) and is known as the Cape Metropole. The Cape Metropole is geographically divided into eight districts and has 55 registered clubs (Addendum A1) eligible to compete in national championships. Community clubs were not included. Four forms of the 10 disciplines of gymnastics are represented in this study (Addendum A02). Gymnastics skill progression is done according to the junior Olympic levels from one to 10.

3.2.3 RESEARCH TEAM

The primary investigator (PI) is a trained physiotherapist in the field of women's health and has nine years clinical experience in this area. Three physiotherapy research assistants (RA) were involved in the data collection phase. RA1 delivered a standardised explanation of the stations (Addendum H3), screened the eligibility criteria (Addendum H2), completed the adolescent informed consent (Addendum D2) and gave the participants an A5 booklet with their unique number at station one. RA2 supervised the incontinence severity index (ISI) (Addendum K1) and the self-compiled questionnaire (Addendum K2) at station three. RA3 manned the fourth station; assessed the A5 booklet (Addendum H1), identified participants that had UI symptoms, handed out the goody bags (Addendum C1 – C4) and placed the data collection information in a sealed box. The PI always performed the Beighton score protocol (Addendum J1) and weight and height measurements (Addendum J2) at station two. The study procedure was tested in a pilot study (Addendum G1-G5) and meticulously followed at each gymnastic club. A statistician was consulted regarding the design of the study, sample size calculation (Addendum A3), setting up of data management system and statistical analysis of data.

3.2.4 ETHICAL CONSIDERATIONS

The project was registered with the Health Ethics Research Committee (S15/05/112) (Addendum B3.) Parental assent was not attained for all the participants and the ethics committee granted a waiver for parental assent. (Addendum B4)

The WCGA agreed via email that the PI may contact the individual clubs. Each club that eventually agreed to participate in the study, received a customised information package (Addendum B1, B2, B3).

All communication and consent forms were in English and Afrikaans. There were no Xhosa participants. An information package (Addendum D1 –D3) was compiled for the club members prior to data collection, citing the aim, date and time of the "Incontinence Awareness Day" and included parental consent. The club representative was requested to send the information package to the members. Unfortunately, only one club seemed to have adhered to this request.

On the scheduled club "Incontinence Awareness Day" a brief information session was presented to the gymnasts prior to the training session (Addendum E). Confidentiality of information, right to withdraw at any time, basic anatomy, incontinence and GJH information was discussed in the information session. After the information session, a numbered list (Addendum F) was available for the gymnasts to write down their names if they wished to participate in the study. The "Participant information leaflet and assent forms" and the "Participant information leaflet and consent form for use by parents/legal guardians" were also available (Addendum D2, 3).

The information of each participant, with their specific number, was kept in a sealed box until the data was entered on a password-protected computer.

Study participants received a goody bag at the final station (Addendum C1-C4). All participants received free SUI and GJH (Addendum C2) information. This goody bag also contained contact details of medical professionals (Addendum C3-C4) who could deal with UI and GJH problems. Participants with SUI were identified at the final station. The therapist also explained where to seek help. The "participant information leaflet and consent form for use by parents/ legal guardians" (Addendum D3) was also in the goody bag.

Informed consent was attained from all 67 adolescent participants (Addendum D2) prior to data collection.

I declare that there is no conflict of interest in this study. The Ethical and Good Clinical Practice Guidelines of the World Medical Association Declaration of Helsinki (2004), as well as the National Health Act, 2003 (Act No 61 of 2003), was adhered to at all times.

3.2.5 POPULATION

Female adolescent gymnasts aged 11 to 19 years, who were present on the data collection day, at the selected gymnastic clubs in the Cape Town Metropole, between May 2016 and October 2016.

3.2.6 SAMPLING

Participants were recruited in a two-phased approach 1) Club selection and 2) Individual selection.

3.2.7 RECRUITMENT PROCEDURE

3.2.7.1 PHASE 1: Club selection

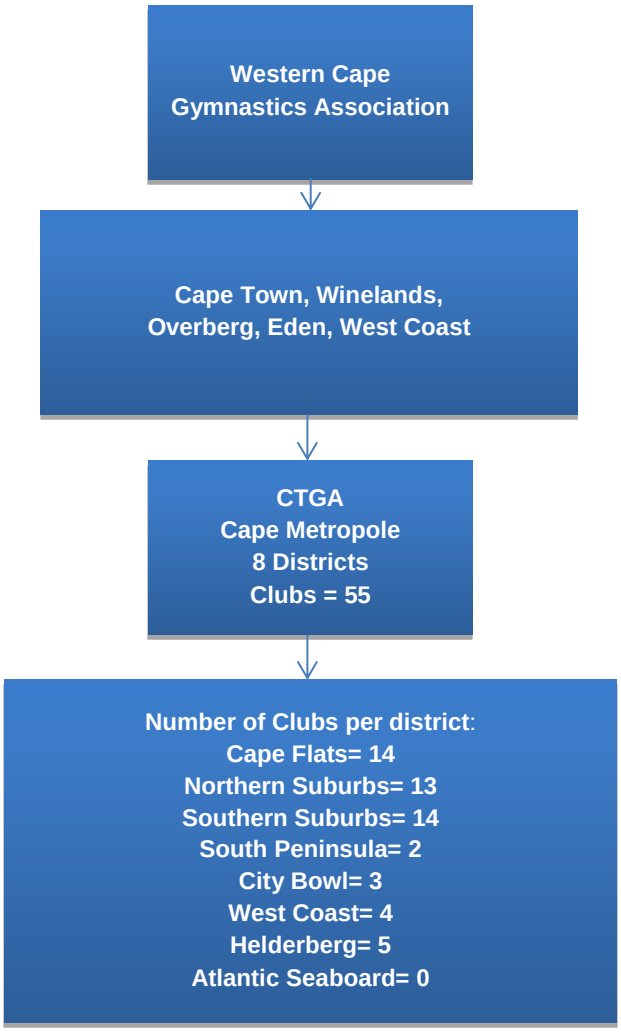

Figure 3.1: Selection process of the gymnastic clubs

The list of CTMG clubs was retrieved from the WCGA website. The 55 gymnastic clubs were divided into eight geographic clusters (Figure 3.1) based on the area in which they operate (Addendum A1). The names of the clubs were placed in seven different opaque envelopes

(based on the cluster; one cluster had no selected clubs). One club was randomly selected from each cluster by pulling a name from the envelope by the PI. The chairperson/manager/owner of each selected club was contacted. If the club could not be reached or included in the study, another name was pulled from the same cluster envelope. A response period of two weeks was set. A minimum of three telephone calls and three emails were made to each contact person. If no response, or if the email returned undelivered, the next club was selected. This did not exclude a gymnastic club's participation, if the club decided to participate at a later stage. Gymnastic clubs with more than five female adolescent gymnasts between the ages of 11 and 19 years were eligible for inclusion. Clubs were excluded if they only had male members; child gymnasts younger than 11 years; only offered "Gym for all" classes or were community gymnastic clubs. Random selection continued until there were seven gymnastic clubs included in the first phase of this study (Addendum A2). Unfortunately, it was not possible for one club from each district to take part. Due to time and financial constraints, the study was stopped after the first phase.

3.2.7.2 PHASE 2: Individual selection: Incontinence Awareness Day

Data collection dates and times were aligned with normal training sessions offered at the club. All female adolescent (11 – 19 years) gymnasts in the Cape Town Metropole were eligible for inclusion. Participants were excluded according to the eligibility criteria (Addendum H2) at the first station.

3.2.8 INSTRUMENTATION

3.2.8.1 The Incontinence Severity Index

(Addendum K1)

The Incontinence Severity Index (ISI) was developed by Hogne Sandvik.(98) This four-level index was developed as an easy tool to identify the severity of UI in epidemiological studies. The ISI uses "frequency of urine loss" and "volume of urine loss" to measure the severity of incontinence.(96,98,99) It has been validated against the gold standard pad weighing test in older populations, not in adolescence.(99) The use of the ISI is financially more effective and less time-consuming in epidemiological studies than the pad weighing test.

The ISI consists of only two questions and depending on the answer, the score combination gives the severity category.

In 2000 Sandvik (97) recommended adding a "0" to the ISI for statistical purposes and for follow-up studies when patients become continent. The use of a "0" was added to this study. The absence of incontinence is scored by numerical number zero. Participants that score a

"0" are seen as "continent" and a score of more than "1" indicates incontinence. In this study, the ISI was available in English and Afrikaans.

3.2.8.2 The Beighton Hypermobility Score Protocol

(Addendum J1)

GJH is classified by the Beighton score (P Beighton).(100) A standardised Beighton score protocol described by Smith-Engelsman was followed.(75)

This scoring system has been validated in multiple populations and age groups and used in epidemiological studies.(100) Smith-Engelsman (75) found it a valid instrument in children age six-12 years of age. It is easy and quick to perform with a large group of people. Four of the five movements are passive joint measurements.

Controversy exists regarding the interpretation of the Beighton score.(75) In this study, a cut-off score of five (GJH5) was used to classify participants as having GJH. It is hypothesised that GHJ4 is an over diagnosis of hypermobility.

3.2.8.3 Self-compiled questionnaire

(Addendum K2)

The questionnaire consisted of twenty questions. The content was based on reviewed literature (Chapter 2). The purpose of this questionnaire was to determine the demographics and gymnastic information of this adolescent population.

MUI was formulated if a participant had a combination of stress and UUI symptoms. SUI was divided into two questions:

"Do you leak urine when you cough, sneeze or laugh?" and

"Do you leak urine during gymnastic training?"

In order to gain some information regarding the strength of the PFMs, the participants were asked if they could stop the stream of urinary flow during micturition. Help-seeking behaviour in the adolescent population was also investigated, by enquiring if participants have ever seen a medical professional for their UI problems.

3.2.9 STUDY PROCEDURE

Participants completed four manned stations in chronological order. A volunteer from each club called the gymnasts from the list of names during training. A manual goniometer was

used to measure and record the joint range of movement in the Beighton score according to the Beighton protocol. The Beighton score was purposefully completed prior to the questionnaires to minimise bias. All the questionnaire answers were self-identified and self-classified. Participants were not allowed to communicate with each other, only with the research team.

3.2.10 DATA ANALYSIS

Data were analysed in consultation with a statistician. Stata version 13 was used to analyse the data. Descriptive analysis entailed frequency tables for categorical variables, reporting percentages in each category. Summary statistics such as mean and standard deviation or median and inter-quartile range were calculated for quantitative variables. Prevalence was reported as percentage and 95% confidence interval. Severity was reported as the ISI. Hypermobility was reported as the Beighton score.

A p-value <0.05 indicates statistical significance. Participants with the outcome (UI) and without the outcome were compared with regards to the exposure of interest and various confounding factors initially using univariate logistic regression analyses, t-tests for normally distributed predictors, and chi-square tests for categorical predictors. Those predictors showing an association with outcome/no outcome status at p<0.1 were selected as independent variables in a multivariate logistic regression analysis. Backward selection based on likelihood ratios was used to arrive at a final model of statistically significant predictors. The exposure of interest was thrown out of the model. Odds ratios and 95% confidence intervals were reported.

3.3 RESULTS

3.3.1 CLUB PARTICIPATION

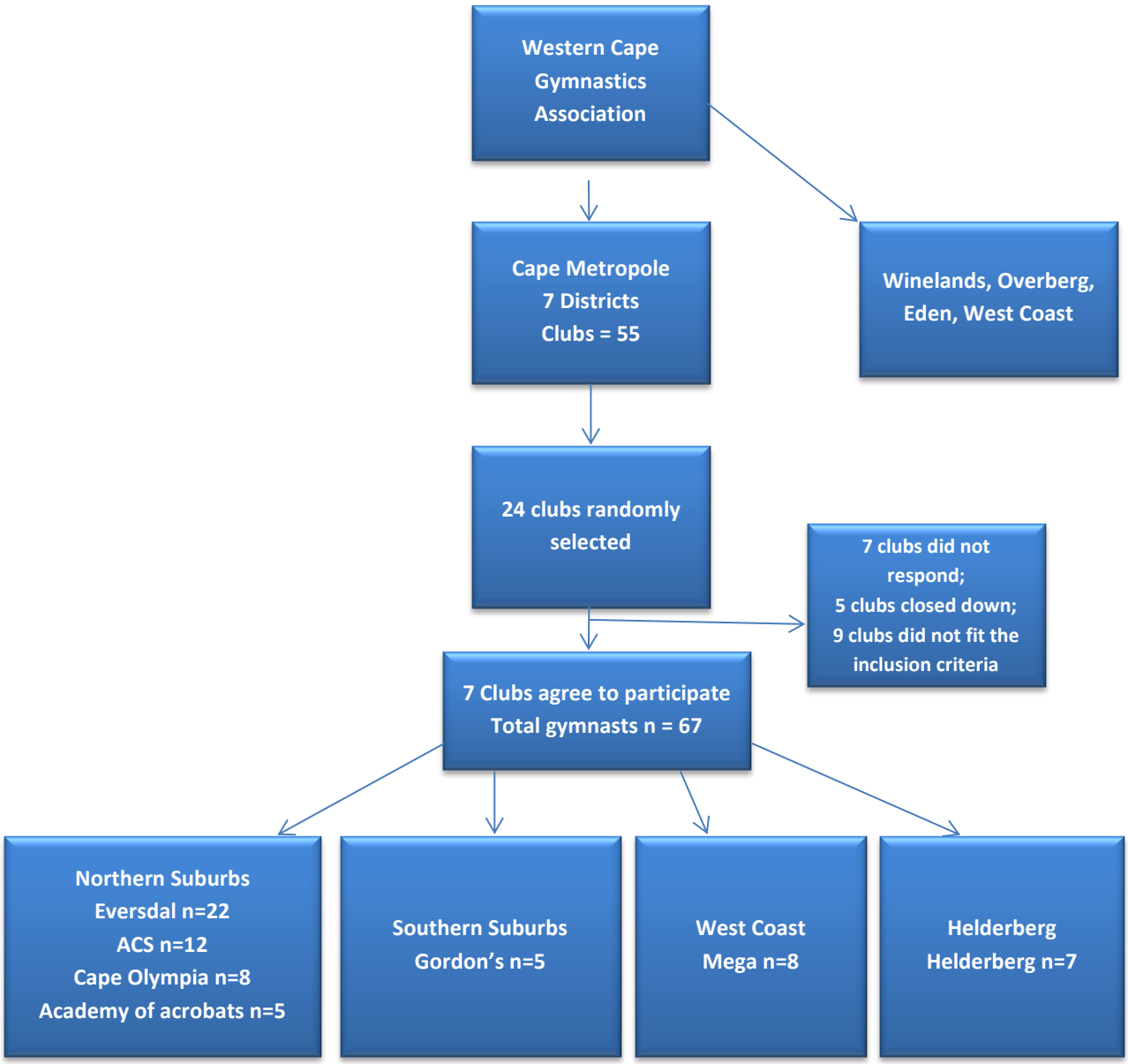

Figure 3.2: Selection proses of club participation and individual participation

The majority of gymnastic club managers and coaches are involved with gymnastics as an additional work commitment. This made initial contact and scheduling data collection dates problematic. Twenty-four clubs (Figure 3.2.) were randomly selected and only seven clubs agreed to participate. Seven clubs did not respond to requests, five closed down and nine did not fit the inclusion criteria.

The clubs in the Northern suburbs formed the largest geographical cluster (52.2%). The South Peninsula, Atlantic Seaboard, City Bowl and Cape Flats districts were not represented.

3.3.2 INDIVIDUAL PARTICIPATION

Sixty-seven adolescent gymnasts were recruited for this study. All 11-19 year old female adolescent gymnasts, who were present at the various clubs on the allocated data collection day, voluntarily participated. There were no exclusions.

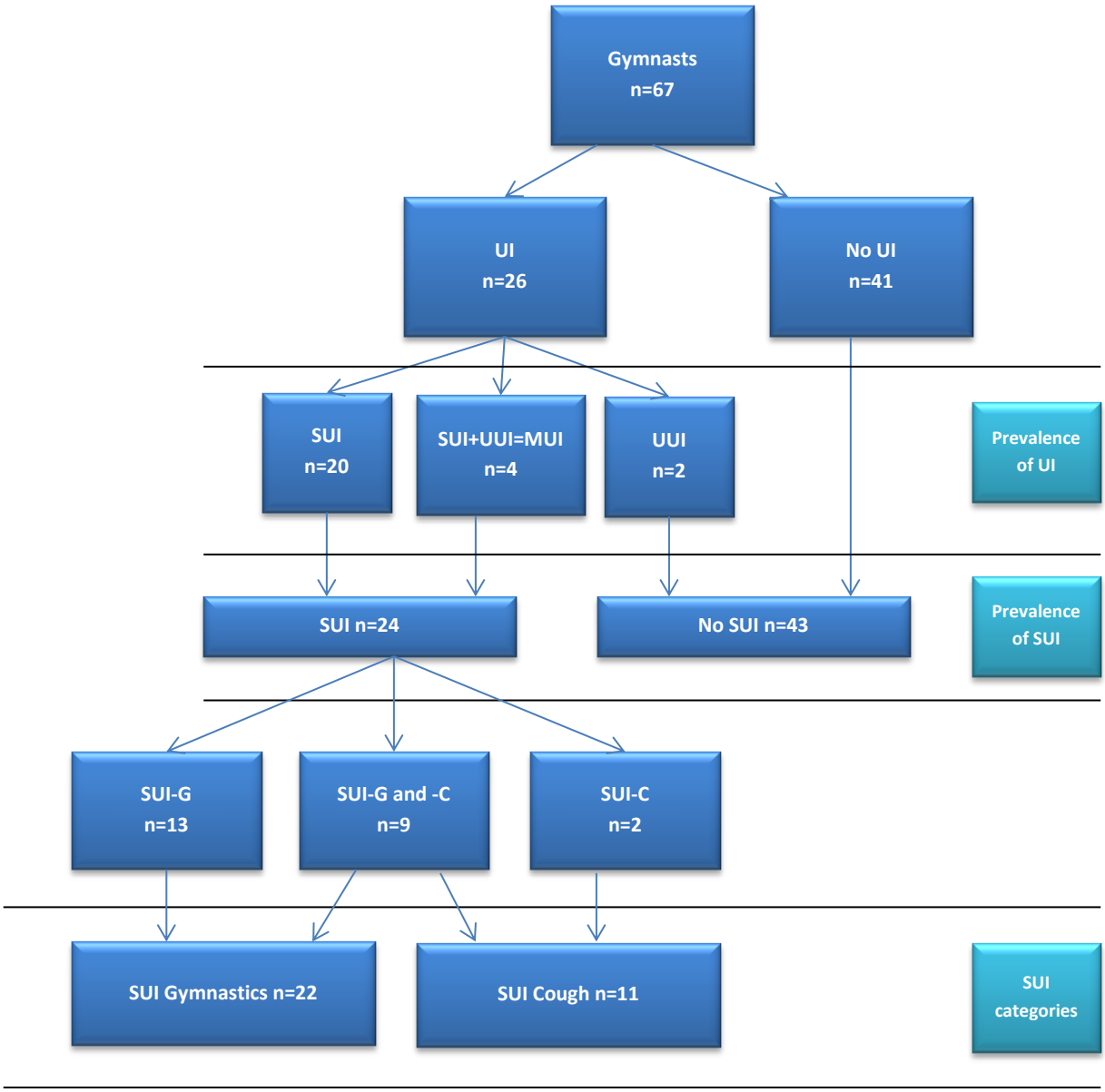

Figure 3.3: Urinary incontinence prevalence in adolescent gymnasts

Twenty-six (38.81% 95% CI [27.38%–51.52%]) female adolescent gymnasts reported signs of UI (Figure 3.3). The majority of adolescents identified with SUI (35.82% 95% CI [24.74% –

48.53%]) and it seems particularly problematic during gymnastic training (32.80%). Six (8.96% 95%CI [3.69% – 19.12%]) participants struggled with UUI.

The characteristics of female adolescent gymnasts presenting with SUI compared with No SUI are summarised in Table 3.1.

Table 3.1: Demographic and anthropology characteristics of female adolescent gymnasts with SUI

			G[7]	SUI				NO SUI				
			n	n	%	mean	SD	n	%	mean	SD	p
Demo[1]	Age[2]		66	24		14.54	2.52	42		13.24	1.89	0.02
	Race	Caucasian	59	22	37.30%			37	62.70%			0.50
		Coloured	8	2	25%			6	75%			
Anthro[3]	BMI[4]		67	24		20.33	2.51	43		19.91	2.67	0.53
	Beighton[5]	Mean	67	24		3.92	2.43	43		3.44	2.28	0.43
		≥5	26	11	42.30%			15	57.70%			0.38
		<5	41	13	31.70%			28	68.30%			
	Ligament[6]		30	13	43.30%			17	56.70%			0.25

[1] = Demographics
[2] = Age in years
[3] = Anthropology
[4] = Body Mass Index
[5] = Beighton Score
[6] = Regular ligament injuries
[7] = Gymnasts

Adolescents presenting with SUI (Table 3.1) were older (p=0.02). Body mass index BMI (p=0.53) and race (p=0.50) had no effect on the presence of SUI, but more than a third of Caucasian gymnasts had SUI symptoms. BMI averages in both groups fell in the normal category for BMI classification.

Some gymnasts compete in more than one form of gymnastics (Table 3.2). Women's artistic gymnastics is the most popular with the highest number of participants. Participants are 8 times more likely to develop SUI when taking part in trampoline gymnastics (OR 8 95% CI [1.91-33.60]). Most adolescents were levels 6 and 8 gymnasts, but none elite. Great variation was observed in the training schedules, but there was no difference in the proportion of athletes presenting with SUI. Most participants experienced SUI when jumping (p≤0.001) (Table 3.3).

Table 3.2: Gymnastic information of female adolescent gymnasts with SUI

	GYMNASTS	SUI		NO SUI		
Gymnastics	**n**	**n**	**%**	**n**	**%**	**p**
Types of gymnastics	84					
Acrobatic dance	5	1	20.0%	4	80.0%	0.65
Rhythmic gymnastics	8	2	25.0%	6	75.0%	0.50
Tumble	13	7	53.8%	6	46.2%	0.13
Trampoline	12	9	75.0%	3	25.0%	0.002
Women's artistic	46	15	32.6%	31	67.4%	0.42
Gym training days[a]						0.61
1-2	7	3	42.9%	4	57.1%	
2-3	10	4	40.0%	6	60.0%	
3-4	24	9	37.5%	15	62.5%	
4-5	20	5	25.0%	15	75.0%	
≥6	6	3	50.0%	3	50.0%	
Gym training hours[b]						0.61
1-2	18	3	16.7%	15	83.3%	
2-3	27	15	55.6%	12	44.4%	
3-4	20	5	25.0%	15	75.0%	
4-5	2	1	50.0%	1	50.0%	
Gym training years[c]						0.82
1-2	5	1	20.0%	4	80.0%	
3-5	15	7	46.7%	8	53.3%	
6-7	19	5	26.3%	14	73.7%	
≥8	28	11	39.3%	17	60.7%	
Gym level[d]						0.85
1	0	0	0.0%	0	0.0%	
2	1	1	100.0%	0	0.0%	
3	3	1	33.3%	2	66.7%	
4	7	4	57.1%	3	42.9%	
5	11	1	9.1%	10	90.9%	
6	21	9	42.9%	12	57.1%	
7	7	1	14.3%	6	85.7%	
8	13	3	23.1%	10	76.9%	
9	0	0	0.0%	0	0.0%	
10	4	4	100.0%	0	0.0%	

[a]=gymnastic training hours per day
[b]=gymnastic training days per week
[c]=gymnastic training years in total
[d]= gymnastics competition level

Table 3.3: Activities that may cause an incontinence episode

Activity	Gymnasts with SUI	p
jump	17	<0.001
run	4	0.01
tumble	2	0.13
trampoline	9	<0.001
dismount/land	4	0.01
vault	0	0
split	3	0.13
other	1	0.36

Table 3.4: Severity of incontinence experienced by adolescent gymnasts

Incontinence Severity Index (ISI)						
Type of UI	**(n) Incontinence**	**%**	**median**	**I.Q.R.**	**severity category**	**p**
UI[e]	26	38.8%	2	1.0-4.0	slight	<0.001
SUI[f]	24	35.8%	2	1.0-4.0	slight	<0.001
SUI-G[g]	22	32.8%	2	1.0-4.0	slight	<0.001
SUI-C[h]	11	16.4%	3	1.0-4.0	moderate	<0.001
UUI[i]	6	9.0%	2	1.0-8.0	slight	0.026
MUI[j]	4	6.00%	5	2.0-8.5	moderate	0.002

[e]=Urinary Incontinence
[f]=Stress Urinary Incontinence
[g]=Stress Urinary Incontinence during gymnastics
[h]=Stress Urinary Incontinence when coughing and sneezing
[i]=Urge Urinary Incontinence
[j]=Mixed Urinary Incontinence

The numerical number “0”, indicating continence, was added to the ISI for this study. With this in mind, this ISI is sensitive enough to distinguish between incontinence and continence (Table 3.4) in this adolescent group (p≤0.001). It is also sensitive enough to distinguish the severity amongst different types of incontinence (Table 3.4) [SUI (p<0.001), MUI (p=0.002), and UUI (p=0.026)]. The ISI is thus a good tool to use to assess severity.

Table 3.5: Incorrect completion of question by adolescent gymnasts

No	Candidate	ISI score	SUI-C	SUI-G	UUI	Activity (table5)
1	A	1	no	no	no	split
2	B	1	no	no	no	jump, trampoline
3	C	1	no	no	no	NA
4	D	1	no	no	no	NA
5	E	1	no	no	no	jump
6	F	1	no	no	no	NA
7	G	1	no	no	yes	NA

Thirty-one (31) participants (Table 3.5) completed the ISI as if experiencing urinary leakage (only 26 UI). Six of the 31 participants experienced “slight incontinence”; whilst denying any incontinence. Three of these six participants also identified with activities that were likely to cause urine loss. Another participant admitted urging incontinence and scored “0” in the ISI (indicating no involuntary urinary loss).

Table 3.6: Other possible risk factors of UI

		UI n=26		NO UI		
Factor investigated	**n**	**n**	**%**	**n**	**%**	**p**
Ability to inhibit urine flow						0.38
Yes	30	14	53.8%	16	39.0%	
No	9	2	7.7%	7	17.1%	
not tried	28	10	38.5%	18	43.9%	
Constipation	4	3	75.0%	1	25.0%	0.29

The ability to inhibit urinary flow does not affect continence in this group (Table 3.6). There are differences in the percentages of the two groups (UI and No UI) of those that said “yes”, “no” and “not tried”, but these differences are not statistically significant (p=0.38) and could be due to a small sample size. Twenty-eight gymnasts have never tried to stop the flow of urine.

Constipation (Table 3.6) was not associated with UI (p=0.29). Although only a small number of adolescents have constipation symptoms, 75% of participants with constipation also had UI.

It is concerning that only three of the 26 UI sufferers have consulted a medical professional for help.

Table 3.7: Characteristics of the hypermobile and normal laxity adolescent gymnasts

			G[11]	Beighton ≥5 Hypermobile				Beighton <5 Normal				
			n	n	%	mean	SD	n	%	mean	SD	p
Demo[1]	Age[2]		66	26	38.8%	14.19	2.53	40	59.7%	13.4	1.959	0.182
	Race	Caucasian	59	22	37.3%			37	62.7%			0.7
		Coloured	8	4	50.0%			4	50.0%			
Anthro[3]		BMI[4]	67	26		20.523	3.011	41		19.76	2.297	0.274
		Lig Inj[5]	30	16	53.30%			14	46.70%			0.028
Gym[6]	Type[7]	Acrobatic	5	2	40.0%			3	60.0%			1.00
		Rhythmic	8	4	50.0%			4	50.0%			0.70
		Tumble	13	4	30.8%			9	69.2%			0.50
		Trampo[8]	12	5	41.7%			7	58.3%			0.82
		WA[9]	46	16	34.8%			30	65.2%			0.32
UI[10]			26	13	43.30%			13	43.30%			0.248

[1] = demographics
[2] = age in years
[3] = anthropology
[4] = body mass index
[5] = regular ligament injuries
[6] = gymnastics information
[7] = type of gymnastics
[8] = trampoline
[9] = women's artistic
[10] = urinary incontinence
[11] = gymnasts

Twenty-five (25) (38.8%) gymnasts were classified with GJH (Table 3.7) according to the Beighton score with a cut-off of 5/9 (GJH5). The presence of hypermobility (GHJ5) did not differ with age (p=0.227), BMI (p=0.274), race (p=0.70) or gymnastic discipline. Regular ligament injuries are three times more common (OR 3.09 95% CI [1.11–8.56]) in GJH5 participants than participants that are not hypermobile.

Table 3.8: Results of stepwise backward logistic regression analysis of adolescent gymnasts with SUI

Description	OR	95% CI	p-value
Regular ligament injury	4.58	1.02-20.47	0.05
Age	1.41	1.03-1.93	0.035
Training hours 2-3hrs	57.99	2.55-1320.96	0.011
Trampoline activity	33.76	2.50-456.57	0.008

Adolescent gymnasts (Table 3.8) presenting with a history of regular ligament sprains (OR=4.58), being older (OR=1.41), participating in trampoline (OR=33.76) and training for two to three hrs daily (OR=57.99) were more likely to present with SUI. Tumbling also presented as a possible risk factor to have urine loss (p=0.13) but was not included in the model. There is a moderate correlation between the model and SUI in adolescent gymnasts (r^2=0.554)

3.4 DISCUSSION

This is the first study to investigate prevalence, severity and risk factors of SUI in the adolescent gymnastic population in South Africa. This adolescent gymnastic sample described a higher prevalence of SUI than documented in the general adolescent population.(27,35,36) However, the prevalence is related to other studies of college and nulliparous elite athletes and gymnasts.(1,23,28,30,32) We argue that the addition of gymnastics increased the SUI prevalence in this adolescent population. Gymnasts participating in trampoline are more likely to have SUI, as reported previously.(23,24,28,58,88) Similar manoeuvres that provoked incontinence in previous literature were found in this study.(1,24,88,89) Somersaults were not included in this study and have to be included in the future.(95)

Trampoline is a branch of gymnastics which includes jumps, twists, and somersaults in the air. These manoeuvres place great force on the body, PF and connective tissue.(24) Young trampolinists reported UI at the end of the training, perhaps as a sign of muscle fatigue.(23) Muscle support is highly important to prevent progressive elongation and strain on the connective tissue (101) and muscle fatigue has been associated with SUI previously.(86)

Contrary to the expected, incontinence prevalence did not differ between Caucasian and Coloured participants (102) nor did it change with BMI.(53) Unfortunately, there were minimal Coloured participants in this study and the BMI range was small. The large number of Caucasian gymnasts in the study may have contributed to the high SUI prevalence.(102,103)

A connective tissue insufficiency is hypothesised in SUI studies.(26,30,43,90) This is why GJH was explored as a risk factor in this paper. This study's GJH prevalence was higher than in the normal adolescent population.(65,67,71) Two possible reasons for the higher prevalence of GJH in our sample exist. Firstly, ballet dancers and gymnastics (79) have higher prevalence rates of GJH when compared to the generalised population. Due to the flexibility acquired in gymnastics, almost all the gymnasts in our sample scored a point for the lumbar flexion manoeuvre, adding to the higher Beighton score.(80) It is uncertain whether GJH improves performance in gymnastics.(81) Secondly, the imprecision of the Beighton score used to classify GJH could explain the difference in GJH prevalence.(80) The prevalence results of three larger studies with a strict Beighton score protocol were similar to results in this study, (75,93,94) emphasising the importance of consistency when using this hypermobility tool. The Beighton score, used in this study, is the most popular hypermobility assessment tool in the literature.(79,80,92,93) Although the previous study

used the Beighton score, not all studies followed the Beighton score protocol. The cut-off score also varies between studies and some feel that a cut-off score of 4/9 (GJH4) is an over diagnosis of hypermobility in adolescence.(75,80,93)

This makes it difficult to compare results between literature studies. No significant association was made between SUI and the Beighton score. The severity of SUI was also not significantly affected by a change in the Beighton score.

Ligament injuries are three times more prevalent in the GJH5 group than in normal mobility gymnasts. One would hypothesise that by being hypermobile; the connective tissue would be more flexible and result in less ligament damage/injuries. Joint and musculoskeletal injuries could easily be mistaken for ligament injuries in this population. If a joint is not sufficiently supported by the connective tissue structures, it could be injured. Less proprioception and stability, is found in GJH candidates. Features of GJH include joint sprain, joint swelling, foot pain, anterior knee pain, back pain, dislocations and musculoskeletal pain.(72)

The ability to interrupt urinary flow is a functional activity supported by the PFMs. Chronic increases of IAP, due to constipation may cause dysfunction of the PFMs. Strong predictors of UI in young nulliparous trampolinists are found to be the inability to interrupt urinary flow and constipation.(24) In this study, there was no association with UI and this may be due to a small sample group. Although adolescents can interrupt the flow of urine whilst on the toilet, they might not be aware that the same action is required to support the urinary system in times of increased IAP. Similar to other studies, there might be a lack of knowledge about the correct use of PFMs (1) in the adolescent group as almost half of the gymnasts are unaware of the correct PFM contraction to inhibit urine flow. Unfortunately it seems like UI is also under reported in the this study as mentioned in the literature.(1,3) Only three of the 26 UI sufferers have consulted a medical professional regarding their problem. Either they regard the problem as too embarrassing to address or they see it as a normal occurrence and not a barrier in sport.

SUI was divided into two parts, to determine whether the gymnasts experienced SUI mostly during activity only or during coughing, which is part of daily life. This renders the questions: Did the incontinence problem become so severe that it is affecting ADL or was the incontinence present with a cough and become exacerbated with gymnastics? This needs to be investigated further.

The ISI is able to differentiate between the severities of different types of UI and by adding the number “0” to the severity categories, it is able to distinguish between the continent and incontinent in an adolescent population. These SUI sufferers experience slight incontinence severity, whereas other nulliparous studies experienced mostly moderate severity.(23)

Training volumes (hours of training per week x years) could not be calculated due to a measurement error in this study. In elite trampolinists, SUI became more severe with an increase in training volumes.(88) No significance was found when comparing individual training values (gym training hours, days of the week, years, and level) with SUI in this study. The only significant association with SUI in the regression model was with training hours (2–3 hrs per day). This might be because novice gymnasts must adhere to the scheduled gymnastic training hours set out by the individual clubs.

Difficulty understanding and answering the questionnaires could influence the quality of information received and some questions were answered incorrectly. Questionnaires were only piloted in English; in the future, it should be in Afrikaans too.

It was really difficult to schedule appointments with the gymnastic clubs. Although the data collection procedure was well executed, it was very difficult to schedule appointments with the gymnastic clubs and to send correspondence to the members. In the future, I would recommend collecting data at a national event or competition.

3.5 CONCLUSION

A high SUI prevalence rate is present in teenage gymnasts. Incontinence is not just a disease limited to old age, menopause, postpartum or even in elite athletes.

GJH presents as joint and connective tissue laxity. Due to the high presence of connective tissue in the urethral sphincter and supportive systems, it was hypothesised that the presence of GJH may create more laxity and thus mobility of the bladder neck. This lack of support and increased bladder neck mobility may then contribute to incontinence and an increase in incontinence severity with raised IAP as during gymnastics. In this study GJH was not associated with SUI.

The hypermobility prevalence is high in this gymnastic population, but the consensus of the cut-off score for hypermobility according to the Beighton score is required in adolescence. Study results are not comparable if there is no consensus regarding the cut off score. It may also lead to an over diagnosis of hypermobility in adolescence. Hypermobility is associated with ligament injuries in gymnastics, but it is uncertain if this is joint and musculoskeletal injuries rather than true ligament damage.

The Beighton score for hypermobility is not associated with SUI or with an increase in the severity of SUI. Ligament injuries are more prevalent in the hypermobile group and associated with SUI in participants of the trampoline. So, a connective tissue dysfunction cannot be excluded in the presence of SUI.

Health professionals and coaches need to be more aware of older trampolinists, who train for two to three hours daily and have regular ligament or joint injuries. They may be more vulnerable in developing SUI. These SUI candidates may benefit from PFM rehabilitation and general rehabilitation including core muscle strengthening, proprioception, improved IAP management and correct jumping techniques.

CHAPTER 4:

GENERAL DISCUSSION AND CONCLUSION

4.1 CONTRIBUTION TO LITERATURE

Great variation has been reported in prevalence rates of UI in the adolescent population. UI prevalence varies from 4.7% to 16.6%, SUI from 7.2% to 22% and UUI from 3.4% to 17%. A possible explanation could be the instruments used to describe prevalence rates. We recommend that questionnaires should be validated in the adolescent population to ensure more accurate data. It is also not clear whether a parent is a reliable proxy for data collection. Inter-rater reliability of data using parents and adolescents needs to be investigated.

In a young nulliparous athletic population the prevalence of UI ranges from 0% to 80%, depending on the sports type.(1,23,24,30,50,88) Many athletes who take part in high-impact sport do not suffer from incontinence (6) and theoretically, it may be that more than one risk factor is involved when predicting incontinence. Connective tissue laxity and dysfunction have been associated with UI and high-impact sports like gymnastics. Gymnastics is known for its flexibility requirements in manoeuvres.(80) The literature overview formed the research question for the primary study: “Does general joint hypermobility predispose female adolescent athletes to SUI?”

This was the first primary study to evaluate the prevalence and severity of SUI in adolescent female gymnasts in South Africa. Previous studies investigating the prevalence of SUI in nulliparous gymnasts were not local and did not include adolescents exclusively. The prevalence results in this study reveal the high percentage of SUI (35.8%) amongst adolescent gymnasts in South Africa (SA). This is higher than the prevalence found in other adolescent studies and more in line with results found in the nulliparous sporting population. Considering the link between incontinence during adolescence and UI in later life (11–13), awareness and treatment should be a priority. All the athletes in this study were exposed to high-impact sport (1,23,24,30,50,88) and 88% of the participants were Caucasian (102–104), which could both add to the high SUI prevalence.

Various risk factors for UI in the adolescent population have been reported (Chapter 2). We included these factors in our primary study. In our population, BMI, race and training factors were not associated with SUI as seen in previous studies.(4,27,37,51,53,102) The BMI range was very small in our study and most participants were Caucasian. These non-elite athletes also adhere to scheduled training hours, which are established by the individual

gymnastic clubs, not linked to the level of competition. We used GJH5 cut-off to diagnose hypermobility in our study, we recommend that stricter criteria than 4/9 should be used in adolescence. In adults, many studies continue with the original cut-off score of 4/9.(61,62) Although joint laxity decreases with age (68), females demonstrated more laxity during puberty than males. Female laxity plateaued post-puberty.(69,70) In children under the age of 12 years, it has been suggested to use a cut-off score of 7/9.(75) Therefore, we recommend, as adolescence is the transition from childhood to adulthood, it requires a stricter cut-off score than four and less than seven.

Gymnasts are more prone to experience SUI than other sportswomen.(1,12,23,28,30,32) A change in connective tissue physiology and structure has been hypothesised to affect urethral support and function and this being the reason for SUI.(6,39,48) A decrease in collagen concentration has been linked to the presence of SUI.(43) UI has also been associated with joint hypermobility, confirming an underlying connective tissue contribution.(61–63) We hypothesised that adolescents that excel in gymnastics, because of the natural joint laxity they possess, are predisposed to UI.

Eliasson (23,24) suggests that trampolinists do not require the same joint mobility and flexibility as the other gymnastic disciplines. Trampoline gymnasts have to be skilled in high jumps and maintain balance during somersaults. The quick change in direction of movement shifts the momentum of the body, placing extra stress on the pelvic floor. It is then hypothesised that the PFM should be able to contract stronger, for longer periods and have eccentric capabilities.

Our results indicate that older (OR=1.41) adolescent trampolinists (OR=33.76) presenting with a history of regular ligament sprains (OR=4.58), and adhering to a training schedule of two to three hrs daily (OR=57.99) were more likely to present with SUI. Gymnastic coaches, health professionals, and parents need to be more aware that gymnasts who fit this profile stand a chance of developing SUI. SUI can be experienced during training or during activities of daily living (ADLs). Available literature reports that elite nulliparous trampolinists that were older (23), presenting with high training volumes (23,24,88), are unable to interrupt micturition and suffer from constipation (24) also have a greater chance of developing SUI.

4.2 CLINICAL IMPLICATION

The goody bag that was handed out to every participant, after each data collection of the primary study, contained information about UI and GJH. Governing bodies like the South African Society of Physiotherapy and the Arthritis foundation did not have pamphlets about incontinence or GJH that could be used for this study. Pamphlets (Addendum L3) were

designed for adolescents and this can be distributed to gymnastic clubs in the Cape Metropole.

In this study, only three of the twenty-six UI sufferers consulted a health professional about their incontinence problem. Our data suggests, and agrees with previous literature, that adolescents do not seek help from medical professionals.(1) More education and awareness needs to be created in the adolescent population. Whether information will affect help-seeking behaviour in the adolescent group needs to be explored. Conservative treatment like PFM rehabilitation has been proven effective in women (7,49,105,106) and may benefit adolescent gymnasts if it forms part of their regular training regime.

4.3 STRENGTHS

- The data collection procedure was followed meticulously. The PI completed all the Beighton score evaluations during the data collection procedures and followed the Beighton Score Protocol developed by Smits-Engelsman.(75)
- All the available gymnasts agreed to voluntarily participate in the study. There were no exclusions.

4.4 LIMITATIONS

- Unfortunately, not all the districts of the Cape Metropole were represented. Many clubs have closed down due to financial constraints. Many gymnastic clubs only have members less than 12 years, which excluded them from the study. The gymnastic clubs are poorly staffed with administrative staff and did not respond to invitations to this study. Scheduling data collection dates and exchanging information to and from the club members was a great challenge. The sample size was thus smaller than statistically recommended, as data collection was stopped after seven clubs were sampled. Large confidence intervals were reported as a result of the small sample.
- There was limited variety in ethnic representation. The sample consisted of mostly Caucasian participants. Racial differences were not associated with SUI like in other studies. The result could be due to the non-diverse sample.
- After numerous attempts, parental assent was not received from all the participants and a waiver from the ethics committee was received (Addendum B4).
- The Beighton score cut-off needs to be standardised in different age groups to be able to compare study results. A possible stricter hypermobility cut-off score is needed in adolescence than 4/9; it may over diagnose hypermobility in adolescence. The ability to touch the floor is trainable which could possibly broaden the Beighton score in sports like gymnastics and ballet.

- While the self-compiled questionnaire was based on the literature overview, and piloted before use in our study further work needs to be done for the questionnaire to be used in future studies. No discrepancy was made between urinary leakage (UL) and UI. Any form of involuntary urine loss was termed “urinary incontinence”. Information related to a chronic cough, respiratory conditions or giggle incontinence should be included.
- The questionnaires used in the data collection, were piloted in English and should have included Afrikaans too.

Numerous hypotheses exist regarding PFM function in athletes. The strain of high-impact exercise either weakens or causes damage to the structures in the PF or it strengthens it. Muscle weakness has been associated with SUI and muscle fatigue in cases with GJH and BJHS. The awareness, strength, and function of PFM need to be assessed with more technologically advanced assessment tools in a general and sporting nulliparous adolescent population. While joint laxity was not associated with SUI in our study, the presence of connective tissue vulnerability in SUI should be explored in future studies. Joint laxity should be included as a possible risk factor in the development of SUI in adolescents who participate in high-impact sporting activities. A validated and reliable questionnaire for adolescents and expansion of the Beighton score is required. A randomised control trial of the effect of a conservative treatment programme like PFM rehabilitation and specific prescription of treatment volume is recommended for trampolinists.

4.5 CONCLUSION

GJH presents as joint and connective tissue laxity. We thus hypothesised that due to the high presence of connective tissue in the urethral sphincter and supportive systems, the presence of GJH may create more laxity and thus mobility of the bladder neck. The lack of support and increased bladder neck mobility may contribute to incontinence and an increase in severity with raised IAP like during gymnastics. Our data did not confirm the hypothesis, even though there was a high prevalence of hypermobility in this gymnastic population. Further work is needed.

The prevalence of SUI in adolescent gymnasts is higher than in the general adolescent population. Health professionals and coaches need to be made aware that older trampolinists, who train for two to three hours daily and have regular ligament or joint injuries, are at risk of developing SUI. Our data suggests that adolescents are reluctant to seek help from health professionals. Parents, coaches and health professionals should be made aware of the under reporting of UI and educated about available treatment options. SUI candidates may benefit from PFM rehabilitation.

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ADDENDA

ADDENDUM A01: IUGA INSTRUCTIONS

International Urogynecology Journal (IUJ)
Instructions for Authors

Editors-in-Chief/Editorial Office

Editors-in-Chief

Peter Dwyer
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Editorial Office

Lindsay MacMurray
iujeditorialoffice@gmail.com

Article Types and Submission Process

The *International Urogynecology Journal* (IUJ) accepts Original articles, Reviews (including Mini Reviews), Clinical Opinions, Editorials, Controversies in Urogynecology, Images in Urogynecology and Video. Original articles must present scientific results that are essentially new. All manuscripts are subject to peer review. All manuscripts must be submitted electronically through Editorial Manager at http://www.editorialmanager.com/iujo, or through the Springer website: http://www.springer.com/medicine/gynecology/journal/192. Manuscripts submitted by regular mail will not be reviewed and will not be returned. Authors will be notified by email to submit electronically. **If you have any questions regarding manuscript submission, please contact the IUJ Editorial Office by email at iujeditorialoffice@gmail.com .**

Authorship and Copyright and Financial Disclosure/Conflict of Interest Form

All submissions must include a completed Authorship and Copyright and Financial Disclosure/Conflict of Interest Form. The corresponding author can complete the copyright portion of the form. All authors must complete and sign the conflict of interest and authorship portion of the form.

The Authorship and Copyright and Financial Disclosure/Conflict of Interest Form may also be obtained at the Editorial Manager login site or on the Springer website.

The Authorship and Copyright and Financial Disclosure/Conflict of Interest Form must be submitted electronically at the time of manuscript submission, without exception. In addition to this form, the title page must include a conflict of interest statement for each author.

If you have any questions regarding manuscript submission, please contact the IUJ Editorial Office by email at iujeditorialoffice@gmail.com.

Authors must disclose all relationships or interests that could influence or bias the work. Although an author may not feel there are conflicts, disclosure of relationships and interests affords a more transparent process, leading to an accurate and objective assessment of the work. Awareness of real or perceived conflicts of interests is a perspective to which the readers are entitled and is not meant to imply that a financial relationship with an organization that sponsored the research or compensation for consultancy work is inappropriate.

When submitting, a full First or Middle name is required for all authors. A complete Last name is required of all authors. For example, A. Clark Hobson is acceptable as an author name, but A.C. Hobson is not.
Examples of potential conflicts of interests *that are directly or indirectly related to the research* may include but are not limited to the following:

- Research grants from funding agencies (please give the research funder and the grant number)
- Honoraria for speaking at symposia
- Financial support for attending symposia
- Financial support for educational programs
- Employment or consultation
- Support from a project sponsor
- Position on advisory board or board of directors or other type of management relationships
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- In addition, interests that go beyond financial interests and compensation (non-financial interests) that may be important to readers should be disclosed. These may include but are not limited to personal relationships or competing interests directly or indirectly tied to this research, or professional interests or personal beliefs that may influence your research.

The corresponding author collects the conflict of interest disclosure forms from all authors. In author collaborations where formal agreements for representation allow it, it is sufficient for the corresponding author to sign the disclosure form on behalf of all authors. Examples of forms can be found here .

The corresponding author will include a summary statement in the text of the manuscript in a separate section before the reference list, that reflects what is recorded in the potential conflict of interest disclosure form(s).

See below examples of disclosures:
Funding: This study was funded by X (grant number X).

Conflict of Interest: Author A has received research grants from Company A. Author B has received a speaker honorarium from Company X and owns stock in Company Y. Author C is a member of committee Z.

If no conflict exists, the authors should state:
Conflict of Interest: The authors declare that they have no conflict of interest.

Patient Confidentiality

Patients have a right to privacy; identifying information, including names, initials, or hospital numbers, should not be published in written descriptions, photographs, videos, or pedigrees unless the information is essential for scientific purposes and the patient (or parent or guardian) gives written informed consent for publication. Patient consent should be written and available to the IUJ Editors upon request.

For **Images in Urogynecology and Video articles**, authors must obtain written consent from the patient. All authors must include a statement before the References section under the heading 'Consent' which reads: '*Written informed consent was obtained from the patient for publication of this Images in Urogynecology / Video article (please delete as appropriate) and any accompanying images.'*

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All manuscripts are treated by the assigned reviewers as privileged and confidential information. Reviewers may request advice from another party, subject to the general principles of confidentiality and permission of the managing editor. Reviewers' comments are not published or made available publicly except with the prior written permission of the reviewer, author, and editor. However, reviewers' comments are shared with the other reviewers of the same manuscript, and reviewers will be notified of the editor's decision. The reviewers' identity remains anonymous. All reviewers are asked to disclose any potential conflict that could influence their opinions of manuscripts, prior to review of a manuscript. Editors will only disclose information pertaining to a specific manuscript (i.e. receipt, status in review process, content, criticism, or final decision) to the author and reviewers.

Manuscript Preparation

Manuscripts **must be written in clear, concise English** and conform to the specifications described herein. Manuscripts that are considered poor quality in terms of English, grammar, and spelling and require extensive revisions for clarity may be returned to the author for revision prior to proceeding to the peer review process. Springer offers a manuscript revision service through Edanz, and can be accessed through a link on the IUJ Springer homepage. Edanz may also be accessed directly at www.edanz.com. This is associated with a fee for service, which is the author's responsibility.

Authors are asked to add continuous line numbering to their manuscript.

Terminology

It is suggested that "Methods, definitions, and units conform to the standards jointly recommended by the International Urogynecological Association and the International Continence Society and , except where specifically noted" (Haylen et al. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction. Int Urogynecol J 2010;21:5-26.

All manuscripts that have been accepted for publication are subject to copy-editing.

Article Types and Specific Requirements

Original Articles

- Title page:
  - all authors and affiliations
  - corresponding author contact information (email mandatory)
  - conflict of interest statement for each author
  - each author's participation in the manuscript
- Structured abstract (250 words) and Keywords (up to 6)
- Brief summary (25 words)
- Word limit of 4000 words (average is 2000 words)

Review Process

Once a manuscript has been submitted, the corresponding author will be contacted by email. Manuscripts that do not conform to the journal style (see **Manuscript Preparation** below) will be returned to the corresponding author for revision and resubmission online, prior to being considered for publication.

Manuscripts which **do not meet the general criteria** for this journal will be returned to the corresponding author without undergoing peer review and will not be accepted. This decision will be made by the Editors-in-Chief. Criteria include but are not limited to:

- relevance to the aims of the journal with the topic being of overall general interest
- sufficiently original and contributing to the advancement of the field
  - clearly written with appropriate study methods, well-supported data and conclusions which are supported by the data
- clear and understandable English, grammar, and spelling

Once a manuscript has been submitted, conforms to journal style, and is deemed appropriate for this journal, it will be assigned to an editor and begin to go through the peer review process. The corresponding author will be contacted by email with editorial decisions as the manuscript moves through the peer review process.

Manuscripts that are returned to the corresponding author with Major Revisions or Minor Revisions, will include the reviewers' and the editor's comments and suggestions for changes. The notification will include the option for the corresponding author to accept or decline submitting a revised manuscript and addressing the reviewers' comments, as well as the deadline for resubmitting a revised manuscript. All revised manuscripts will be submitted online via Editorial Manager. **Revised manuscripts should clearly show where revisions have been made by using the Track Editing option in Microsoft Word, and include a cover letter addressing each reviewer's point with a counterpoint**. Manuscripts which have been returned with a decision of Major Revisions or Minor Revisions are not guaranteed acceptance after a revised manuscript has been resubmitted. Revised manuscripts will go through the peer review process. Manuscripts which have been reviewed and a decision for revisions (major or minor) has been made may be considered as new submissions if not resubmitted **within three months from the time of notification**. Requests for extension of the resubmission deadline should be directed by email to the Editorial Office.

Redundant, Duplicate, or Fraudulent Publication

Authors must not simultaneously submit their manuscript to another journal if that manuscript is under consideration by the *International Urogynecology Journal* (IUJ). Redundant or duplicate publication is considered as a manuscript that overlaps substantially with one already published in print or electronic media. At the time of manuscript submission, authors must inform the editor about all submissions and previous publications that might be regarded as redundant or duplicate publication of the same or very similar work. Any such publications must be referred to and referenced in the new manuscript. Copies of such material should be included with the submitted manuscript as a "supplemental file".

Authors must not:

- Willfully and knowingly submit false data
- Submit data from a source not the authors' own
  - Submit previously published material (with the exception of abstracts) without correct and proper citation
- Omit reference to the work of other investigators that establishes a priority
- Falsely certify that the submitted work is original

- Maximum of 6 authors (more than 6 authors requires submission of a letter to the editorial office explaining the reasons)
- Maximum of 30 references
- Maximum of 6 figures/tables (If the article contains a large number of illustrations then the length of the text should be adjusted accordingly to a lower word count)

Review Articles

- Title page:
  - all authors and affiliations
  - corresponding author contact information (email mandatory)
  - conflict of interest statement for each author
  - each author's participation in the manuscript
- Structured abstract (250 words) and Keywords (up to 6)
- Brief summary (25 words)
- Word limit of 6000 words
- Maximum of 6 authors
- Maximum 100 references
- Maximum of 10 figures

Images in Urogynecology

- Title Page
  - All Authors and Affiliations (3 authors or fewer)
  - Corresponding author contact information (email mandatory)
  - Disclosure / Conflict of Interest Statement for each author
  - Each author's participation in the manuscript
- No Abstract
- Keywords (up to 6) required
- Word Limit of 300 words
  - Include an Introduction and brief case study of presented images
- 3 to 5 5 images allowed
  - Figure legends / descriptions may be up to 250 words each
  - Images should be high quality, at least 300 dpi
- Maximum of 3 references

Current Opinion/Updates

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  - conflict of interest statement for each author
  - each author's participation in the manuscript
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- Word limit of 3000 words
- Maximum of 7 authors
- Maximum of 25 references

Letters to the Editor (Comments)*

- Title and corresponding author
- Word limit of 400 words
  - Maximum of 5 references (the first reference must be the publication in question if letter relates to a publication)

*NOTE: The editorial staff reserves the right to shorten letters if necessary and to make minor editorial alterations without reference to the writer; letters may be published together with a reply from the original author. If the original author does not respond, a notation indicating 'response declined' will be published. As space for Letters-to-the-Editor is limited, only a selection of letters submitted may be published.

Video Article

In addition to a video authors should submit a manuscript text. This should include:

- Title page (incorporating a structured abstract, keywords and references):
  - Title of video
  - All authors and affiliations
  - Corresponding author contact information (email mandatory)
  - Conflict of interest statement for each author
  - Abstract (up to 200 words)
- Structured text (800-1200 words):
  1. Aim of the video / Introduction
  2. Method
  3. Results (if presenting data)
  4. Conclusion

Presenting results and using tables is encouraged.

- Keywords (up to 6)
  - Up to 10 references
- Video format:
  - Should not exceed 9 minutes
  - File size should not exceed 100MB
    - All videos should be in MP4 format and will be playable on a Windows-based computer
  - The use of unnecessary audio (i.e. music) is discouraged
  - The content of the video file(s) must be identical to that reviewed and accepted by the editors
    - All narration should be in English
    - Information that may identify patients, including names, initials, or hospital numbers, should not be included in videos unless the information is essential for scientific purposes and the patient (or parent or guardian) gives written informed consent for publication. Patient consent should be written and available to the IUJ Editors upon request. All authors must include a statement before the References section under the heading 'Consent' which reads: *'Written informed consent was obtained from the patient for publication of this video article and any accompanying images.'*

Manuscript Format

The following sections must each begin on separate pages:

- Title Page*
- Abstract*
- Text (Introduction, Materials and Methods, Results, Discussion)*
- Acknowledgements
- References*
- Figure Legends (if any figures)
- Tables
- Appendices (if any)

*Mandatory sections

Manuscripts must have all pages numbered and the text should be double spaced.

Title page

The title page MUST include:

- **Title -** Capture the essence of the scientific contribution in no more than 15 words, including spaces. It should be specific enough for electronic retrieval and searches
- **Author Details -** Name(s) and institutional affiliation(s) of all the author(s)
- **Corresponding Author** and contact information (address, telephone, fax, email)
- **Word Count –** Must be included in the lower left hand side of the title page. Word count includes abstract and main text but *not* references.
- **Financial Disclaimers/Conflict of Interest** statement **(if none, state FINANCIAL DISCLAIMER/CONFLICT OF INTEREST: NONE)**. NOTE: This does not replace the mandatory Copyright and Authorship Form which must be completed and included at the time of submission.
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- If this work has been presented at a prior conference or meeting congress, please list: a) the name of conference, b) location and c) date
- List each author by surname (family name) and describe each of their contributions

(select all that apply) to the manuscript using the following terms:

- Protocol/project development Data collection or management Data analysis
- Manuscript writing/editing
- Other (please specify briefly using 1 to 5 words)
- (Adapted from WAME Authorship paper, www.wame.org, posted January 10, 2007)
- *For example:*
  - AR Smith: Project development, Data Collection, Manuscript writing
  - TS Jones: Data collection
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Abstract

Each original article and review/mini review article must include a structured abstract of up to **250 words** that is intelligible to the journal's general readership without reference to the text and must reflect the content of the article accurately. All original articles and reviews/mini reviews should present the abstract in a structured format as follows:

- Introduction and Hypothesis
- Methods (include sample size and statistical approaches).

- Results - The Results must contain sufficient data for readers to evaluate the credibility of the conclusion. All of the data does not need to be presented. The conclusion should be an inference, not a summary.
- Conclusions - Readers should be able to understand the question asked in the study and why and how it was done.

Keywords

Up to **3-6 keywords** should be supplied in alphabetical order after the Abstract, characterizing the scope of the manuscript.

Brief summary

A **25-word summary** is mandatory and will be used in the table of contents of the journal.

Abbreviations

These should be defined at first mention in the abstract and again in the main body of the text and used consistently thereafter.

Introduction

Develop the study rationale and avoid a literature review. Literature should be cited only to the extent that helps the reader understand why the question is asked. End the Introduction with a stated aim or question, preferably expressed as a testable hypothesis. For example, if the study is aimed at identifying the color of apples, or asks what color are apples, state 'we hypothesized that apples will be green rather than red'. The reason for this hypothesis should be contained in the rationale.

Materials and Methods

The Materials and Methods section should describe the procedures used and include sufficient information such as subjects and measurements) so that a reader can evaluate the credibility of results and interpretation in the light of possible methodological limitations. Detailed statistical methods should be included. Findings should be quantified when possible and presented with appropriate indicators of measurement error or uncertainty, e.g. confidence intervals. The source or manufacturer name of all products used should be stated. Authors should always consider clarity for other workers about how and why a study was done in a particular way. All original articles should include Ethics/Institutional Review Board (IRB) approval for all studies, human or animal. Studies in which ethics approval does not apply or is waived by the IRB/Ethics Committee should state this in the manuscript, and the reason for the exemption or waiver.

Randomized Controlled Trials (RCT)

In cases of prospective, randomized trials (RCT), it is strongly encouraged that they are registered with a public clinical trial registry, such as www.clinicaltrials.gov (NO FEE) prior to commencing patient recruitment. Proof of IRB approval is MANDATORY (or an explanation for exemption or waiver). Authors should refer to the CONSORT statement (http://www.consort-statement.org/), including the flow diagram and checklist (http://www.consort-statement.org/consort-statement/overview0/#checklist) when preparing a manuscript reporting RCT. The flow diagram should be included as Figure 1 in the document.

Results

Results concerning the primary testable hypothesis should be presented first. Do not 'save the best for last'. Data should be presented as concisely as possible, if appropriate in the form of tables and/or graphs, although very large tables should be avoided. If authors wish to present the full data of the study, and any technical details, these can be included as Electronic Supplementary Material.

Discussion

The following paragraph structure is recommended:

- Summarize the main findings from most to least important, including a statement whether the results are consistent with the stated hypothesis.
- Discuss how the results confirm or contrast with published literature.
- If the results differ, discuss the possible reasons for this. Details of methodology and results of published literature may be appropriate here. Avoid reviewing literature outside the scope of the study.
- Discuss the significance and implications of this new data. Having developed the rationale to define the limits of current knowledge, how does this new information advance understanding?
- Write a paragraph concerning the limits of the study – this is critical. The inferences made throughout the Discussion must be written bearing in mind the constraints of the methodological limitations of the work. Papers written without this section will not be considered for publication.
- Summarize and Conclude. The conclusion is an inference. Within the constraints of the limitations of the study, the authors may boldly speculate regarding the significance of the findings and future research.

Acknowledgements

The acknowledgements should be as brief as possible. They should include the specific contributions of all persons who have substantially contributed to the work reported, e.g. technical assistance, data collection, analysis, writing or editing assistance, but who do not fulfill authorship criteria. Authors should obtain written permission from all persons listed in the Acknowledgement section. All institutional and corporate funding sources should be mentioned. The names of funding organizations should be written in full.

Funding

Authors are expected to disclose any commercial or other associations that might pose a conflict of interest in connection with submitted material. All funding sources supporting the work and institutional or corporate affiliations of the authors should be acknowledged even if there are no conflicts of interest or disclosures and must be clearly stated within the manuscript file.

Citation

Reference citations in the text should be identified by numbers in square brackets. Some examples:

1. Negotiation research spans many disciplines [3].
2. This result was later contradicted by Becker and Seligman [5].
3. This effect has been widely studied [1-3, 7].

Reference list

The list of references should only include works that are cited in the text and that have been published or accepted for publication. Personal communications and unpublished works should only be mentioned in the text. Do not use footnotes or endnotes as a substitute for a reference list.

The entries in the list should be numbered consecutively.

- Journal article

  Gamelin FX, Baquet G, Berthoin S, Thevenet D, Nourry C, Nottin S, Bosquet L (2009) Effect of high intensity intermittent training on heart rate variability in prepubescent children. Eur J Appl Physiol 105:731-738. doi: 10.1007/s00421-008-0955-8

  Ideally, the names of all authors should be provided, but the usage of “et al” in long author lists will also be accepted:

  Smith J, Jones M Jr, Houghton L et al (1999) Future of health insurance. N Engl J Med 965:325–329

- Article by DOI

  Slifka MK, Whitton JL (2000) Clinical implications of dysregulated cytokine production. J Mol Med. doi:10.1007/s001090000086

- Book

  South J, Blass B (2001) The future of modern genomics. Blackwell, London

- Book chapter

  Brown B, Aaron M (2001) The politics of nature. In: Smith J (ed) The rise of modern genomics, 3rd edn. Wiley, New York, pp 230-257

- Online document

  Cartwright J (2007) Big stars have weather too. IOP Publishing PhysicsWeb. http://physicsweb.org/articles/news/11/6/16/1. Accessed 26 June 2007

- Dissertation

  Trent JW (1975) Experimental acute renal failure. Dissertation, University of California

Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviations, see

- www.issn.org/2-22661-LTWA-online.php

For authors using EndNote, Springer provides an output style that supports the formatting of in-text citations and reference list

Endnote style (zip, 2kB)

Authors preparing their manuscript in LaTeX can use the bibtex file spbasic.bst which is included in Springer's LaTeX macro package.

Standardization articles

If referencing standardization articles that are in collaboration with the International Continence Society please use the following references:

- Haylen, B.T., Freeman, R.M., Swift, S.E., Cosson, M. and Davila, *G.W. et al* (2011) **An International Urogynecological Association (IUGA) / International Continence Society (ICS)joint terminology and classification of the complications related directly to the insertion of prostheses (meshes, implants, tapes) & grafts in female pelvic floor surgery**. Int Urogynecol J 22:3-15. doi: 10.1007/s00192-010-1324-9.
- Toozs-Hobson, P., Freeman, R., Barber, M., Maher, C. and Haylen, *B. et al.*(2012) **An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for reporting outcomes of surgical procedures for pelvic organ prolapse.** Int Urogynecol J 23:527-535. doi: 10.1007/s00192-012-1726-y
- Haylen, B.T., de Ridder, D., Freeman, R.M., Swift, S.E. and Berghmans, *B. et al. (2010)* **An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction.** Int Urogynecol J 21: 5-26. doi: 10.1007/s00192-009-0976-9
- Bernard T. Haylen, B.T., Freeman, R.M., Lee, J., Swift, S.E. and Cosson, *M. et al.(2012)* **An International Urogynecological Association (IUGA)/International Continence Society (ICS)joint terminology and classification of the complications related to native tissue female pelvic floor surgery.** Int Urogynecol J 23: 515-526. doi: 10.1007/s00192-011-1659-x

Illustrations

A **Legend of Figures** is required when using figures (to follow the References on a separate page). Each figure must be listed with a succinct, self-sufficient explanation of the photographs, graphs or diagrams. All abbreviations and symbols used in the figure should be explained. All figures must be cited in the text, and each numbered consecutively throughout. Figure parts should be identified by lower-case roman letters.

Figures should not be included in the main manuscript document but rather submitted as separate image files on Editorial Manager.

Details that might identify patients should be omitted unless absolutely necessary for scientific reasons. Falsification or altering of data should never be used as a means of ensuring anonymity; masking of the eye region in photographs of patients may be inadequate. If identification of patients is unavoidable, the author must guarantee that the reproduction of illustrations in which a patient is recognizable is approved either by the patient him-/herself or by his/her legal representative.

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All illustrations should be submitted as electronic files with a minimum resolution of 800 dpi for line drawings and 300 dpi for digital half-tones. It is recommended that individual file sizes are no more than 500 KB and not exceeding 2 MB, with the total size for all files no exceeding 25 MB. Store color illustrations as RGB (8 bits per channel) in TIFF format. Color illustrations in the print journal incur a charge (€ 950, plus VAT) and the authors will be expected to make a contribution towards the extra costs, irrespective of the number of color figures (this is for print only - online publication of color figures does not require extra cost).

Tables

All tables should be cited in the text and each numbered consecutively throughout. Data presented in tables should not be repeated in the text. Each table should appear on a separate page, following the Legend of Figures, and listed numerically. Tables should have a title and a legend explaining any abbreviations used in that table. Footnotes to tables should be indicated in superscript lower-case letters or asterisks for significance values and other statistical data, and explained at the bottom of each table.

Appendices

If there is more than one appendix, they should be numbered consecutively. Equations in appendices should be designated differently from those in the main body of the paper, e.g. (A1), (A2) etc. In each appendix, equations should be numbered separately.

Electronic Supplementary Material

Electronic supplementary material (ESM) for an article in the journal will be published in SpringerLink provided the material is:

- Submitted to the Editor(s) in electronic form together with the paper
- Subject to peer review
- Accepted by the journal's Editor(s)

ESM may consist of:

- Information that cannot be printed: animations, video clips, sound recordings.
- Information that is more convenient in electronic form: sequences, spectral data, etc.

- Large original data that relate to the paper, e.g. additional tables, illustrations (color and black & white), etc.
- Expanded Methods section

After a manuscript has been accepted, ESM will be published as received from the author in the online version only. References will be given in the printed version.

Proofreading

Proofreading is the responsibility of the author. Corrections should be clear and standard correction marks should be used. Corrections that lead to a change in the page layout should be avoided. The author is entitled to formal corrections only. Substantial changes in content, e.g. new results, corrected values, title and authorship, are not allowed without the approval of the editor. In such a case, please contact the Editorial Office before returning the proofs to the publisher.

Proprietary Substances and Materials, and Instruments

The correct designation and the manufacturer's name should be given. Where the manufacturer is not well known, the city and country should also be included.

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Please adhere to internationally agreed standards such as those adopted by the commission of the International Union of Pure and Applied Physics (IUPAP) or defined by the International Organization of Standardization (ISO).Metric SI units should be used throughout except where non-SI units are more common [e.g. litre (l) for volume].

Drug Names

When drugs are mentioned, the international (generic) name should be used. The proprietary name, chemical composition, and manufacturer should be stated in full in Materials and Methods. The source of any new and experimental preparation should also be given. Generic names of drugs and pesticides are preferred; if trade names are used, the generic name should be given at first mention.

Ethical Responsibilities of Authors

This journal is committed to upholding the integrity of the scientific record. As a member of the Committee on Publication Ethics (COPE) the journal will follow the COPE guidelines on how to deal with potential acts of misconduct.

Authors should refrain from misrepresenting research results which could damage the trust in the journal and ultimately the entire scientific endeavour. Maintaining integrity of the research and its presentation can be achieved by following the rules of good scientific practice, which includes:

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- A single study is not split up into several parts to increase the quantity of submissions and submitted to various journals or to one journal over time (e.g. "salami-publishing").
- No data have been fabricated or manipulated (including images) to support your conclusions
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Consent to submit has been received from all co-authors and responsible authorities at the institute/organization where the work has been carried out *before* the work is submitted.

Authors whose names appear on the submission have contributed sufficiently to the scientific work and therefore share collective responsibility and accountability for the results.

In addition:

- Changes of authorship or in the order of authors are not accepted *after* acceptance of a manuscript.
- Requests to add or delete authors at revision stage or after publication is a serious matter, and may be considered only after receipt of written approval from all authors and detailed explanation about the role/deletion of the new/deleted author. The decision on accepting the change rests with the Editor-in-Chief of the journal.
- Upon request authors should be prepared to send relevant documentation or data in order to verify the validity of the results. This could be in the form of raw data, samples, records, etc.

If there is a suspicion of misconduct, the journal will carry out an investigation following the COPE guidelines. If, after investigation, the allegation seems to raise valid concerns, the accused author will be contacted and given an opportunity to address the issue. If misconduct has been proven, this may result in the Editor-in-Chief's implementation of the following measures, including, but not limited to:

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- If the article has already been published online, depending on the nature and severity of the infraction, either an erratum will be placed with the article or in severe cases complete retraction of the article will occur. The reason must be given in the published erratum or retraction note.
- The author's institution may be informed.
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- An erratum reporting the conflict is published
- A full retraction of the article is undertaken. The nature of retraction will depend on
- whether the article is online first, or has already been published in a print issue.

→*Online First Publication*: The article will be fully retracted from SpringerLink, Springer's online full-text journal platform- the PDF will no longer be available and no related articles, abstracts, and references will be found on SpringerLink. The initial PDF document will be replaced by a retraction note. Springer will pursue the retraction of this article from other online services besides SpringerLink. Please note that the metadata of the article (author's name and title) will still be findable on SpringerLink.

→*Print publication in journal issue*: Since the article is already published, a retraction is no longer possible. The content will remain in its existing print form. However, in the next issue of the journal a retraction note referring to the article will be published. In addition, the title and each page of the related online article will be marked with a clear "RETRACTED" stamp

(For full policy document, go the IUJ Springer Homepage:

http://www.springer.com/medicine/gynecology/journal/192)

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http://springer.com/journal/192

ADDENDUM A02: GYMNASTIC DISCIPLINES

Gymnastics disciplines	Description according to WCGA website 23 Sept 2017
Acrobatic gymnastics	Acrobatics is the performance of extraordinary feats of balance, agility, and motor coordination. It can be found in many of the performing arts as well as in many sports events, and martial arts. Acrobatics is most often associated with activities that make extensive use of gymnastic elements, such as acro dance, circus and gymnastics, but many other athletic activities such as ballet and diving may also employ acrobatics.
Acrobatic dance	Acro dance is a style of dance that combines classical dance technique with precision acrobatic elements. It is defined by its athletic character, its unique choreography, which seamlessly blends dance and acrobatics, and its use of acrobatics in a dance context. It is a popular dance style in amateur competitive dance as well as in professional dance theatre and in contemporary circus productions such as those by Cirque du Soleil. This is in contrast to acrobatic, artistic and rhythmic gymnastics, which are sports that employ dance elements in a gymnastics context under the auspices of a governing gymnastics organization (such as FIG) and subject to a Code of Points.
Aerobic gymnastics	Aerobic Gymnastics is perhaps the most dynamic and energetic of all the gymnastic disciplines. Finding its roots in the group fitness and aerobic classes of the late 80's, Aerobic Gymnastics is a recent addition to the stable of gymnastic disciplines. The basis of all aerobic routines lies in the performance and combination of seven basic aerobic movements involving both the arms and legs: march, jog, skip, knee lift, kick, jack and lunge. Mastering these movements is often the focus of introductory aerobic gymnastics programmes.
Gym for all	Gymnastics for All (GfA) is the historical and cultural discipline of the FIG. Created by its founder, Nicolas Cuperus (BEL) in 1881, GfA bring together gymnasts of all ages, all genders, of all cultural backgrounds to enjoy the diverse range of physical activities that gymnastics offers. Gymnastics for All activities contribute to personal health, fitness and well-being – physical, social, intellectual and psychological. The focus of GfA is the F4 (Fun – Fitness - Fundamentals - Friendship) and can involve gymnastics with or without apparatus, gymnastics and dance. It offers aesthetic experiences in movement for participants and spectators while providing the opportunity to focus on items that are of particular interest in a national and cultural context.
Men's gymnastics	Men's artistic gymnastics (often shortened to simply men's gymnastics), is the oldest form of gymnastics, and a popular Olympic sport. Men have competed in gymnastics since the 1896 Athens Olympics, though it often featured track and field events along with the traditional men's apparatus. Apparatus: floor exercises, pommel horse, rings, vault, parallel bars, horizontal bar
Rhythmic gymnastics	Rhythmic gymnastics combines ballet and creative movements to music, while working with ribbons, balls, hoops, ropes and clubs in a choreographed dance-and-tumble routine. It has a lot more dance than artistic gymnastics. Everything is done on the floor with far different routines and different music. It can be done individually or in groups. Apparatus: Rope, Hoop, Ball, Free, Clubs, Ribbon
Rope Skipping	Rope skipping is done by twirling and jumping over the rope. The length of rope (usually with handles on each end) is swung around while someone jumps over it. A cardiopulmonary exercise is given in which the skipper jumps over, through or around the swinging rope.
Trampoline	Trampoline Gymnastics consists of four events; Individual Trampoline, Synchronised Trampoline, Double Mini Trampoline, and Tumbling. The routines are judged according to difficulty and execution as seen in others sports such as diving. There are different trampolining events i.e. individual, synchronised and double mini.
Tumbling	Tumbling is the most similar to artistic gymnastics, with the athlete performing a series of tumbling exercises along an 84-foot sprung floor. This event has also seen

	much improvement in the apparatus, with most competitions using what is called a rod floor. Routines consist of 8 skills, and the athlete competes in two different routines, one that contains twisting, and one that is straight somersaulting.
Women's Artistic	Women's Artistic Gymnastics is the most popular and well known to the public of all the gymnastics disciplines. It is an incredibly challenging sport, demanding strength, power, flexibility, agility, courage, and a combination of technical precision and artistic creativity. Apparatus: Vault, Uneven bars, Beam, Floor Exercise

ADDENDUM A1: GYMNASTIC CLUBS FROM WCGA WEBSITE IN CAPE METROPOLE DIVIDED INTO DISTRICTS

CAPE FLATS

Blomvlei Primary	Hanover Park
Brooklands Primary	Belhar
Cedar High	Mitchells Plain
CWD Rope skipping	Ottery
GCU Academic jump rope	Athlone
Giants	Mitchells Plain
Netreg	Athlone
Phillippi Gymnastics	Phillipi
Phoenix High	Manenberg
Portland Primary	Mitchells Plain
Rhythmic Salaagh	Langa
Silverstream Primary School	Manenberg
Wasabi Sport Club	Lotus River
Zeekoeivlei PS	Lotus River

NORTHERN SUBURBS

ACS Gymnastics	Monte Vista
Academy of Acrobats	Durbanville
All Stars Gymnastics	Boston
Cape Olympia	Bellville
Cape Stars	Durbanville
E-sport	Durbanville
Eversdal Gymnastics	Brackenfell
Labiance	Bellville
Spectrum	Kraaifontein
Spectrum	Bellville
Tiny Tumblers	Brackenfell
Tyger Gymnastics	Bellville
Young Minds	Brackenfell

SOUTHERN SUBURBS

Brawns	Bergvliet
Children's Paradise Educare	Plumstead
Dynamic	Rosebank
Early Years daycare	Diep Rivier
Flairs Gymnastics	Plumstead

Gordon's Gymnastics Club	Mowbray
High Flyers Gymnastics	Plumstead
Parkwood Primary	Southfield
Shine the Way	Plumstead
Southern Gym	Claremont
St Marys Primary	Retreat
Steenberg High	Steenberg
University of Cape Town (UCT)	Mowbray

SOUTH PENINSULA

Fish Hoek	Fish Hoek
Tumbling Stars	Fish Hoek

CITY BOWL

Excel Gym Club	Cape Town
Kiddies Paradise@ St James	Cape Town
Rabboni	Cape Town

WEST COAST

Dance United School of Dance	Melkbosstrand
Giants	Blouberg
Honey Pot	Milnerton
Mega	Milnerton

HELDERBERG

Firgrove Primary	Firgrove
Helderberg Gymnastics	Strand
Kirsty's Rhythmic Dance Centre	Somerset West
Parel-Vallei	Somerset West
Schick	Gordon's Bay

ADDENDUM A2: CLUB SELECTION

Cape Flats: 0 selected

1. CWD Rope skipping - Not answering telephone of contact number. No response to email.
2. GCU Academic jump rope - Telephone number faulty. No response to email.
3. Giants - Part of a Catholic Welfare development group NGO, closing down.
4. Netreg - No response to email or telephone calls.
5. Phillippi Gymnastics - Part of Giants NGO group that is closing down.
6. Wasabi sport club - No response to telephone calls. Email incorrect and not delivered
7. Blomvlei primary - outside of inclusion criteria age group.
8. Brooklands primary - outside of inclusion criteria age group.

Many clubs have closed down and did not correspond to any communication, sampling ceased as most of the clubs are situated in Langa, Manenberg or Mitchells Plain (according to the club's physical city on the WPGC website) and safety has become a concern for data collection.

Northern suburbs: 4

1. ACS Gymnastics - Unable to get hold of the owner. Left messages with a club rep. No response to email.
2. Tyger Gymnastics - Age group falls outside of inclusion criteria
3. Academy of acrobats - Busy with competitions, will get back to me at a later stage.
4. Cape Stars - Closed down.
5. Tiny Tumblers - Age group falls outside of inclusion criteria
6. Cape Olympia - Busy with competitions, will contact me at a later stage.
7. All stars gymnastics - No response to telephone or email.
8. Eversdal Gymnastics - Agree to participate in the study. Schedule 2 data collection evenings as they have many adolescents in this age group.

After the data collection was completed at Eversdal Gymnastics, the gymnastic clubs of ACS, Cape Olympia and Academy of Acrobats were available and consented to take part in the study. Data collection days were scheduled with them.

Southern Suburbs: 1

1. Shine the way - outside of the inclusion criteria age range.
2. Gordon's Gymnastic Club - Agreed and consented to take part in the study. Most efficient administration.

South Peninsula: 0

1. Fish Hoek - outside of the inclusion criteria age range.
2. Tumbling stars - outside of the inclusion criteria age range.

These were the only clubs in this district.

City Bowl: 0

1. Excel gym club - Agreed to take part in the study, but never returned any emails to confirm a data collection date - Unreachable after many telephone calls and messages.
2. Kiddies Paradise - outside the age inclusion criteria.

3. Rabboni - Does not exist anymore – not enough club members.

West Coast: 1

1. Giants - Closed down
2. Honey Pot - outside of age inclusion criteria.
3. Mega - Agreed to take part in the study.

Helderberg: 1

1. Schick - Not responding to email or telephone calls.
2. Helderberg Gymnastics - Agreed to take part in the study, but very poor administration. Had to visit the club twice in order to confirm a data collection date.

The selected seven gymnastic clubs gave written consent to take part in this study. Four of the seven districts were represented.

-

Gym Club	Frequency	Percent
Gordon's	5	7.50%
HBG	7	10.40%
Eversdal	22	32.80%
Cape Olympia	8	11.90%
AoAcrobats	5	7.50%
ACS	12	17.90%
Mega	8	11.90%
Total	67	100%

ADDENDUM A3: SAMPLE SIZE

PASS software was used to calculate sample size (Hintze,J. (2013). PASS 12 NCSS, LLC. Kaysville, Utah, USA. www.ncss.com.). Group sample sizes of 97 with the outcome (urinary incontinence) and 97 without the outcome, achieves 80% power to detect an odds ratio in the group proportions of 2.3000. The proportion of exposure (hypermobility) in the outcome positive group is assumed to be 0.5000 under the null hypothesis and 0.6970 under the alternative hypothesis. The proportion in the outcome negative group is 0.5000. The test statistic used is the two-sided Z test with pooled variance. The significance level of the test was targeted at 0.05000. The significance level actually achieved by this design is 0.0523.

ADDENDUM B1: STANDARDISED INFORMATION PACKAGE FOR THE SELECTED CLUBS

Dear Club owner/ manager

This physiotherapy master's research project will be performed by Annegret Wilsdorf-Samuel. The goal of this project is to find out how many female adolescent gymnasts struggle with stress urinary incontinence in the Cape Metropole. Another objective is to determine how many female adolescent gymnasts have general joint hypermobility and if this could contribute to the presence of stress urinary incontinence. The club members and parents will be informed of the study and have to give consent to be able to take part. No member will be forced to take part in this research project.

This research project aims to create awareness of urinary incontinence. A data collection phase will take place on a prescheduled day that will suit the club and address the correct age group of adolescent gymnasts.

The study procedure will include:

1. A 10 min talk about stress urinary incontinence and general joint hypermobility before training starts.
2. During a training session the data collection will take place.
3. Data collection requires
    a. the voluntary participants and their parents to give consent to take part
    b. the participants to complete two written questionnaires, one clinical flexibility measuring tool and height and weight measurements
4. Each participant will receive a goody bag with information about treatment options

All information will be kept confidential. The participants will be allocated a number to remain anonymous.

What is required of the club?

1. A date and time has to be set that will suit the club
2. Information regarding the research project (given to a club manager by the researcher) has to be emailed to the club members prior to the data collection day.
3. A private room where the data collection can take place
4. Five tables and eight chairs
5. One club representative to assist the researcher on the day of data collection

ADDENDUM B2: PERMISSION LETTER FOR CLUB PARTICIPATION

This letter serves as proof that the …….. Gymnastic club agrees to take part in the following physiotherapy master's research project:

"Does general joint hypermobility predispose female adolescent gymnasts to stress urinary incontinence?"

The club agrees:

- Email information to the club members
- Allow access to the club facilities on the day of data collection
- Allow goody bags and information pamphlets to be given to the voluntary participants

Participants and their parents will decide if they want to take part in the study. They will have to give consent. This is not the clubs responsibility. The club only offers the opportunity for the study to take place on their premises.

Signature: ……..

Name: ……

Date: ……..

ADDENDUM B3: ETHICS APPROVAL

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Approved with Stipulations
New Application

18-Jun-2015
Samuel, Annegret A

Ethics Reference #: S15/05/112
Title: **Does general joint hypermobility predispose female adolescent gymnasts to stress urinary incontinence?**

Dear Mrs Annegret Samuel,

The **New Application** received on **13-May-2015**, was reviewed by members of **Health Research Ethics Committee 1** via Expedited review procedures on **18-Jun-2015**.

Please note the following information about your approved research protocol:

Protocol Approval Period: **18-Jun-2015 -18-Jun-2016**

The Stipulations of your ethics approval are as follows:
The supervisor's contact details and not your own should be reported in section 3 of the application form.

Please remember to use your **protocol number** (**S15/05/112**) on any documents or correspondence with the HREC concerning your research protocol.

Please note that the HREC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

After Ethical Review:
Please note a template of the progress report is obtainable on www.sun.ac.za/rds and should be submitted to the Committee before the year has expired. The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly for an external audit.
Translation of the consent document to the language applicable to the study participants should be submitted.

Federal Wide Assurance Number: 00001372
Institutional Review Board (IRB) Number: IRB0005239

The Health Research Ethics Committee complies with the SA National Health Act No.61 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 Part 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

Provincial and City of Cape Town Approval

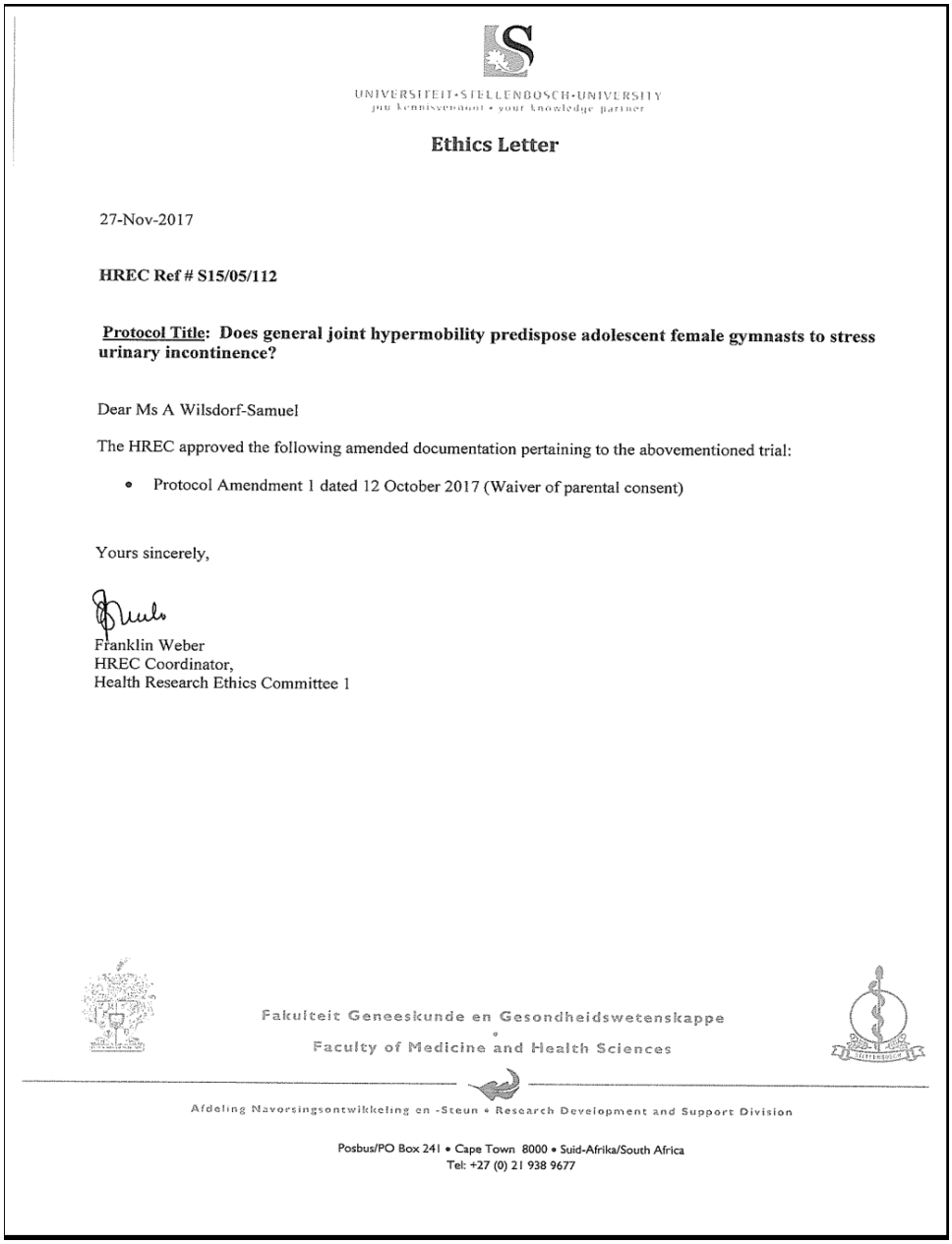
Please note that for research at a primary or secondary healthcare facility permission must still be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Contact persons are Ms Claudette Abrahams at Western Cape Department of Health (healthres@pgwc.gov.za Tel: +27 21 483 9907) and Dr Helene Visser at City Health (Helene.Visser@capetown.gov.za Tel: +27 21 400 3981). Research that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

We wish you the best as you conduct your research.
For standard HREC forms and documents please visit: www.sun.ac.za/rds

If you have any questions or need further assistance, please contact the HREC office at 0219399657.

Included Documents:

ADDENDUM B4: PARENTAL WAIVER



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Ethics Letter

27-Nov-2017

HREC Ref # S15/05/112

Protocol Title: Does general joint hypermobility predispose adolescent female gymnasts to stress urinary incontinence?

Dear Ms A Wilsdorf-Samuel

The HREC approved the following amended documentation pertaining to the abovementioned trial:

- Protocol Amendment 1 dated 12 October 2017 (Waiver of parental consent)

Yours sincerely,

Franklin Weber
HREC Coordinator,
Health Research Ethics Committee 1

Fakulteit Geneeskunde en Gesondheidswetenskappe
Faculty of Medicine and Health Sciences

Afdeling Navorsingsontwikkeling en -Steun • Research Development and Support Division

Posbus/PO Box 241 • Cape Town 8000 • Suid-Afrika/South Africa
Tel: +27 (0) 21 938 9677

ADDENDUM C1: INCONTINENCE AWARENESS ROADSHOW AND GOODY BAG

The contact details of the practicing Women's Health physiotherapists in the Western Cape will be available for the study participants if further treatment is required. (Addendum C3)

Rheumatologists treat, amongst others, patients suffering from GJH. Their contact details will be available for participants seeking treatment. Urologist practicing in the Western Cape will also be available. (Addendum C4)

The Women's Health National Executive Committee (WHNEC) does not have any informative pamphlets that can be used at the Roadshow. The PI's private practice constructed and sponsored pamphlets about urinary incontinence and general joint hypermobility. (Addendum C2)

Sponsor	**Item**
Sally Williams	90 Nougat pieces
SASP	Bags
	Cell phone stands
	Towels
	Water bottles
	Pens
	Lanyards
Cipla	water bottle
	cap
	Pen
	Notepad
	lip ice
Solutions	Pens
Media 24	Magazines 67
Cape Gate Therapy	50 hand creams
Abrahams Dentist	Tooth paste samples
Herbal Life en Discovery (Denise Carstensen)	bags
Jetline	20 Eng 20 Afri Booklets, 50 Flyers

ADDENDUM C2: SUI AND GJH PAMPHLETS

YOUR PELVIC FLOOR

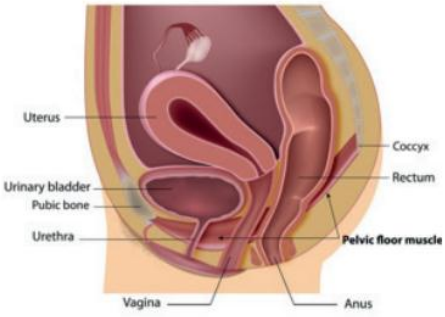
a guide for teenagers

It is unusual for young adults to struggle with urinary incontinence (leaking urine), but being aware of your pelvic floor can help manage a very embarrassing problem. The involuntary loss of bladder and bowel contents can happen when there are problems with the pelvic floor organs or the pelvic floor muscles.

What is the pelvic floor?

It is a group of muscles inside the body that stretches from the front to the back of the pelvis. It keeps the pelvic organs in place and helps to control urine, poo and wind.

If the pelvic floor muscles are too weak or too tight it will not work properly. This might cause urinary leakage when you cough, sneeze, run, jump or lift heavy objects. Pelvic floor insufficiency can be caused by: constipation, lifting heavy things, coughing a lot, being overweight, lots of active aerobic exercise and having a baby.



If you have a problem to control your urine/poo/wind please consult your doctor or women's health/pelvic floor specialist physiotherapist

How to identify your pelvic floor:

Try to stop the flow of urine when you are weeing when on the toilet. ***Important: this is only to identify the pelvic floor muscles – this is not the exercise.*** Your tummy and bum muscles should not be doing any work and no breath holding.

Once you have successfully identified the pelvic floor muscles it can now be used during specific exercises.

Getting Started:

Lie, sit or stand with your legs in a relaxed position.

Identify the pelvic floor muscles and do the correct squeeze.

Squeeze once and see if you could hold it for 10 sec.

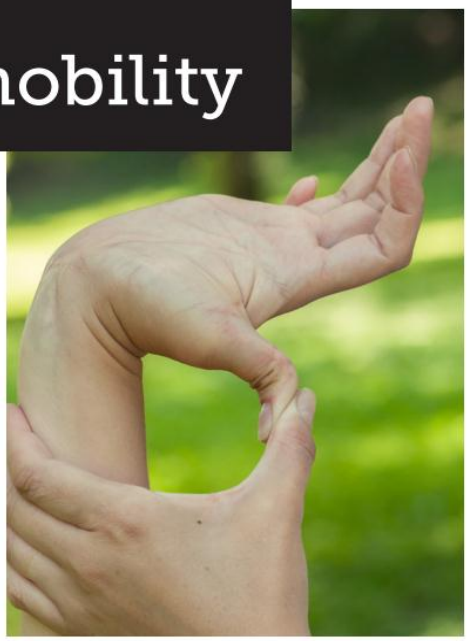
Now see if you could do 10 faster repetitions of the same exercise.

aucamp&wilsdorf
PHYSIOTHERAPISTS

This pamphlet is only a guideline and should not be used as a treatment program.

FAST FACTS about

Generalized Joint Hypermobility



- A person is considered hypermobile if their joints move in excess or beyond the normal range of motion.
- People with hypermobility have been called "double-jointed."
- Hypermobility may be associated with muscle and joint pain that is especially worse with activity and at night.
- Typically girls tend to be more hypermobile compared to boys.
- Its exact cause is unknown. Genes that are involved in the production of collagen are believed to play a role.
- While some children may have no symptoms, others may have aches and pains in the knees, elbows and calf and thigh muscles. Symptoms usually improve with rest.
- Hypermobile children are more prone to sprains, soft tissue injuries, back pain, flat feet and dislocations of affected joints. Others may have loose skin, increased bruising, thin scars and nerve compression disorders. Growing pains may be seen more often in hypermobile children.
- Joint protection techniques, improving muscle tone and muscle strength help reduce pain and repeated injuries to children with hypermobility.

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PHYSIOTHERAPISTS

ADDENDUM C3: WOMEN'S HEALTH PHYSIOTHERAPY MEMBERS IN THE WESTERN CAPE 2016 (PROV BY SASP WH)

Physiotherapist Western Cape	Area	email	Contact details
Mrs Celeste Andrea	Kuilsrivier	celesteandrea2010@gmail.com	021 903 8677
Miss Marlene Beuster		marlenebeuster@gmail.com	021-712-7754
Mrs Robinne Bigalke		robbigalke@gmail.con	021 85 5 4077
Mrs Lizette De Klerk		lizette.deklerk@icloud.com	021 91 4 4745
Mr Wessel De Kock	Panorama	wessel@physiolife.co.za	021 9 1 9 3059
Mrs Andrea Talitha Collins	Kuilsrivier	andreamy101@gmail.com	021 90 0 6244
Miss Ilse		ilseduplessis@yahoo.com	
Mev. Hilda Du Toit		h.dutoit@live.com	023 342 2805
Mrs Cindy Faull	Southern Sub	cindyfaull@gmail.com	021 53 1 7873
Miss Carmen Patricia Foley		carmenfoley@live.co.za	021 531 5395
Mrs Malikah Gaidien		malikahgaidien@gmail.com	
Mrs Dianne Wendy Orpen-Lyall		wendyorpenlyall@gmail.com	
Mrs Pamela K Hansford		pamkhand3@gmail.com	021 67 1 8439
Miss Nazrena Hassim		nazreena.hassim@gmail.com	
Mrs Helen Henning		helen.henning@gmail.com	021 97 5 4281
Ms Fiona Joy Hermanus		fhermanus@telkomsa.net	021 78 5 5569
Mrs Isabeau Neethling		nsaphysio@telkomsa.net	021-557-2780
Miss Deborah Jenkins	Southern Sub	dj@isat.co.za	072 50 6 3001
Miss Ruth Katzman	Southern Sub	rkatzman@mweb.co.za	082 86 4 8232
Miss Tessa Loftus	Stellenbosch	loftustessa@gmail.com	021 88 3 9761
Mrs Marietjie Martin	Durbanville	marietjie.martin@webmail.co.za	021 9 7 6 4832
Mrs Marianna Marais	Durbanville	marianna.marais@gmail.com	021 97 6 4922
Mrs Lonese Jacobs	Melkbos	lonese.jacobs@gmail.com	021 5 5 3 3049
Mrs Anelle Serafin	Bellville	anelleserafin@gmail.com	021 948 4052
Mrs Mariette Pitlo	Southern Sub	mariettephys@iafrica.com	021 531 7279
Mrs Rosalin Grünewald		rosalin_pretorius@yahoo.com	044 80 2 4410
Mrs Mariette Pitlo	Southern Sub	mariettephys@iafrica.com	021 531 7279000
Mrs Christina		christinasinclair1@gmail.com	
Mrs Forbes		sfsarahforbes@gmail.com	
Mrs Dana Frank		danafrank@cybersmart.co.za	082 56 6 5660
Mrs Nadine Thompson		nadine@sachin.co.za	021 9 1 3 7024
Mrs Ina Van Der Walt	George	inavdwalt@gmail.com	072 21 6 5578
Mrs Heleen Groenewald	Panorama	ricusgroen@mweb.co.za	021 9 3 0 6040
Miss Chantelle Van Den Berg		info@physioathome.co.za	071-889-2356
Mrs Marisa Breytenbach		marisabreytenbach@gmail.com	076 54 6 1025
Mrs Trinette Govender	Southern Sub	trinettevde@gmail.com	
Mrs Lindsay Wallace	Southern Sub	Lawallace@mweb.co.za	083 29 9 3937
Mrs Annegret Wilsdorf	Durbanville	annegretwilsdorf@yahoo.com	021 98 7 0111
Miss Anne Wolfaardt	Bellville	fisioanneretwolfaardt@gmail.com	021 94 3 3580

ADDENDUM C4: RHEUMATOLOGISTS AND UROLOGISTS IN THE WESTERN CAPE

RHEUMATOLOGISTS IN WC 2016

Rheumatologist	Contact details	Area
Dr Heather Angus	021 531 6655	Vincent Palloti Hosp
Dr EM Bhettay	021 590 4032	N1 City Hosp
Dr RB Bhorat	021 510 6638	Pinelands
Dr R Dersley Breeds	021 552 8100	Milnerton Mediclinic
Dr R Du Toit	021 938 9044	Tygerberg Hosp
Dr M Esser	021 930 0630	Tygerberg Hosp
Constantia Arthritis Clinic	021 797 6699	Constantia
Dr A Halland	021 939 6106	Panorama
Dr B Hodkinson	021 882 8252	Stellenbosch
Prof A Ali Kalla	021 404 2131	Groote Schuur
Dr I Louw	021 930 0869	Panorama Mediclinic
Dr M Manie	021 938 9044	Tygerberg Hosp
Dr C Piek	021 872 1711	Paarl Hosp
Dr C Pope	021 404 5387	Rooi Kruis
Prof H Reuter	021 882 8252	Stellenbosch
Dr B Sarembock	021 422 2450	Chris Barnard Hosp
Dr C Scott	021 658 5111	Rooi Kruis
Dr C Spargo	021 510 6638	Pinelands
Dr G Tarr	021 882 8252	Stellenbosch
Dr A Tooke	021 799 6289	Wynberg

UROLOGISTS IN THE WESTERN CAPE 2016

Urologist	Area	Contact details
Dr M Bigalke	Somerset West	0218526941
Dr M Bolus	Somerset West	0218526941
Dr I Breytenbach	Durbanville	0219761103
Dr I Breytenbach	Netcare Kuils River Hospital	(021) 900 6575
Dr G Bruwer	Durbanville	021 9756470
Dr W Botha	Cape Town	0214262060
Dr K Jehle	Netcare Christiaan Barnard Hospital	(021) 422 1050
Dr K Jehle	Vincent Palloti	215064186
Dr K Jehle	Cape Town	021 4262060
Dr J Joffe	Milnerton	021 5516114
Dr P Whitaker	Netcare Blaauwberg Hospital	(021) 554 2952
Dr P Whitaker	Milnerton	0215510947

Dr A Lecuona	Bellville	021 9489372
Dr B Stopforth	Bellville	021 9486023
Dr L Van Niekerk	Netcare Kuils River Hospital	(021) 900 6580
Dr L v Niekerk	Bellville	0219486023
Dr A Naude	Panorama	0219110833
Dr H Rabe	Panorama	0219304450
Dr P v Vollenhoven	Panorama	021 9304450
Dr C Moolman	Vincent Palloti	0215064186
Dr C Moolman	Plumstead	0217626062
Dr G Webb	Plumstead	0217617047
Dr J Stander	Brackenfell	0219835600
Dr L Kaestner	UCT Private Academic Hospital	(021) 447 9807
Dr Dick Barnes	UCT Private Academic Hospital	(021) 406 6529
Dr DJ Bowden	Netcare Christiaan Barnard Hospital	(021) 422 1050
Dr MLS De Kock	Netcare N1 City Hospital	(021) 595 1544
Dr SM Eppel	Netcare Christiaan Barnard Hospital	(021) 424 1626
Dr Stephan van Vuuren	Melomed	(021)9488131
Dr S Jansen van Vuuren	Netcare Kuils River Hospital	(021) 900 6324
Dr Lisa Kaestner	UCT Private Academic Hospital	(021) 442 1816 / 1966
Dr PHO Kirsten	Netcare Christiaan Barnard Hospital	(021) 423 7123
Dr A Naidoo	Netcare Blaauwberg Hospital	(021) 554 2976
Prof J Naude	Netcare Christiaan Barnard Hospital	(021) 424 1626
Prof Alan Pontin	UCT Private Academic Hospital	(021) 406 6529
Dr P Theron	Netcare N1 City Hospital	(021) 595 4669
Dr Andre Van der Merwe	UCT Private Academic Hospital	(021) 938 9577
Dr L Jee	Vincent Palloti	0215312331
Dr P Le Maistre Nicolle	Kingsbury Hosp	0216831974
Dr L Aldera	Kingsbury Hosp	0216831975
Dr P Govender	Kingsbury Hosp	0216831976
Dr T Borchers	Kingsbury Hosp	0216831977
Dr S Jeffrey	Cape Town	0214269003
Dr P Kruger	Cape Town	0214269003
Dr T Meintjies	Durbanville	0219761103

ADDENDUM D1: INFORMATION PACKAGE FOR THE PARENTS AND GYMNASTIC CLUBS

Dear Parents / Guardians

The ……. Gymnastics Club will be hosting an Incontinence Awareness and Research Day.

This day will take place

On:……..

At:……

From: ……..to……..

All club members between the ages of 11 – 19 years, together with their parents or guardians, are invited to attend.

This includes:

- A 10 minute information session regarding **urinary incontinence** and **general joint hypermobility.**
- The research collection period taking place during the normal training session where volunteers will complete 2 x questionnaires, 1 x clinical measuring tool as well as height and weight measurements.
- Receiving a “goody bag” with information regarding urinary incontinence and general joint hypermobility and treatment options.

It is important for research purposes that all participants that volunteer to take part in the study discuss it with their parents and obtain permission from them. (All the necessary forms are attached)

The information collected will be used in a Physiotherapy Master’s Thesis. All information collected will be kept confidential and anonymous with publication.

The thesis topic:

“Does general joint hypermobility predispose female adolescent gymnasts to stress urinary incontinence?”

Thank you very much for reading this email and considering participating in this research project.

Annegret Wilsdorf-Samuel

Physiotherapist (Pelvic floor specialist)

ADDENDUM D2: INFORMED CONSENT ADOLESCENTS

	STELLENBOSCH UNIVERSITY **FACULTY OF HEALTH SCIENCES**	

PARTICIPANT INFORMATION LEAFLET AND ASSENT FORM

TITLE OF THE RESEARCH PROJECT: *Does being double jointed cause teenage gymnasts to leak urine?*

RESEARCHERS NAME(S): Annegret Wilsdorf Samuel

ADDRESS: Physiotherapy Department Stellenbosch University

CONTACT DETAILS: 0765524997 or annegretwilsdorf@yahoo.com

What is RESEARCH?

Research is something we do to find new knowledge about the way things (and people) work. We use research projects or studies to help us find out more about disease or illness. Research also helps us to find better ways of helping, or treating children who are sick.

What is this research project all about?

This project will help determine if double jointed female teenage gymnasts stand a greater chance of leaking urine than those that are not double jointed.

Why have I been invited to take part in this research project?

Any teenage girl, between the ages of 11 to 19 years that does gymnastics, is invited to be part of this study. If you struggle with urinary leakage, it is of greater importance that you take part in the study.

Who is doing the research?

I, Annegret Wilsdorf Samuel, will be conducting the research. I am a Physiotherapist working in the Durbanville area and have specialized in urinary problems for the past 8 years. This study forms part of my post graduate studies. I want to investigate why some teenagers struggle with urinary incontinence. Three other physiotherapists from my practice will assist with gathering information.

What will happen to me in this study?

You are only required to answer questions and perform one flexibility test.

- *The information will be gathered during a gymnastics training session and will not exceed 15 minutes.*
- *A short presentation before training will inform gymnasts about stress incontinence and lax ligaments.*
- *Participants then have the opportunity to write down their names on a list. A specific number will be allocated to the participant. This list will be destroyed after the data collection phase to secured anonymity.*
- *Each participant will receive their own booklet with questionnaires.*

- *Data collection will take place in a private room; participants will be called one at a time.*
- *In the room there will be 4 stations where forms will be completed and one flexibility test done. Flexibility of the little fingers, wrists, elbows, knees and lumbar spine will be measured. There will be a physiotherapist at each station.*
- *At the end of station 4 each participant will receive a goody bag as appreciation for taking part in the study. Participants will not be contacted again.*

Can anything bad happen to me?
No, nothing can go wrong. There will only be one station where flexibility will be measured. If you have any discomfort after the measurements, please inform the physiotherapist and your parents. There is however no risk of injury.

Can anything good happen to me?
In case a problem is identified, treatment options will be made available.

Will anyone know I am in the study?
Only when called to the private room, fellow gymnasts might be aware of your participation. Outside of the training session, no one will be aware of your participation. Only the researcher (Annegret) will receive the information – but this will also be anonymous.

Who can I talk to about the study?
Annegret Wilsdorf Samuel: 0765524997 or annegretwilsdorf@yahoo.com

What if I do not want to do this?
You are allowed to withdraw at any stage without any consequence. You will not be in any trouble.

Do you understand this research study and are you willing to take part in it?

YES NO

Has the researcher answered all your questions?

YES NO

Do you understand that you can pull out of the study at any time?

YES NO

_____ _____
Signature of Child Date

ADDENDUM D3: INFORMED CONSENT PARENTS

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM FOR USE BY PARENTS/LEGAL GUARDIANS

TITLE OF THE RESEARCH PROJECT:

Can female teenage gymnasts suffer from stress urinary incontinence because they are double jointed?

ETHICS REFERENCE NUMBER: S15/05/112

PRINCIPAL INVESTIGATOR: Annegret Wilsdorf-Samuel

ADDRESS: Physiotherapy Department Stellenbosch University

CONTACT DETAILS: 0765524997, annegretwilsdorf@yahoo.com

Your child is being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the researcher any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how your child could be involved. Your child's participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you or your child negatively in any way whatsoever. You are also free to withdraw her from the study at any point, even if you do initially agree to let her take part.

This study has been approved by the **Health Research Ethics Committee at Stellenbosch University** and will be conducted according to the ethical guidelines and principles of the International Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study all about?

- The aim of this study is to determine whether very flexible female teenage gymnasts are more likely to suffer from urinary incontinence. I have been a physiotherapist in the women's health field for 8 years treating patients that struggle with incontinence. Some adults have mentioned that their problem started in their teenage years. I have also noticed that more sporty teenage girls complain of urinary incontinence. I would like to determine which factors contribute to this problem in order to provide early intervention.
- This research project includes gymnastic clubs in the Cape Town Metropole and they are randomly selected. If they meet the requirements to the inclusion criteria they are invited / selected.
- Data collection will be done on an arranged date at each gymnastic club. The aim is to inform the teenagers and their parents about urinary incontinence and general joint hypermobility symptoms and offer treatment options.
- The information will be collected during a gymnastics training session. This will not take longer than 15 minutes. A short talk before the training session is aimed to inform gymnasts about female urinary incontinence and general joint hypermobility. Thereafter volunteers can place their names on a list and continue with the training session. A number will be allocated to each participant. This list of names will be

destroyed for anonymity. Participants will be taken individually to a separate room where 4 stations will be set-up to continue with the data collection phase. A physiotherapist will be available at each station. At the end of the data collection each participant will receive a goody bag. Neither the teenagers nor their parents will be contacted again for follow-up appointments unless they would like any further information or treatment.

Why has your child been invited to participate?

- All 11 – 19 yr. old female gymnasts are invited to take part. If your child has a urinary incontinence problem I would urge you to give permission for your child's participation in this study. The information would be very valuable.

What will your responsibilities be?

- To give written consent for your child's participation in this study.

Will your child benefit from taking part in this research?

- This is an opportunity to identify a problem. Your child will receive information regarding different treatment options if necessary. The results will contribute to more knowledge about urinary incontinence amongst teenage girls and the presence of general joint hypermobility.

Are there any risks involved in your child taking part in this research?

- No

If you do not agree to allow your child to take part, what alternatives does your child have?

- Information about incontinence will be available on the awareness and data collection day.

Who will have access to your child's medical records?

- All information will be kept confidential and participants will be anonymous. The research personnel and I will have access to the completed forms. Personal information will be destroyed. The information will be stored on a password protected computer anonymously.

What will happen in the unlikely event of your child getting injured in any way, as a direct result of taking part in this research study?

- There is **no risk of injury**. The participants will complete forms at each station and one station will include a clinical evaluation tool to determine joint laxity of the wrists, little fingers, elbows, knees and lower back.

Will you or your child be paid to take part in this study and are there any costs involved?

You or your child will not be paid to take part in the study. There will be no costs involved for you if your child does take part.

Is there anything else that you should know or do?

- You can contact Annegret on 076 5524997 or via email annegretwilsdorf@yahoo.com if you have any further queries or encounter any problems.
- You can contact the Health Research Ethics Committee at 021 938 9207 if you have any concerns or complaints that have not been adequately addressed.
- You will receive a copy of this information and consent form for your own records.

Declaration of underaged participant

I (name of child/adolescent) …….....……. have been invited to take part in this research project.

- The Physiotherapist/ my parents explained the details of this study to me and I understand what they told me.
- They explained to me that the study includes the following: complete written forms and perform one flexibility test.
- I know that if I am unhappy, I can withdraw at any stage during this study.
- By entering my name at the bottom, I understand that taking part in this study is **voluntary** and I have not been pressurised by the physiotherapist or my parents to take part.

.....	.....
Name of child (Signed by child if possible)	**Witness**

Declaration by parent/legal guardian

By signing below, I *(name of parent/legal guardian)* ……...……

agree to allow my child (name of child) ……..… who is ……. years

old, to take part in a research study entitled *(insert title of study)*

I declare that:

- I have read or had read to me this information and consent form and that it is written in a language with which I am fluent and comfortable.
- If my child is older than 7 years, she must agree to take part in the study and her ASSENT must be recorded on this form.

- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to let my child take part.
- I may choose to withdraw my child from the study at any time and my child will not be penalised or prejudiced in any way.
- My child may be asked to leave the study before it has finished if the researcher feels it is in my child's best interests, or if my child does not follow the research plan as agreed to.

Signed at (*place*) .....…….. On (*date*) ……...…….

....

Signature of parent/legal guardian **Signature of witness**

Declaration by investigator

I *(name)* ……..…… declare that:

- I explained the information in this document to ……..
- I encouraged her to ask questions and took adequate time to answer them.
- I am satisfied that she adequately understand all aspects of the research, as discussed above
- I did not use an interpreter

Signed at (*place*) .....…….. on (*date*) ……...……...

.....

Signature of investigator

ADDENDUM E: INFORMATION SESSION BEFORE TRAINING

GENERAL INFORMATION, STRESS URINARY INCONTINENCE AND GENERAL JOINT HYPERMOBILITY

GENERAL INFORMATION:

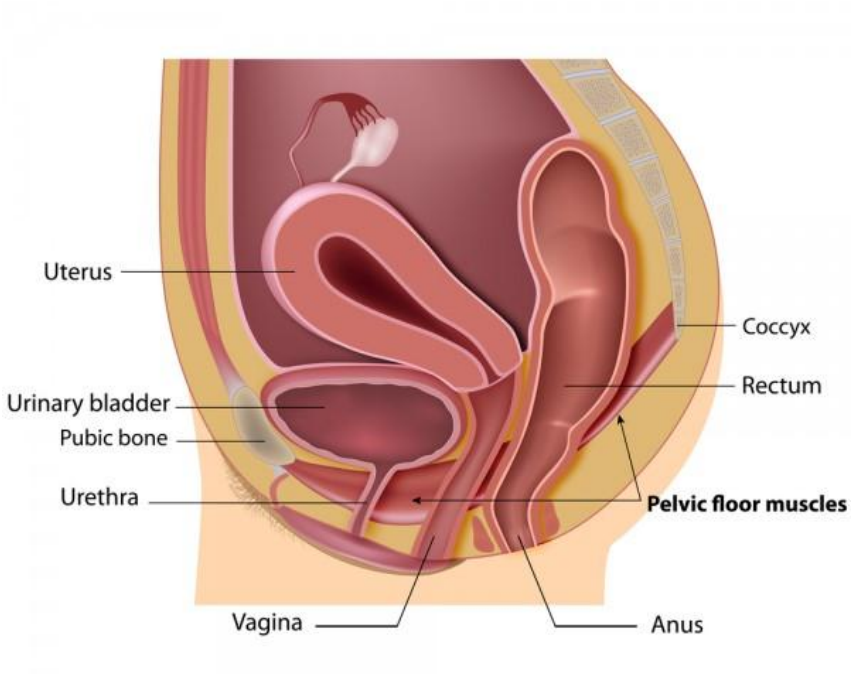
Inform participants about study procedure. Complete 2 x questionnaires and one physical assessment. Complete questions to the best of their ability. Honest as possible.

Participants will remain anonymise throughout study and information stays confidential. Have the right to withdraw at any stage.

An eligibility screening will be done at the first station, before proceeding. Also inform participants about criteria.

(SUI AND GJH)

1. Definition of urinary incontinence(UI) , stress urinary incontinence(SUI) and urge urinary incontinence (UUI)
    a. UI is the involuntary loss of urine
    b. SUI is the involuntary loss of urine when you cough, sneeze, or during activities
    c. UUI is the involuntary loss of urine when you can't control the urge to urinate.
2. Examples of SUI, UUI
    a. Cough / sneeze/ laugh
    b. Getting up from a chair / picking up a heavy object
    c. Jumping / running / any sport activities
    d. Not reaching the toilet in time
    e. urgency situations, key in door, many times short period
3. Brief anatomy of the pelvis, pelvic organs and pelvic floor muscles



4. How pelvic floor muscles work
    a. The pelvic floor muscles helps to keep all the abdominal organs inside the body

   b. The pelvic floor supports the organs when you are physically active
   c. It helps to control you bladder and stop you from leaking
5. Definition of General Joint Hypermobility (GJH)
   a. It is a condition where an individual is a lot more flexible than normal. Most or all of your joints can move more than other people's joints. All the ligaments and connective tissue* structures can stretch further than normal. These people are usually called "double jointed".
6. Examples of GJH
   a. Dancers, gymnasts and musicians are often hypermobile
   b. If your joints can bend and stretch more than normal.
   c. If your skin is more stretchy than normal
   d. Sometimes you can develop muscle and joint pains.
   e. Some have difficulty with joints that dislocate quickly, esp shoulders and ankles

ADDENDUM F: CANDIDATES WILLING TO PARTICIPATE IN STUDY

1. ……

2. ……

3. ……

4. ……

5. ……

6. ……

7. ……

8. ……

9. ……

10. ……

11……

12. ……

13……

14……

15……

16……

17……

18……

19……

ADDENDUM G1: PILOT STUDY

A pilot study was conducted at Aucamp and Wilsdorf Physiotherapy, on 16.3.16 and 17.3.16

Aim:

a) To determine if the participants understood the questions in the ISI and the self-compiled questionnaire. Ask for feedback from the participants and if any adjustments need to be made. (Addendum G2, 4)
b) To determine the time needed to complete the Beighton Score when measuring with a goniometer. (Addendum G3)
c) To determine if the station setup for data collection is reproducible and easy to follow.
d) To determine the time needed to complete all four stations. (Addendum G1)
e) Intra-rater reliability of the physiotherapist using the goniometer.

Three adolescent girls (aged 16, 14 and 13 years) from Eversdal Gymnastics Club were invited to take part in the pilot study.

The four stations for the data collection phase were quick and easy to setup at the PI's physiotherapy practice. Three physiotherapists and the PI were present. The data collection setup was followed meticulously.

Each participant used a stop watch to time the individual procedure from station 1 to station 4. (Addendum G1-G5)

Station set up for pilot study

Participant: station set up	Time to complete Beighton score	Time to complete all four stations
Adolescent 1	5 min 30s	20 min
Adolescent 2	4 min	15 min
Adolescent 3	3 min	15 min
Average	4 min 10 sek	17 min

Amendments to questionnaires:

Amendments to the format of both questionnaires were made. Tick boxes and bold print for specific attention was added.

The participants felt that the question about constipation might be embarrassing. They were unsure if the ability to stop urine flow was one the toilet or during an incontinence episode. The later question was changed slightly, but both questions were explained to the study participants prior to data collection.

This age group might not fill in the true answer due to being shy or self-conscious. Therefore, after the pilot study was completed, the questionnaires were adjusted. The data collection took place in a separate area/room.

Things to be aware of for data collection:

Place the measuring tape firmly on the wall and take a scale.

Make sure all joints are exposed during measurement for the Beighton score.

Due to time constraints, change the order of measurement of the Beighton score (Addendum J1 9 point manoeuvre score: change order to 1,2,3,5,4.). Start in standing and progress to supine.

PI's intra-rater reliability:

To evaluate the PI's intra-rater ability; goniometer testing was done on the 4 physiotherapist as they were available for follow-up measurements.

Goniometer (32cm) measurement of right knee extension in supine for pilot study

Participant for goniometer pilot	Measurements 16.3.16 9:30am	Measurements 17.3.16 8:30am
Physiotherapist A	-8°	-5°
Physiotherapist B	-5°	-5°
Physiotherapist C	-3°	0°
Physiotherapist D	-1°	0°

ADDENDUM G2: PILOT TIME

Pilot study:

Time according to stop watch to complete station 1 - 4

Participant 1:

Participant 2:

Participant 3:

Average time: 1 + 2 + 3 / 3 =

ADDENDUM G3: PILOT ISI EVALUATION

Pilot study:

Does general joint hypermobility predispose female adolescent gymnasts to stress urinary incontinence?

Evaluation of the Incontinence Severity Scale

1. Did you understand the questionnaire?

YES	NO

If no, what part did you not understand?

SECTION	WHY

2. Were you uncomfortable answering the questions?

YES	NO

If yes, which questions made you feel uncomfortable?

SECTION	WHY

3. Did you understand the words used in the questionnaire?

YES	NO

Which word/s did you not understand?

SECTION	WORD

4. Did any of the questions make you feel embarrassed?

YES	NO

If yes, which questions made you feel embarrassed?

SECTION	ANSWER

5. Did any of the questions confuse you?

YES	NO

Is yes, which questions?

SECTION	ANSWER

ADDENDUM G4: PILOT BEIGHTON TIME

Pilot study:

Beighton scale time:

Participant 1:

Participant 2:

Participant 3:

Average: 1 + 2 + 3 / 3 =

ADDENDUM G5: PILOT SELF-COMPILED EVALUATION

Pilot study:

Does general joint hypermobility predispose female adolescent gymnasts to stress urinary incontinence?

Evaluation of the Self-compiled questionnaire

1. Did you understand the questionnaire?

YES	NO

If no, what part did you not understand?

SECTION	WHY

2. Were you uncomfortable answering the questions?

YES	NO

If yes, which questions made you feel uncomfortable?

SECTION	WHY

3. Did you understand the words used in the questionnaire?

YES	NO

Which word/s did you not understand?

SECTION	WORD

4. Did any of the questions make you feel embarrassed?

YES	NO

If yes, which questions made you feel embarrassed?

SECTION	ANSWER

5. Did any of the questions confuse you?

YES	NO

Is yes, which questions?

SECTION	ANSWER

6. Is the questionnaire too long?

YES	NO

If yes, which question?

SECTION	ANSWER

7. Is there something else I could have asked?

YES	NO

Please list what else you think I could have asked?

SECTION	ANSWER

Thank you for your time

ADDENDUM H1: A5 BOOKLET FOR DATA COLLECTION

CHECKLIST

Station 1 INITIAL

- Consent forms ……..
- Eligibility criteria ……..
- Standardized explanation of station set up ……..

Station2

- Height and Weight measurement ……
- Beighton Score ……

Station 3

- Incontinence Severity Index ……
- Self-compiled questionnaire ……

Station 4

- Checklist ……
- Goodie bags ……

ADDENDUM H2: ELIGIBILITY SCREENING

Candidate number:

The participant will be excluded from the study if any of the following criteria is true:

1. Male
2. Outside of adolescent age category
    - Younger than 11 years on the day of data collection
    - Older than 19 years on the day of data collection
3. Born with or currently have existing urogenital problems
    - Any bladder problems
    - Any uterine or ovarian problems
4. Any known connective tissue disorders like Ehlers Danlos syndrome
5. Any urogenital surgical history
6. Any pregnancy history
7. No consent given by adolescent

ADDENDUM H3: STANDARDISED EXPLANATION OF STATION SET UP (English and Afrikaans)

- You will receive one A5 booklet that will accompany you from the first to the last station.
- Please do not write your name on the booklet.
- The stations have to be completed from 1 to 4 in chronological order.
- The physiotherapist at each station will help you with the section that has to be completed.
- There will be 2 questionnaires to complete. Please only tick one answer for each question. If you are unsure please raise your hand and ask for help. Do not ask one of your classmates for help.
- One station will measure your flexibility, please tell the physiotherapist if any of the measurements are painful.

ADDENDUM J1: BEIGHTON SCORE PROTOCOL

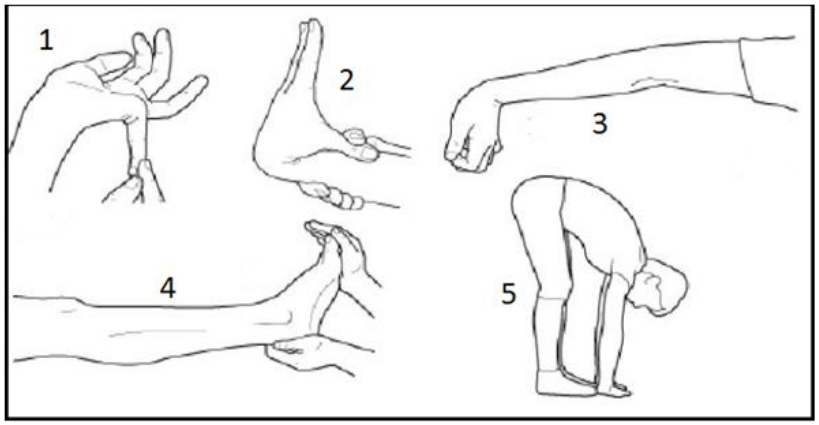
According to Smith-Engelsman (75) :

- All items were described and visualised
- Cut off points for declaring an item negative or positive was included
- Goniometry was used to measure passive bilateral
    - Dorsiflexion of the fifth metacarpophalangeal joint
    - Elbow hyperextension
    - Knee hyperextension

Station	2			
Nr:				
Position	**Description**	**Bilat testing**	**Left**	**Right**
1	Passive dorsiflexion of the fifth metacarpophalangeal joint to 90 degrees	yes	1	1
2	Passive hyperextension of the elbow > 10 degrees	yes	1	1
3	Passive hyperextension of the knee > 10 degrees	yes	1	1
4	Passive opposition of the thumb to the flexor side of the forearm, while shoulder is flexed 90, elbow extended and hand is pronated	yes	1	1
5	Forward flexion of the trunk, with the knees straight, so that the hand palms rest easily on the floor (active)	no		1
	Total			9

Beighton	**Position 1**	**Position 2**	**Position 3**	**Position 4**	**Position 5**
Position	Sit on chair with arm in 80 degree abduction. Elbow flexed at 90 degrees Forearm resting on table and pronated	Sit on a chair with shoulder 90 degrees supported. Forearm supinated.	Lying backwards with legs in horisontal.	Shoulder 90 degrees flexed Elbow extended and hand pronated	Forward flexed trunk. Knees straight. Palms resting easy on floor.
Position goniometer	Passive df MCP5	Passive extension of lateral epicondyle	Lateral femur epicondyle	Entire thumb touching the forearm	
Anatomical landmark	Dorsal side MCP5, length 5th digit	humerus pointed at tub major humeri, radius pointed at proc stiloideus	Femur pointed at trochanter major Fibula pointed at lateral malleoli	none	none

Beighton manoeuvres 9 point scale



1. A passive dorsiflexion of the little finger above 90degrees (1 point for each hand).
2. Bringing the thumb passive against the ventral side of the forearm (1 point for each thumb). (Visual observation)
3. Hyperextension of the elbow above 10 degrees (1 point for each elbow)
4. Hyperextension of the knee above 10 degrees (1 point for each knee)
5. Flexion of the trunk, with knees straight and the palms flat on the ground (1 point)

ADDENDUM J2: HEIGHT AND WEIGHT

Candidate number

Height ……cm

Weight ……kg

ADDENDUM K1: INCONTINENCE SEVERTIY INDEX (ISI)

Candidate number:

Please circle the correct answer of the following two ISI questions:

1. How often do you experience urinary leakage?
   0. Not at all
   1. Less than once a month
   2. A few times a month
   3. A few times a week
   4. Every day and/or night
2. How much urine do you lose each time?
   0. None
   1. Drops
   2. Small splashes
   3. More

FOR ADMINISTRATION USE: Physiotherapist to complete the following results:

Formula: Q1 x Q2 = score not lower than 0 or higher than 12

Q1 ……. x Q2 ……. = …….

Please select the appropriate category for the score achieved

SEVERITY CATEGORIES:

Category	**Tick**	**Candidate score**
0 - none		
1-2 - slight		
3-6 - moderate		
8-9 - severe		
12 – very severe		

ADDENDUM K2: SELF-COMPILED QUESTIONNAIRE

Candidate number:

Complete the questions and choose the most correct answer.
ONE ANSWER PER QUESTION PLEASE.
Answer by ticking the correct box [X]

1. Date of Birth .....

2. Race

☐ White	☐ Coloured	☐ Asian
☐ Black	☐ Indian	☐ Other

3. Which gymnastic club are you a member of

.....

4. Which level of gymnastics do you take part in?

☐ Level 1	☐ Level 5	☐ Level 9
☐ Level 2	☐ Level 6	☐ Level 10
☐ Level 3	☐ Level 7	
☐ Level 4	☐ Level 8	

5. Which type of gymnastics do you do?

☐ Acrobatic dance	☐ Rope skipping
☐ Acrobatic gymnastics	☐ Tumbling
☐ Aerobic gymnastics	☐ Trampoline
☐ Rhythmic gymnastics	☐ Women's Artistic

6. How many training days per week do you attend?

☐ 1 - 2 days	☐ 3 - 4 days	☐ 6 days and more
☐ 2 - 3 days	☐ 4 - 5	

☐ ☐ days

7. How many hours do you train per day?

☐ 1 -2 hrs ☐ 3 - 4 hrs ☐ 6 hrs and more

☐ 2 - 3 hrs ☐ 4 - 5 hrs

8. How many years have you been taking part in gymnastics?

……

9. Do you have regular ligament sprains? Like twisting your ankle, wrist or shoulder?

☐ Yes ☐ No

10. Do you leak urine when you cough, sneeze or laugh?

☐ Yes ☐ No

11. Do you leak urine during gymnastics training?

☐ Yes ☐ No

12. If you leak urine during gymnastics, which activities cause the leak?

☐ jump ☐ trampoline ☐ splits

☐ run ☐ dismount/ landing ☐ other

☐ tumbling ☐ vault ☐ not applicable

13. Do you make use of sanitary pads when doing gymnastics (not for menstruation but for urinary leakage?)

☐ Yes ☐ No

14. Do you need to change your gymnastics clothes because it is too wet due to urinary leakage?

☐ Yes ☐ No

15. Do you need to empty your bladder before gymnastics training starts because you are worried you might leak urine?

☐ Yes ☐ No

16. When you are on the toilet urinating, can you stop weeing half way through and start again?

☐ Yes ☐ No ☐ I haven't tried

17. In general, how many times do you get up at night to urinate?

☐ 0 ☐ 3

☐ 1 ☐ 4

☐ 2 ☐ more than 4

18. Do you suffer from constipation?

☐ Yes ☐ No

19. Do you sometimes wet your underwear before you reach the toilet, because the urge to pee is too big?

☐ Yes ☐ No

20. Have you ever consulted a medical doctor because of accidental loss of urine?

☐ Yes ☐ No