

**The prevalence of posture deformities among black African
children in selected schools in the North West Province**



**Isabeau van Biljon
(B.Sc. Hons.)**

**Dissertation in partial fulfilment of the requirements for the degree
Magister Scientiae in Human Movement Science (Biokinetics) at the
North-West University
(Potchefstroom Campus)**

Supervisor: Prof. C.J. Wilders

**May 2007
Potchefstroom**

**The prevalence of posture
deformities among black
African children in selected
schools in the North West
Province**

Isabeau van Biljon

For Gert and Anita van Biljon

Acknowledgments

I wish to express my gratitude to the following persons and organisations for their guidance and support. The completion of this study would have not been possible without their help.

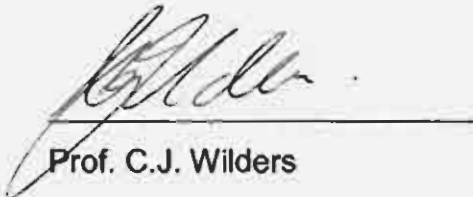
- ❖ God, my heavenly Father, for the discipline, strength and health to complete this study.
- ❖ Special thanks to my mother, father and sister for their encouragement, patience and financial support throughout the course of my study.
- ❖ My husband for his motivation and understanding.
- ❖ My study leader, Professor C.J. Wilders (School for Biokinetics, Recreation and Sport Science at the North-West University), for supervision, guidance and assistance with the analysis of the statistical data.
- ❖ Professor L. Greyvenstein for the language editing of the manuscript.
- ❖ A special thanks to the personnel of the **PLAY (Physical Activity of the Young)** project for allowing me to do this research on the children.
- ❖ To all the personnel and students and friends of the Institute for Biokinetics, for their assistance and motivation.
- ❖ To the respondents that participated in the project for their involvement and co-operation.

I. van Biljon

May 2007

Declaration

Hereby the co-author, Prof. C.J. Wilders gives permission that the review articles (Chapter 3 & 4) may form part of the candidate, Ms. I. van Biljon's, Masters dissertation. The contribution of the co-author was limited to his professional advice and guidance as study leader towards the completion of the study and thereby enabling the candidate to submit the dissertation for examination purpose.



Prof. C.J. Wilders

Supervisor

Co-author (Chapter 3 & 4)

Congress Presentation

The presentation was based on this dissertation and was delivered as follows:

VAN BILJON, I. & WILDERS, C.J. The prevalence of posture deformities among black African children in selected schools in the North West Province. Presented as a poster at the South African Sport and Recreation Conference in Potchefstroom, 7-9 September, 2006.

Opsomming

Die voorkoms van postuurafwykings in swart Afrika kinders in geselekteerde skole in die Noordwes Provinsie

Postuurafwykings is 'n algemene probleem in kinders en alhoewel dit ernstig van aard is, word dit maklik deur ouers en onderwysers geïgnoreer. Kinders se sosio-ekonomiese toestande, lewenstyl, kultuur, tradisie en omgewingsfaktore, wat ook 'n invloed op die huidige studie gehad het, word as oorsake van postuurafwykings gegee. 'n Swak postuur word geassosieër met verskeie gesondheidsprobleme, naamlik: long- en hartdefekte, slegte spysvertering en rugpyn. Een van die mees algemeenste probleme verwant aan 'n swak postuur is rugpyn wat ook aan die toeneem is onder kinders. Rugpyn word as een van die duurste mediese eise beskou en dit plaas 'n geweldige ekonomiese las op die industrie van 'n land. Die toename in postuurafwykings en die probleme wat daarmee gepaardgaan, wys op die belangrikheid van deurgaande postuurevaluerings in kinders. Daar word voorgestel dat vroegtydige identifisering van 'n postuurafwyking die kanse op herstel kan verbeter.

Verskeie studies oor postuurafwykings by kinders asook die oorsake van die afwykings is al gedoen. In die studies is daar hoofsaaklik gefokus op die rapportering van geselekteerde postuurafwykings. Min studies wat postuurafwykings van die hele muskuloskeletale sisteem gerapporteer het, kon gevind word. Die bestaande literatuur verskaf dus nie voldoende inligting wat die probleem betref nie. Daar kon ook net een studie oor postuurafwykings in die swart populasie gevind word.

Die doel van die studie was eerstens om die voorkoms van postuurafwykings onder swart Afrika kinders te bepaal en tweedens om die verskil in die voorkoms van postuurafwykings tussen meisies en seuns te bepaal. 'n Totaal van 251 kinders is vir postuurafwykings van die hele liggaam geëvalueer (136 meisies en 115 seuns). Die postuurevaluering is volgens die "New York Posture test" met behulp van 'n postuurrooster gedoen. Pasiënte is in 'n staande posisie van die posterior en laterale kant geëvalueer. Voetafwykings is deur middel van 'n swartbord en wit kalk gemeet. Vir die verdere evaluering van skoliose is die "Adams forward bending test" gedoen.

Die resultate het getoon dat die voorkoms van postuurafwykings onder swart Afrika kinders hoog is. Die voorkoms van lordose (84%) en 'n vooruitstaande abdomen was die hoogste (67%) terwyl die voorkoms van 'n gekantelde kop die laagste (8%) was. Daar was ook 'n 8% verskil in die voorkoms van postuurafwykings tussen meisies en seuns, waar die voorkoms van postuurafwykings hoër in die meisies (54%) as in die seuns (46%) was.

Sleutelwoorde: postuurafwykings, kinders, lordose, kifose, skoliose, voetafwykings

Summary

Summary

The prevalence of posture deformities among black African children in selected schools in the North West Province

It is well establish that posture deformities are a common problem among children that is often ignored by parent and teachers. Posture deformities in children could be related to their socio-economic status, lifestyle, culture, tradition, environmental factors, as well as activity levels and are associated with numerous adverse health effects, which include lung and heart defects, indigestion and back pain. Children who experience back pain are at increased risk of having back pain as adults. The economic impact of back pain affects the industry, were back problems are the most expensive type of injury claim. The increase in spinal problems, such as lower back pain in children and adolescents, points to the need for continued screening. It is suggested that early detection of postural deviation could provide an improve chance for corrective remedies and posture development.

On investigating the relevant literature it becomes clear that attempts to define the prevalence of posture deformities among children have focused on reporting selected deformities only. Consequently the literature contains insufficient information on posture deformities involving the entire musculoskeletal system, as well as the prevalence of posture deformities among black African people.

The purpose of this study was firstly to determine the incidence of posture deviations among black African children in the North West Province and secondly to determine the difference in the prevalence of posture deformities between boys and girls. In a longitudinal study posture deformities including

the entire musculoskeletal system were assessed in 251 schoolchildren (136 girls and 115 boys). Posture screening was done according to the New York Posture test and a posture grid. Subjects were evaluated in a standing position from the rear and lateral side. Foot deformities (flat foot) were also measured with the use of white chalk and a black board. Thereafter the "Adam's test" (forward bending test) were used for further scoliosis evaluation.

The prevalence of posture deformities was reported to be high among black African schoolchildren. The incidence of lordosis (84%) and protruding abdomen (67%) was the highest, while twisted head (8%) was reported as the lowest. Gender difference in the prevalence of posture deformities was also found, with a higher incidence of posture deformities reported in girls (54%) as in boys (46%).

Key words: posture deformities, children, lordosis, kyphosis, scoliosis

Contents

Chapter 1: Problem statement and aim of the study

1.1 Introduction	2
1.2 Problem statement.....	3
1.3 Aim of the study	6
1.4 Hypotheses.....	7
1.5 Structure of the dissertation	7
List of References	9

Chapter 2: Posture development and evaluation

2.1 Introduction.....	14
2.2 Posture: Good and poor	15
2.3 Influences on posture	19
2.4 Posture development.....	24
2.5 Posture deformities	28
Forward head syndrome	28
Scoliosis	31
Kyphosis.....	38
Lumbar Lordosis	43
Flat and Claw feet	48
2.6 Posture and pathology.....	52
2.7 Conclusion.....	54
List of References	55

Chapter 3: The prevalence of posture deformities among black African children in selected schools in the North West Province

Abstract	67
Introduction.....	68
Experimental methods and procedures.....	70
<i>Subjects</i>	<i>70</i>
<i>Design of study</i>	<i>70</i>
<i>Measurement procedure</i>	<i>70</i>
<i>Postural evaluation.....</i>	<i>71</i>
<i>Assistants.....</i>	<i>74</i>
<i>Statistical analysis</i>	<i>74</i>
Results.....	74
Discussion.....	79
Summary	82
List of References.....	83

Chapter 4: The difference in the prevalence of posture deformities among black African boys and girls in selected schools in the North West Province

Abstract	91
Introduction.....	92
Experimental methods and procedures.....	93
<i>Subjects & design of study</i>	<i>93</i>
<i>Measurement procedure</i>	<i>93</i>
<i>Postural evaluation.....</i>	<i>93</i>
<i>Assistants.....</i>	<i>96</i>
<i>Statistical analysis</i>	<i>96</i>

Results.....	97
Discussion.....	99
Summary	102
List of References.....	103

Chapter 5: Summary, conclusion and recommendation

5.1 Summary	108
5.2 Conclusion	109
5.3 Recommendation.....	110
5.4 Limitations.....	111
List of References.....	113

APPENDIX A.....	116
APPENDIX B.....	119
APPENDIX C.....	122
APPENDIX D.....	124

List of figures

Chapter 2

Figure 2.1: The forward head posture	31
Figure 2.2: Kyphosis.....	42
Figure 2.3: Lordosis.....	46

Chapter 3

Figure 3.1: Asymmetry of acromial height	73
Figure 3.2: Adams forward bending test.....	74
Figure 3.3: Posture deviations in the sagital plane	76
Figure 3.4: Posture deviations in the posterior plane.....	77
Figure 3.5: The incidence of flat feet	78
Figure 3.6: Poor posture of a Grade 8 child.....	78
Figure 3.7: Asymmetry of acromial height with scoliosis	79

Chapter 4

Figure 4.1: Asymmetry of acromial height	95
Figure 4.2: The prevalence of posture deformities among boys and girls.....	98
Figure 4.3: The prevalence of posture deformities according to gender (Sagital plane)	98
Figure 4.4: The prevalence of posture deformities according to gender (other).....	99

List of tables

Chapter 3

Table 3.1: Incidence rates for posture deviations	75
---	----

Chapter 4

Table 4.1: Gender differences in the prevalence of posture deformities...	97
---	----

List of Abbreviations

%	Percentage
n	Number of respondents
cm	Centimetres
AIS	Adolescent idiopathic scoliosis
PSIS	posterior/superior iliac spines
ASIS	anterior/superior iliac spines
CT or CAT scan	Computed tomography scan
PA	posterior/anterior, or back and front
ATR	axial trunk rotation

Chapter 1

Chapter 1

Problem statement and aim of
the study

Chapter 1: Problem statement and aim of the study

1.1 Introduction.....	2
1.2 Problem statement	3
1.3 Aims of the study.....	6
1.4 Hypothesis	7
1.5 Structure of the dissertation.....	7

1.1 Introduction

For generation after generation the importance of a good posture has been in dispute. The concept of a "good posture" dates back as early as the ancient Greek times where sickness was considered as "physical imbalance" and as demonstrated by numerous statues of the period. The ancient Greeks also recognized deformities like scoliosis and kyphosis (Karampelas *et al.*, 2004:2). Increasingly in this technological age, individuals are experiencing levels of spinal discomfort and poor posture.

As posture will be the essence of this study it is important to first clarify the concept of posture as such. The term posture contains an element of placement, since the root of the word is the Latin *positūra*, position, which means, "to place" or "arrange" (Shrecker, 1965:3). The term posture means that the body is held or placed in a certain position, as a whole or in parts (Shrecker, 1965:3; Kendall *et al.*, 1993:3; Loots 1999:1; Stroebe, 2002:1).

Good posture is important for an attractive appearance, but more importantly it is essential if the body is to function with an economy of effort and contributes to a person's well-being, musculoskeletal and

neuromuscular condition (Kendall *et al.*, 1993:5; Bloomfield *et al.*, 1994:95).

It has been stated that if body segments are held out of alignment for extended periods, the muscles will rest in a shortened or lengthened position and over time, adapt to these changes (Kuhns, 1962:64; Kendall *et al.*, 1993:76). Such changes in resting muscle length may influence posture alignment. Considerable deviations from optimal posture may be aesthetically unpleasant, adversely influence muscle efficiency and predispose individuals to musculoskeletal or neurological pathologic conditions (Bloomfield *et al.*, 1994:95; Novar & Mackinaron, 1997:151; Howe & Oldham, 2001:226).

The concept of posture seems to have dominated the thinking of our generation of orthopaedics and pediatrics and there is a high incidence of postural defects among Western society (Colgan, 2002:5). Posture deformities are also commonly seen in children (Francis & Bryce, 1987: 1221-1225; Ragheb & Gregory, 1993:32–35; Stroebel, 2002:63–66, 93).

Due to the fact that posture is taken for granted, it is often overlooked in therapies and not even noticed at all in daily life (Loots, 1999:4; Stroebel, 2002:6). *"Posture is a subject with infinite possibilities and merits"*, as quoted by Loots (1999:4).

1.2 Problem statement

Environmental factors influencing man's posture, with their adaptations and dispositions, are related internally to physical growth and externally to special activities conditioned by cultural demands. This may result in posture deformities. These are further directed by the individual's inherited body matrix with its tendency to grow in a certain manner as well as the stresses and strains the bone has to endure during normal activities to produce numerous varieties of posture (Phelps *et al.*, 1956:167-169; Kendall *et al.*, 1993:3).

Unfortunately, the majority of the population rarely adopts good posture, with slouching being particularly prevalent (Howe & Oldham, 2001:226). Industrialization caused by cultural demands and modern tendencies of inactivity place more stress on the structures of the human body than before. Conversely, a bad posture is caused by a bad habit (Kendall *et al.*, 1993:3).

Deformity frequently occurs in growing children who have had poor posture for a long time (Kuhns, 1962:64). Age, sex, stage of development and body type plays an important role in postural patterns of children and may vary accordingly. A pattern only becomes constant at the age of 10 years and older when the child has attained a sufficient degree of development (Asher, 1975:47). Children 9 to 12 years of age are proportioned much like an adult and their posture is erect with square shoulders. Between 12 and 14 most children are undergoing puberty and during this time, the pelvis begins to tilt backward, lessening swayback and flattening the abdomen. It is also between these ages that some children develop posture problems (Brower & Nash, 1979:60).

Girls from ages 7 – 13 maintain their balance slightly better than boys of the same age – girls averaging 10% steadier (Loots, 1999:24). Girls are also more likely to have scoliosis, which is seen as one of the most common pubertal problems (Brower & Nash, 1979:60; Mellin *et al.*, 1988:152; Herman & Pizzutillo, 2002:361). By ages 15 to 18, growth is usually complete and adult posture attained (Brower & Nash 1979:60). According to Asher (1975:47), it is not possible to describe a typical adolescent posture as the child now emerges as an individual and his stance is dependent on his body build and stage of development.

Postural deformities among children in primary and secondary schools are often associated with lack of postural awareness. Although some musculoskeletal deformities are congenital, more are acquired (Francis & Bryce, 1987:1221). Most postural deviations in the growing child fall in

the category of developmental deviations and when patterns become habitual they may result in postural faults. Developmental deviations are those that appear in many children at about the same age and that improve or disappear without any corrective treatment, sometimes even despite unfavourable environmental influences (Kendall *et al.*, 1993:3).

Children who are engaged in repetitive asymmetrical activities, vocational or recreational, are prone to develop muscle imbalance problems that can lead to lateral deviations of the spine (Kendall *et al.*, 1993:126).

Good postural development is dependent upon good structural and functional development of the body, which, in turn, is highly dependent upon adequate nutrition. After growth is completed, poor nutrition is less likely to cause structural faults that directly affect posture. At this stage, deficiencies are more likely to interfere with physiological function and to be represented posturally in position of fatigue (Kendall *et al.*, 1993:109).

The subject and the study of posture are regularly, but not often, dealt with in literature – scientific and otherwise (Loots, 1999:5). As posture is usually thought of in terms of the spine, it should be remembered that all body parts have a role to play in postural alignment (Howe & Oldham, 2001:226). Most of the posture screening programmes are aimed at the detection of scoliosis only (Stroebe, 2002:6). As a result there is a lack of understanding of certain aspects of posture and many questions are not dealt with properly (Loots, 1999:5). A study done by Nussinovitch *et al.* (2002:32) stated that screening programmes can identify previously undetected orthopaedic abnormalities in the school-age population and are worthwhile.

The improvement of faulty posture not only aids in the general improvement of many diseases and disturbances, but leads to a better health and vigour. Many posture problems of school age children are indications of health problems that could become serious if not treated early (Brower & Nash, 1979:58). For example, poor posture can cause a

downward pressure on the internal organs which can produce a broad range of health problems namely, fatigue, abdominal pain, breathlessness, palpitations, faintness, kidney and bladder problems, and constipation, to name just a few (Banfield, 2000:49).

Therefore, identification of postural deformities at an early stage is very important, as more serious disorders can be prevented in the process (Kuhns, 1962:70). In adult life, symptoms or disease are frequently found with exaggeration of the faulty adjustment of the parts of the body (Kuhns, 1962:70). No studies could be found reporting the prevalence of posture deformities among black African children.

It is in light of the literature background that the following research questions are proposed. Firstly, whether the prevalence of postural deformities is high among black African Grade 8 children in selected schools in the North West Province. Secondly, is there a gender difference in the prevalence of postural deformities among black African Grade 8 children in selected schools in the North West Province?

1.3 Aim of the study

The aim of this study is to:

- determine the prevalence of postural deformities among black African Grade 8 children in selected schools in the North West province.
- investigate gender differences in the prevalence of postural deformities among black African Grade 8 children in selected schools in the North West province.

1.4 Hypotheses

- There is a high incidence of postural deformities among black African Grade 8 children in selected schools in the North West province.
- The prevalence of postural deformities is higher among girls in black African Grade 8 children in selected schools in the North West province.

1.5 Structure of dissertation

Posture deformities are common in children, however, there is a need for comparable research completed in the broad spectrum of postural deformities. In this study the researcher will focus on reporting posture deformities among black African children including the entire musculoskeletal system. The term posture, factors that influence posture, as well as the types of postural deformities are discussed.

- ❖ Chapter 1 is the introductory chapter where the problem statement, aim and hypotheses of the study are stated. The list of references is proposed at the end of the chapter according to the regulations of the North-West University (Potchefstroom Campus).
- ❖ Chapter 2 is a review chapter and will focus on the terms involving posture, influences on posture, posture development, posture deformities and health implication of poor posture. The list of references is proposed at the end of the chapter according to the regulations of the North-West University (Potchefstroom Campus).
- ❖ As only one study on posture deformities and the black population could be found, Chapter 3 will be the first of two research articles, which will investigate the prevalence of posture deformities among black African children in the North West Province. This article was presented for publication in the *African Journal for Physical, Health*

Education, Recreation and Dance. The list of references at the end of the chapter will be proposed according to the regulations of this journal. The regulations of the journal will be attached as *Appendix A* (Guidelines for authors) at the end of the dissertation.

- ❖ Chapter 4 will be the second research article and will focus on the difference in the prevalence of posture deformities among black African boys and girls. Only a few studies on posture and gender differences could be found. This article was presented for publication in the *International Council for Health, Physical Education, Recreation, Sport and Dance Journal of Research*. The regulations of the journal will be attached as *Appendix B* (Guidelines for authors) at the end of the dissertation. The list of references at the end of the chapter will also be proposed according to the regulations of the journal.
- ❖ Chapter 5 will consist of the summarized results of the study together with the conclusions and recommendations for future research.

List of References

ASHER, C. 1975. Postural variations in childhood. Boston: Butterworths. 122 p.

BANFIELD, M.A. 2000. The posture theory: some additional considerations. The physical basis for hypochondria. 11th ed. South Australia, Adelaide: Banfield Publisher. 1004 p.

BLOOMFIELD, J., ACKLAND, T.R. & ELLIOT, B.C. 1994. Applied anatomy and biomechanics in sport. Melbourne: Blackwell Scientific Publication. 374 p.

BROWER, E.W. & NASH, C.L. 1979. Evaluating growth & posture in school-age children. *Nursing*, 9(4):58-63, Apr.

COLGAN, M. 2002. Perfect posture: the basis of power. Canada: Apple Publishing. 63p.

FRANCIS, R.S. & BRYCE, G.R. 1987. Screening for musculoskeletal deviation – A challenge for the physical therapist. *Physical therapy*, 67(8):1221-1225.

HERMAN, M.J. & PIZZUTILLO, P.D. 2002. Treating adolescent idiopathic scoliosis. Management options to straiten the spine. *Women's health in primary care*, 5(6):361–367.

HOWE, T. & OLDHAM, J. 2001. Posture and balance. (In Trew, M. & Everett, T., eds. Human movement: An introductory text. 4thed. New York: Churchill Livingstone. p. 225 - 239.)

KARAMPELAS, I., BOEV, A.N., FOUNTAS, K.N. & ROBINSON, J.S. 2004. Sciatica: a historical perspective on early views of a distinct medical

syndrome. *Neurosurgical Focus*, 16(1):1-4, Jan.
<http://www.aans.org/education/journal/neurosurgical/jan04/16-1-6.pdf> Date of
access: 4 Mar. 2007.

KENDALL, E.R., MCCREARY, E.K. & PROVANCE, P.G. 1993. Muscles testing and function. 4th ed. Baltimore: Williams and Wilkins. 450 p.

KUHNS, J.G. 1962. Diseases of posture. *Clinical orthopedics and related research*, 25:64–70.

LOOTS, M. 1999. A multi-variate approach to posture. Pretoria: University of Pretoria. (Thesis – D.Phil.) 348 p.

MELLIN, G., HÄRKÖNEN, H. & POUSSA, M. 1988. Spinal mobility and posture and their correlations with growth velocity in structurally normal boys and girls aged 13 to 14. *Spine*, 13(2):152-154.

NOVAR, C.B. & MACKINARON, S.E. 1997. Repetitive use and static postures: a source of nerve compression and pain. *Journal of hand therapy*, 10:151-159.

NUSSINOVITCH, M., FINKELSTEIN, Y., AMIR, J., GREENBAUM, E. & VOLOVITZ, B. 2002. Adolescent screening for orthopedic problems in high school. *Public health*, 116:30-32.

PHELPS, W.M., KIPHUTH, R.J.H. & GOFF, C.H. 1956. The diagnosis and treatment of postural defects. 2nd ed. Charles C Thomas. Springfield, Ill: Thomas. 190 p.

RAGHEB, M.A. & GREGORY, W.B. 1993. Postural deviations of Bahraini Schoolboys: Ages 6 – 8. *International journal on health, physical education, and recreation*, 30(2):32–35.

SHRECKER, K.A. 1965. Corrective gymnastics for schools. Cape Town: Balkema Academic and Technical Publication. 73 p.

STROEBEL, S. 2002. The prevalence of postural deformities among children age 11 – 13 years in some Western Cape schools. Stellenbosch: University of Stellenbosch. (Thesis – M.Sc.) 130 p.

Chapter 2

Chapter 2

Posture development and evaluation

"The Doctor of the future will give no medicine, but will interest his patient in the care of the human frame, in diet and in the cause and prevention of disease."

Thomas Alva Edison (1847 – 1931)

Chapter 2: Posture development and evaluation

2.1 Introduction.....	14
2.2 Posture: Good and poor	15
2.3 Influences on posture	19
2.4 Posture development	22
2.5 Posture deformities.....	28
Forward head syndrome	28
Scoliosis	31
Kyphosis.....	38
Lumbar Lordosis	43
Flat and Claw feet	48
2.6 Posture and pathology.....	51
2.7 Conclusion	54

2.1 Introduction

Although sometimes similar, every individual's posture is unique and no one has the same posture. An individual's posture is determined by the the structure and size of the bones, the position of the bony landmarks, injury and disease, static and dynamic living habits and the person's physiological state (Rathbone & Hunt, 1965:83; Bloomfield *et al.*, 1994:95).

The patterns of man's movements have altered considerably during the ages and are still altering. Over the last hundred years or so, food availability and convenience technologies arose without a corresponding change in our physical bodies. In part the changes have been responses

to altered conditions of living. In contrast to our ancestors, more time is spent "at rest" while sitting behind a desk for example, slumping over a computer, watching television or slumping over a steering wheel, all are factors contributing to a bad posture. Early man and women spent about two-thirds of their waking time on foot, hunting, gathering, and making objects (Rathbone & Hunt, 1965:83; Colgan 2002:1-3). Children today spend significantly more time sitting than they did twenty years ago and are less active. Such sedentary lifestyle can be the cause of poor posture and health problems (Banfield, 2000:9,55). On the other hand posture has a direct relation to the comfort, mechanical efficiency and physiologic functioning of the individual (Howorth, 1946:1398).

This chapter is concerned with a definition of good posture, the cause and the effect of poor posture, and to describe the common disturbances of posture development and postural deformities during childhood and adolescence. In the interest of supporting the healthy development of children, it is believed that more awareness is needed about the subject posture.

2.2 Posture: Good and poor

In 1947 The Committee of the American Academy of Orthopaedic Surgeons defined posture as the relative arrangement or alignment of body parts (quoted by Kendall *et al.*, 1993:3). Different versions of this definition were also mentioned in Asher (1975:48), Bloomfield *et al.* (1994:96), Norris (2000:134), Howe and Oldham (2001:226) and Kendall *et al.* (2005:51).

Martin (1977:25) went a step further and defined posture as a position of the body proposed by two relationships, namely that of the body to the ground and that of the body parts to each other. While Howorth

(1946:1398), Sherrill (1993:366) and Moss (2001:39) stipulated the importance of the dynamic nature of posture by defining posture as the composite of the positions of all the joints of the body at any given moment throughout the day and throughout life, whether static or dynamic. Howorth (1946:1398) also stated that it is through both static and dynamic positions that posture becomes more important and most effective.

According to Rathbone and Hunt (1965:83), it is probably incorrect to hold up a common standard of postures for all individuals, because what is ideal for one individual would not be ideal for another.

Although the above is relevant, in order to recognize postural deformities it is still necessary to set a norm of what normal or good posture is that could be applied to all (Shrecker, 1965:3; Norris, 2000:134).

Shrecker (1965:3) defined a good posture as free and erect carriage of the body, in standing and other positions, which includes walking and running.

Correct posture is usually described in an upright position when one is examined and normal posture is described in terms of standing and sitting. Howorth (1946:1401) brought dynamics into his definition by stating that a good dynamic posture meant using the body in the simplest and effective way, with the use of the following aspects: muscle contraction and relaxation; balance and coordination; rhythm and timing; inactivity and momentum. On the other hand Kendall *et al.* (1993:5) state that a good posture is simply a good habit that contributes to a person's well-being, musculoskeletal and neuromuscular condition.

According to Howe and Oldham (2001:226), good posture refers to a position that requires the least effort to maintain, puts the least strain on ligaments, bones and joints or maintains the center of mass over base

support. The reason for difficulty in defining a good posture is that every person has a unique anthropometric and physiological profile. Morphological body types (somatotypes) may be classified according to their extremes: ectomorphs (long and thin), endomorphs (short and fat) and mesomorphs (athletic and muscular) (Bloomfield *et al.*, 1994:46). Most people are a combination of all three. These anatomical differences, particular the inborn length of the ligaments, account for many of the greatest differences in posture (Howe & Oldham, 2001:226). Howe and Oldham (2001:226) also stated that balance and posture are intimately related and that balance is essential for carrying out activities. Muscles make repeated adjustments to maintain balance and equilibrium. Balance can be defined as the state in which the body is in equilibrium; and posture is a result of balancing each body part with respect to the other body parts (Loots, 1999:12; Howe & Oldham, 2001:226).

Posture as a state of the body is defined by two relationships which we separate – that of the body to the ground and that of the parts to each other (Martin, 1977:25). Posture can be simply defined as, “Any position in which the body resides”. Good posture is a rational adjustment of the various parts to each other and of the body as a whole to its environment, task or work. The complex human organism is constantly in motion, so our posture is continually shifting (Howorth, 1946:1398; Tattersall & Walshaw, 2003:18).

Shrecker (1965:5), Kendall *et al.* (1993:3) and Magee (2002:873) stated that when viewing an ideal posture from the lateral aspect, a plumb or imaginary vertical line should pass just anteriorly to the lateral malleolus of the ankle, immediately anterior to the midline of the knee and then directly through the greater trochanter, bodies of the lumbar vertebrae, shoulder joint and lobe of the ear.

According to Rhodes (1996:44), a good alignment makes the body more energy-efficient, because the muscles that are used are designed for the specific purpose of holding the body upright, and not those muscles that are pressed into service to compensate for weak postural muscles.

Barlow (as quoted by Asher, 1975:47) is of the opinion that the posture of the head is the most important single factor in establishing good posture, and, if the position of the head is correct, the rest of the body will fall into line. In any case the only form of treatment which might improve these children, would be recognition of body image and re-education (Asher, 1975:47).

In 1946 Howorth (1946:1398) described poor standing posture as a forward movement and a tilt of the pelvis, with an increased lumbar lordosis and thoracic round back. The knees sag and protrude, the chest flattens, and the shoulders, head and neck are advanced. He also described poor sitting posture characterized by a drooping of the spine and trunk, with the lumbar and thoracic spine flexed, the pelvis tilted back, the abdomen and chest flattened and compressed, and the shoulders and head forward.

Roaf (1977:2) argued that it is impossible to define a poor posture, as posture is the position the body assumes in preparation for the next movement. According to Roaf (1977:2), standing up straight cannot be seen as true or normal posture, as it is static.

Poor posture can be defined as a faulty relationship between the different segments of the body, causing pressure on supporting structures to increase (Bloomfield *et al.*, 2004:97). Poor posture can also be defined as posture that is related to pathology, hinders performance, or embarrasses parents, any or all of which can be true in a given case (Moss, 2001:39).

It seems that there are different opinions in existing literature with regards to good and poor posture. In conclusion one could argue that most of the literature refer to the alignment of body parts for a specific purpose.

2.3 Influences on posture

According to the Center for Disease Control (as quoted by Colgan, 2002:5) the soaring incidence of postural effects stems from three main sources: domestication, cultural demands and longevity. Colgan (2002:5) is of the opinion that many people today spend their lives in pre-human postures inapt to our physiological evolution, and thereby developing numerous defects and weaknesses.

Domestication

Over the last 100 years, domestication of the human species has accelerated faster than at any other time in history (Colgan, 2002:5). People are becoming more sedentary and have grown a labour-saving culture with food availabilities and technologies making life as convenient as possible (Banfield, 2000:9). Backache is common among civilized people, probably because of their more sedentary ways of life (Banfield, 2000:93).

Cultural demands

According to Colgan (2002:6) one spends 10 – 15 years bend over desks, work tables and computers learning to write and read, creating objects and playing games, while most people then spend another 40 years earning a living in almost the same manner. The modern occupations of stenography, bank clerk and desk work usually involve a lack of exercise, bad sitting and working habits

which cause people to adopt a poor posture, and can affect health in adverse ways (Banfield, 2000:55, 95).

Longevity

The lifespan of people is longer than a century ago. With people living longer, gravity has a greater effect on posture, causing it to droop. Gravity, fatigue, internal and external forces and parents generally have the most influence on posture. Any of all of these factors can be present at a given time. The severity and constancy of poor posture for short periods of time might be harmless, whereas minimally poor posture for extended periods of time might have extremely harmful effects (Moss, 2001:39; Colgan, 2002:7).

It has been reported that height loss occurs due to compression of intervertebral discs in the spine as a person ages (Banfield, 2000:77).

As the recent study's main concern is posture in school children, the following factors are discussed briefly to serve as a background:

Non-specific risk factors associated with poor posture in schools

Sitting position

Children adopt very different postures for prolonged periods during lessons, increasing muscular fatigue in the neck and back (Murphy *et al.*, 2004:118; Cardon *et al.*, 2004:133-142). School furniture may contribute to postural variations, but children do adopt various postures regardless of the furniture. In a study done by Murphy *et al.* (2004:118) the characteristics of the school furniture were found to have a strong relationship with pain. Chair height, backrest height and backrest position were all associated with pain.

Backpacks

The most common disabilities associated with backpack use are the potential for back pain and spinal deformity (Alexander, 1999; Mackenzie *et al.*, 2003:78). Daily backpack carrying is a frequent cause of discomfort for schoolchildren (Negrini & Carabalona, 2002:187 –195). Heavy backpack loads have been shown to effect children's posture (Goodgold *et al.*, 2002:214) and may be causing long-term damage to their growing bodies (Jacobs, 2002). Walking with heavy loads can change posture. According to Vacheron *et al.* (as quoted by Mackenzie *et al.*, 2003:79), subjects tend to lean forward and raise their heads. In a study done by Goodgold *et al.* (2002:213-220) it showed trunk-forward-lean to increase with carrying a heavy backpack, although it was not dose dependant. Carrying a schoolbag on one side of the shoulder or in one hand leads to side bending and causes poor posture (Banfield, 2000:54). In a study by Negrini and Carabalona (2002:187–195) on the relationship between school backpacks and back pain, the following were reported: 79.1% of children felt school backpacks to be heavy; 65.7% of children were experiencing fatigue because of backpack load; and 46.1% were complaining of back pain. Fatigue during and time spent backpack carrying, but not the backpack's weight, were associated with back pain. An Academy survey of 101 physicians disclosed that 58% had seen school-age patients complaining of back and shoulder pain caused by heavy backpacks (Alexander, 1999). Chansirinukor *et al.* (2001:110) concluded that a backpack weighing 15% of bodyweight results in increased forward head position when the weight was carried over both shoulders. Trunk posture also increased when carrying a backpack (International Chiropractic Pediatric Association, 1998; Chansirinukor *et al.*, 2001:110). Reduction of the daily backpack load of schoolchildren is recommended both because of the current results

and because it exceeds, proportionally, the legal load limits set even for adults (Negrini & Carabalona, 2002:195).

Other non-specific factors that influence posture

Although this is not part of the study per se, it is important to mention these factors. This could serve as a starting point for further research.

Diseases

Posture deformities can result from diseases that infect individual bone in the spine and cause them to crack and to collapse. It can also result from diseases that require long periods of recovery where there is a lack of exercise and back muscles weakens or in disease which causes extreme weight loss and loss of fat which leaves the bones of the skeleton sagging (Banfield, 2000:54).

Eating habits

In a study done by Kristjansdottir and Rhee (2002:852) it was found that various behavioural factors and eating habits can lead to related posture deformities. Sometimes even malnutrition, especially during the childhood formative years, can be a contributing factor to poor posture. A person with poor nutrition is likely to have sagging posture, round narrow shoulders, poor muscle tone and slightly knocked knees. Various spinal instabilities can occur as a result of poor diet causing osteomalacia or rickets, which makes the bones soft and easily bent by bodyweight (Whitney *et al.*, 1998:388; Banfield, 2000:54). Symptoms of these illnesses include bowing of the legs, protruding belly in children and forward bending of the spine in adults (Whitney *et al.*, 1998:388).

2.4 Posture development

Postural patterns in childhood vary with age, sex, stage of development and body type (Asher, 1975:13). According to Kendall *et al.* (2005:97),

children tend to adopt a certain posture when patterns become habitual. This may result in a posture deformity, although most postural deviation of the growing child is seen as developmental deviation (Kendall *et al.*, 2005:97). Developmental deviations are associated with stages of development. They arise in response to problems of balance, which occur as results of changes in body proportions and body components and usually appear and disappear at approximately the same age (Asher, 1975:1; Kendall *et al.*, 2005:97).

Pre-natal development and birth: During prenatal development, the spinal column of the fetus is kyphotic of nature, with the elbows, hips and knees deeply bent, and physiologic relaxation of ligaments and musculotendinous structures being pronounced (Goff, 1953:66, 67). Only if the kyphotic or C curve is present before birth, the following segments, namely the thoraces, sacrum and coccyx will be kyphotic at a later stage of life (Banfield, 2000:78).

Infancy: Acquiring and maintaining upright stance is a relatively difficult task for infants with top-heavy bodies. It takes them about 11 months to acquire independent upright bipedal stance and it is not until the end of the first year that infants can remain upright independently with a moving base of support (i.e. walking) (Chang, 2003:1). At birth, the entire spinal column of the infant is still flexed in a single C curve (Sherrill, 1993:371). These curves including the thoracic spine and sacrum, which are founded at birth, are called primary curves. These curves maintain the original position found at birth (Magee, 1987:377). During childhood growth, secondary curves develop that are convexed forward or extended (Magee, 1987:377). As soon as the infant is laid on its back, the primary curves seem to lessen (Shrecker, 1965:9). By turning the infant on its stomach, allowing random kicking and wiggling, the extensor muscles of the neck and back are sufficiently strengthened and the cervical and lumbar curves

begin to appear (Shrecker, 1965:9; Sherrill, 1993:371). When the infant is old enough to hold up its head, approximately at the age of three months, the C curve disappears (Bloomfield *et al.*, 1994:96; Magee, 2002:873). During infancy the child is continuously adopting a new posture. The cervical curve that is convexed forward develops at about 4 to 5 months (Bloomfield *et al.*, 1994:96; Sherrill, 1993:371; Magee, 1987:377) and forms a cervical lordosis, which enables the infant to sit up (Magee, 1987:377; Bloomfield *et al.*, 1994:96). A mild degree of bow leg in infancy (12 to 18 months) is normal (Sharrard, 1976:827; Scougall, 1977:21) and according to Scougall (1977:21) it is related to the child's sleeping in the "knee-chest" position.

The data analyzed so far indicate that infants achieve stable postures, in which they keep their head upright and coordinate head turns with arm movements, several weeks before they begin to reach out and grab objects. Each posture invokes a particular kind of coordination between perception and action (Bower, 1999:184).

Toddlers: The lumbar curve develops sometime after the child learns to walk. These curves are classified as secondary (Sherrill, 1993:371). With development, infants gain an understanding of their body position and use touch differently depending on their current position relative to their "functional boundaries" (Chang 2003:1). Toddlers rely not only on their lower limbs but also use their upper body (including hand use) to maintain their upright stance and to support their posture when they learn to stand and walk (Chang, 2003:6). When children begin walking (10 –18 months) the following posture is recognizable: stance and gait over a wide base of support; slightly flexed knees and hips; arms forward over the head for balance; bowed legs; knees externally rotated for stability; flat feet; and lumbar lordosis (McCoy & Dickens, 1997; Magee, 2002:873; Kendall *et al.*, 2005:100). Flat backs will occur in toddlers and young children who

struggle to walk upright. This condition is normally during the months where the child is gaining confidence in walking and running activities. When a flat back remains after the toddler stage, it is considered a postural deviation (Sherrill, 1993:371; Magee, 2002:873). It is normal for an infant or a toddler to have a flattening of the medial longitudinal arch in their feet when they start walking (Scougall, 1977:23; McCoy & Dickens, 1997; Kendall *et al.*, 2005:99). A degree of knock-knees is common at the age 2 – 5 year group (Sharrard, 1976:827; Scougall, 1977:23; McCoy & Dickens, 1997; Kendall *et al.*, 2005:99). According to Scougall (1977:23), knock-knees generally occurs with out-toeing, and it is usually caused by the child's sleeping pattern. *"The habitual sleeping, sitting or lying posture of a child exerts a recurring torsional force on his growing epiphysis, or unequal forces on either side of an epiphysis, so that over a period of time the increasing effect of these forces is to mould lower limb alignment."* (Scougall, 1977:21.)

Preschooler: The normal preschool child tends to develop an exaggerated lumbar curve, which may persist throughout elementary school. An imbalance in the strength of the abdominal and hip flexor muscles can cause this condition. The abdominal muscles of the preschooler are normally too weak to maintain the pelvis in a neutral position (Sherrill, 1993:371). It is a characteristic of small children to have a protruding abdomen (Sherrill, 1993:371; Kendall *et al.*, 2005:98). Lordosis (swayback) is thus a characteristic of the young child's posture, until the abdominal muscles of the child are strong enough to counteract the downward pull of the hip flexors. Therefore, lordosis should not be labeled as a deviation until the child reaches adolescence. The degree of lumbar curvature should, however, lessen from year to year (Sherrill, 1993:371). By 4 – 6 years of age flat feet tend to disappear, but if it persists even after the age of 6, he either has general familial ligamentous

laxity or could be seen as a postural problem (Sharrard, 1976:827; Scougall, 1977:23; McCoy & Dickens, 1997; Kendall *et al.*, 2005:99).

Scholar: During the growing years, between the ages 6 and 18, children are prone to a variety of health problems – including posture disorders. Although some problems are not serious, other problems, if they go undetected, may become serious (Brower & Nash, 1979:50). Postural patterns vary frequently in children under ten years; they are constantly experimenting with different ways of reacting to gravity (Asher, 1975:52; Sharrard, 1976:826).

In a 6-year-old, the spine makes a series of gentle bends – forward at the neck; backward at the thorax; forward at the lumbar area and backward at the sacral area (Brower & Nash, 1979:50). The knock-knee posture disappears by the age of seven and a child who has not been knocked kneed previously, starts to show this deformity at the age of ten (Sharrard, 1976:827; McCoy & Dickens, 1997; Kendall *et al.*, 2005:99).

As early as 8 to 10 years, posture deviations related to handedness patterns may appear which include a slightly lower shoulder in compensation of a higher hip (Kendall *et al.*, 2005:97). From ages 9 to 12, children's proportion is much like an adult's and their posture is erect with squared shoulders (Brower & Nash, 1979:50). According to Goff (1953:72), at ages 11 to 12 years the girl continues to grow ahead of the boy in weight and in stature until menarche at 12 to 13 years slows her down. During these ages the back and hamstrings tighten up. The child becomes less flexible and the proportion of lower extremity growth is accelerated. Muscular development of the girl is rapid, and body contours appear. Breasts are composed and frequently a great source of postural faults because of inadequate sex attitudes and journalistic conditioning (Goff, 1953:72).

Between the ages 10 and 14, as children continue to mature, the pelvis begins to tilt backwards, lessening swayback. The waistline of the child becomes relatively smaller and the protruding abdomen disappears (Brower & Nash, 1979:50; Kendall *et al.*, 2005:98). By ages 15 to 18, growth is usually complete and the adult posture is attained. From the side, the high thoracic spine is gently curved to the back the lumbar spine is curved to the front about the same amount (Brower & Nash, 1979:50). During adolescence the child's actual stance will depend on body build and stage of development (Asher, 1975:47). Accelerated growth during adolescence leads to substantial body distortions and can cause much damage to body-image and self-esteem (Dekel *et al.*, 1996:187). The adolescent now emerges as an individual and it is not possible to describe a typical adolescent posture (Asher, 1975:47). Adolescents and adults, on the other hand, usually have acquired well-marked postural sets, which may or may not be regarded as satisfactory (Asher, 1975:52). Treatment at adolescence may be necessary if a faulty posture has been assumed which is based on a faulty body image (Asher, 1975:47).

For the purpose of this study only the following deformities will be discussed namely: forward head syndrome; kyphosis; scoliosis; lordosis; flat feet and claw feet.

2.6 Posture deformities

Before we can establish and report on postural deformities, one must look at the statement in consensus literature with reference to different deformities.

Forward Head Syndrome

Definition

Forward head posture involves flexion of the lower cervical spine in combination with extension of the upper cervical spine and is often accompanied by protracted scapulae and increased thoracic kyphosis (Christman, 1999:6).

Etiology

When the head is held in a forward position, there is considerably more weight and tension exerted at the base of the cervical spine. Normally the vertebrae should act as a weight-bearing column and transfer the weight of the head to the base of the cervical spine. In forward head syndrome, however, the neck acts as a lever arm causing a torque force at the base of the cervical spine (Saunders & Saunders, 1993:151).

Poor posture places the head forward or sideways that puts strain on the spinal muscles and causes neck and backache. It also places extra pressure on the chest and abdomen and can, therefore, causes chest pain and restrict breathing, and it can compress the stomach, impede digestion and stunt growth (Banfield, 2000:54).

There are four instances when the forward head posture occurs:

1. The forward head posture may be a result of lumbar lordosis or lumbar extension syndromes or may occur simultaneously with lumbar lordosis or lumbar extension (Saunders & Saunders, 1993:151).
2. The forward head posture may also result from the development of joint or muscular tightness in the upper cervical spine due to muscular tension or poor ergonomics factors. If the upper back exhibits a kyphotic posture in standing or sitting, there will be a compensatory change in the position of the head and neck (Saunders & Saunders, 1993:151; Arnheim & Prentice, 2000:708). Because of muscular tension or awkward positions, the cervical spine tilts more and more into extension. This causes the lower cervical spine and the upper thoracic spine to flex in order to keep the eyes level, which tends to produce short but strong neck extensors and weak, long neck flexors (Saunders & Saunders, 1993:151; Arnheim & Prentice, 2000:708). Thus, the head will be held in a forward position (Arnheim & Prentice, 2000:708). This syndrome is often accompanied by squinting and elevation of the shoulders (Saunders & Saunders, 1993:151).
3. The forward head posture may result from weakness of the lower cervical, upper thoracic and interscapular stabilizing muscles, and tightness of the anterior chest/suboccipital muscles (Saunders & Saunders, 1993:152).
4. An acute cervical sprain or strain, which has become chronic, can result in forward head syndrome. A person is likely to let the cervical spine slump into flexion, because of pain in the acute and sub-acute stages of cervical strain or sprain. Usually, if the person tries to hold the head erect the injured muscles or joints tend to become painful. In time, the muscles become weak and the joint loses extension mobility. This causes the

upper cervical spine to extend in order to keep the eyes and the head level. By the time the precipitating injury has healed, the person is fixed in a new posture (Sherrill, 1993:374; Saunders & Saunders, 1993:153)

Strain on the ligaments and muscles in the posterior lower cervical and upper thoracic spine are caused by chronic forward head posture. Symptoms of this syndrome include a generalized, non-specific pain in the neck and upper back, headaches and occasional referred pain into the upper extremities (Saunders & Saunders, 1993:154).

Diagnosis

Forward head posture is diagnosed when the earlobe and the tip of the shoulder is no longer aligned (Sherrill 1993:374). According to Saunders and Saunders (1993:151) the upper cervical spine is extended in the forward head posture syndrome, while the lower cervical and upper thoracic spine is relatively flexed. Additionally, forward head posture is usually accompanied by rounded shoulders; slumped sitting; weakness of upper back muscles; tightness of anterior chest and upper cervical muscles and abduction of the scapula (Sherrill, 1993:374; Saunders & Saunders, 1993:151).



Figure 2.1: The forward head posture, accompanied by round shoulders (PLAY-project).

Scoliosis

Dekel *et al.* (1996:187) refer to scoliosis as one of the most common postural deformities which is known to develop during adolescence.

Definition

Scoliosis is defined as a deformity in which there are one or more lateral curvatures of the lumbar region (Dekel *et al.*, 1996:188; Magee, 1987:147). Calliet (1975:1) defines scoliosis as an abnormal curvature of the spine. Many definitions for scoliosis exist, but in general it is referred to in literature as a lateral deformity or sideways curvature to the spine (Shrecker, 1965:39; Kendall *et al.*, 1977:195; Sherrill, 1993:377; Dekel *et al.*, 1996:187-188; Arnheim & Prentice, 2000:109; Banfield, 2000:59).

Magee (1987:147) also defined scoliosis as torticollis, should the lateral curvature be situated in the cervical spine. The athlete with scoliosis exhibits a recognizable abnormal curve in one direction and a

compensatory secondary curve in the opposite direction (Arnheim & Prentice, 2000:709).

Etiology

The most common form of scoliosis falls into a classification known as Adolescent Idiopathic Scoliosis (AIS) (Dekel *et al.*, 1996:188). In this group the cause remains unclear in a large number of cases. Hazebroek-Kampschreur *et al.* (1992:480) and Dekel *et al.* (1996:188) describe idiopathic scoliosis as a structural deformity of unknown etiology. According to Sherrill (1993:381) about 75% of the known cases are idiopathic, about 12.5% are congenital anomalies, and the other 12.5% are from paralysis or paresis of muscles on one side of the spinal column. Many persons with poliomyelitis have scoliosis (Sherrill, 1993:381).

Adolescent idiopathic scoliosis (AIS) is a spinal deformity of 10° or greater that is diagnosed in children older than 10 years, when measured using the Cobb technique. It has a prevalence of 1% to 3% in the general population (Herman & Pizzutillo, 2002:361).

The loss of flexibility in a spinal curvature defines it as a structural spinal deformity; a curvature sufficiently mobile to resolve with change in a posture is a non-structural or functional scoliosis which is within normal limits of the movement of the human spine (Hawes, 2003:171).

According to Soucacos *et al.* (1997:1498), the specific definition of scoliosis varies among reports, with the minimum size of curving ranging from 5 to 10 degrees. As a result the prevalence reported in the literature varies greatly.

Lateral curvature to the left or the right of part of the spine can cause the vertebral column to become S-shaped. Scoliosis occurs in about 5% of all children in a normal population, but a mild form is more common than that among athletes who pursue asymmetrical training (Peterson & Renström, 2001:255).

Scoliosis is divided into two distinct forms: **nonstructural** and **structural**. **Nonstructural** or **functional** scoliosis is a lateral curvature of the vertebral column not associated with any structural deformity of the vertebrae or intervertebral discs, and is non-progressive (Dekel *et al.*, 1996:188). A **functional** scoliosis can be caused by a nonspinal defect such as unequal leg length, muscle imbalance or poor postural habits (Saunders & Saunders, 1993:39). The scoliotic curve will disappear on forward flexion, whereas the spine with structural scoliosis remains twisted. With the athlete in this position, one side of the spine may be more prominent than the other (Arnheim & Prentice, 2000:709).

A **structural** scoliosis is caused by a defect in the bony structure of the spine such as wedging of the vertebral bodies (Saunders & Saunders, 1993:39). Lateral bending of the spine is symmetric on clinical and radiographic examination and the curve is usually mild without fixed rotation (Dekel *et al.*, 1996:188). Structural scoliosis is characterized by three features:

- a. the soft tissue contracts in the concavity of the curve;
- b. structural change processes occur in the vertebrae involved in the deformity;
- c. a fixed rotating deformity of a vertebrae's body which occurs with rotation toward the convexity of the curve (Dekel *et al.*, 1996:188).

Idiopathic scoliosis is more likely to occur in girls (Sherrill, 1993:381; Dekel *et al.*, 1996:188; Nussinovitch *et al.*, 2002:31) with onset usually occurring at the skeletal age of 10 –12 years (Dekel *et al.*, 1996:188). According to Herman and Pizzutillo (2002:361), girls are more likely than boys to have severe curvature (greater than 20°). In boys idiopathic scoliosis is more likely to occur at the age of 14 years as well as after skeletal maturation. The right thoracic curve is the most frequent finding (Dekel *et al.*, 1996:188).

In a study done by Soucacos *et al.*, (1997:1500), the prevalence of scoliosis varied according to the age of the patient and the magnitude of the curve. Only a small percentage of scoliosis was detected in the children from age 9 to 10 with the greatest prevalence of scoliosis observed in 13 and 14 year olds. The curvature tends to increase slowly during the growth period and the degree of the curve does not increase after the 15th year. The prevalence of scoliosis is the highest in preadolescents (Soucacos *et al.*, 1997:1498). The severity of the curve varies between individuals with less than 5% requiring special correction (Banfield, 2000:64). The study also showed that small scoliotic curves are the most common (Soucacos *et al.*, 1997:1500).

According to Herman and Pizzutillo (2002:361), children with scoliosis often have early pubertal growth spurts and increased growth velocity. In a study done by Nissinen *et al.*, (1994:9), it was found in the prescoliotics of both sexes, that body height and sitting height were greater than in other children.

A variation in the prevalence of scoliosis in ethnic groups has also been reported in other studies (Segil, 1974:393; Hazebroek-Kampschreur *et al.*, 1992:480).

Diagnosis

Over-all, screening children for scoliosis with the use of a simple test appears to be an effective means for the early detection and non-operative treatment of scoliosis and makes prevention of severe deformity possible (Hazebroek-Kampschreur *et al.*, 1992:480; Soucacos *et al.* 1997:1503). Furthermore, school screening programmes generate important data regarding not only the prevalence but also the natural history of spinal deformities. Such data are fundamental to an understanding of the development of scoliosis and its treatment (Soucacos *et al.*, 1997:1503).

Positive signs for scoliosis include asymmetrical shoulder levels, scapular prominence; unequal distance from upper extremities to the flanks or difference in length of the lower limbs while the patient is standing (Soucacos *et al.*, 1997:1499). The height of the iliac crest, posterior/superior iliac spines (PSIS), anterior/superior iliac spines (ASIS), gluteal folds and fibular heads must also be checked for inequity (Saunders & Saunders, 1993:73). Whenever uneven shoulders are noted, a lateral spinal curve convex on the same side should be expected. This is not a problem if scoliosis is not found. In normal development the dominant side of the body has a slightly depressed shoulder and higher hip. This should not be confused with scoliosis (Sherrill, 1993:381).

Several methods and techniques have been developed in an attempt to predict scoliotic deformities. Only a few traditional methods including the Adams- forward bending test, Cobb angle technique, the scoliometer, Moiré topography; and the measuring of the rib hump form the basis of most of the worldwide reported screening test.

- ❖ *Adams-forward bending test:* There are many techniques for detecting scoliosis, but the forward bending test developed by Adams is the most widely used method (Soucacos *et al.*,

1997:1499). In the study done by Nissinen *et al.* (1994:12), the majority of the patients with scoliosis had prepubertal large humps, suggesting the importance of the forward bending test in the screening of scoliosis. According to Saunders and Saunders (1993:39), a structural scoliosis does not straighten during forward bending or sidebending away from the direction of the curve. Because lateral bending is always accompanied by rotation, a “lumbar bulge” and or “rib hump” will be observed when the patient bends forward, if a structural scoliosis is present. Generally, a functional scoliosis of this type will straighten during forward and sidebending away from the direction of the curve, but this may not be true if muscle spasm and guarding is present or if the soft tissue structures have shortened on the concave side of the curve.

- ❖ *Cobb angle technique:* A measurement used for evaluation of curves in scoliosis on a PA (posterior/anterior, or back and front) radiographic projection (x-ray) of the spine. When assessing a curve the apical vertebra is first identified. This is the most likely displaced and rotated vertebra with the least tilted end plate. The end/transitional vertebra is then identified through the curve above and below. The end vertebra is the most superior and inferior vertebra which is least displaced and rotated and have the maximally tilted end plate. A line is drawn along the superior end plate of the superior end vertebra and a second line drawn along the inferior end plate of the inferior end vertebra. If the end plates are unclear the line may be drawn through the pedicles. The angle between these two lines (or lines drawn perpendicular to them) is measured as the Cobb angle. In S-shaped scoliosis where there are two contiguous curves the lower end vertebra of the upper curve will represent the upper end vertebra of the lower curve. Because the Cobb angle reflects curvature only in a single plane and fails to account for vertebral rotation it may not accurately

demonstrate the severity of three-dimensional spinal deformity. As a general rule a Cobb angle of 10 is regarded as a minimum angulation to define scoliosis (Korovessis & Stamatakis, 1996:1661; Moe *et al.*, 1978:32; Calliet, 1975:28).

- ❖ *The scoliometer:* This is an inclinometer designed to measure trunk asymmetry, or axial trunk rotation (ATR), also commonly referred to as the “rib hump deformity”. The scoliometer’s high interrater reliability and validity values suggest that the instrument would provide useful data in scoliosis screening programmes, but should not be used exclusively as a diagnostic tool. The scoliometer does not correlate highly with the radiographic assessment of the Cobb angle and pedicle rotation (Korovessis & Stamatakis, 1996:1661; Amendt *et al.*, 1990:116).
- ❖ *Moiré topography:* The Moiré apparatus was built primarily for the purpose of evaluating scoliosis patients by measuring the asymmetry of the body surface resulting mainly from deformity of the ribs and muscles. The Moiré pattern is an optical effect produced when the subject is positioned behind a grid of horizontal lines illuminated by a point light source. The line shadows cast by the grid conforms to the surface topography of the subject (Warner *et al.*, 1992:192).

Although several procedures for operative and non-operative treatment of scoliosis have evolved, the most effective treatment is still based on early detection. In this regard school screening is a powerful tool that can be used to identify children who may have scoliosis, as well as those who may be at risk for the disease. Several techniques have been described for the early detection of scoliosis, and the most widely used method is the forward bending test developed by Adams, with or without a scoliometer

(Soucacos *et al.*, 1997:1498; Nussinovitch *et al.*, 2002:30). Over-all, screening children for scoliosis with use of a simple test appears to be an effective means for the early detection and non-operative treatment of scoliosis and other spinal deformities.

Kyphosis

Kyphosis or simple round shoulders is common in young children, usually because of poor posture (Banfield, 2000:56).

Definition

According to Sherrill (1993:375), *kyphos* literally means a sharp angulation. Kyphosis is characterized by an increase thoracic curve (Sherrill, 1993:375; Arnheim & Prentice, 2000:708) and by scapulae that are protracted, which produce a rounded shoulder appearance. Kyphotic deformity may be defined as an abnormal posteriorly directed sagittal plane curvature of the spine due to trauma or some disease (White *et al.*, 1977:8) and is also referred to as round shoulders (Banfield, 2000:123). The condition is also known as humpback, hunchback, Pott's curvature, or round upper back. Kyphosis is usually associated with forward head syndrome (Sherrill, 1993:375).

Etiology

There are different types of kyphosis in children and adolescents.

- *Postural kyphosis*

Postural kyphosis is associated with disease of the intervertebral disks or of the epiphyseal area of the vertebrae (Sherrill, 1993:375). Kyphosis is a non-structural, functional deformity with onset during the

late juvenile period, usually 9–12 years and does not involve the centers of ossification of the vertebral bodies (Domisse, 1998:48).

- *Scheuermann's kyphosis*

Another type of kyphosis that affects children, as well as adolescent males is called Scheuermann's disease. It is a disease of unknown etiology. This condition is known to cause progressive thoracic or lumbar kyphosis (Arnheim & Prentice, 2000:708). Scheuermann's disease is a structural deformity with the onset of puberty: 11 – 15 years for girls and 13 –17 years for boys. Thus disease is more likely to affect boys, and boys outnumber girls in the proportion of 5 to 3. Many cases in girls are due to bad shape of their stays which are too narrow in front. The girl has to move her shoulders forward to ease off the pressure on the front of the chest (Domisse, 1998:48; Banfield, 2000:56). Scheuermann's disease involves the secondary ossification centers of the vertebral bodies, usually at mid-thoracic and thoracolumbar levels. An abnormal wedge-shaped vertebral body, instead of a rectangular-shaped vertebral body is formed. The region that is most affected extends from T6-T11/12. This region is very rigid and, therefore, the most vulnerable segment of the spinal column. Scheuermann's is three times more likely to occur than kyphosis (Domisse, 1998:48).

- *Congenital kyphosis*

A malformation of the spinal column during fetal development causes kyphosis in some infants. Several vertebrae may be fused together or the bones may not form properly. This type of kyphosis may worsen as the child grows (Winter, 1977:26; Boachie-Adjei & Lonner, 1996:883; McMaster & Singh, 1999:1367)

Clinical evaluation of posture and the estimation of the range of kyphosis and lordosis are subjective and vary among different examiners, due to

the lack of simple, accurate objective methods (Willner & Johnson, 1983:874). A study done by Willner and Johnson (1983:875) shows the obvious relationship between the velocity of growth and the mean range of kyphosis for boys and girls respectively. When the growth rate is at its slowest, the kyphosis is least pronounced. A slow increase of the lumbar lordosis was observed in boys as well as in girls between 8 – 16 years of age. In boys, however, a decrease of the lordosis similar to that in kyphosis was seen at the age of 10. The lordosis in the girls, however, seemed to be more prominent than in boys (Willner & Johnson, 1983:875).

In a study done by Milne and Lauder (1974:336), it shows an increase in kyphosis with an increase in age. The effects of occupation and of habitual posture with loss of muscle tone as age increases, as well as spinal osteoporosis and senile emphysema can be given as reasons for kyphosis increasing with age (Milne & Lauder, 1974:336). The absence of lordosis, according to the study of Milne and Lauder (1974:336), after 64 years of age, may result from the increasing kyphosis pushing the center of gravity in the body forward, with loss of lordosis from compensatory straightening of the lower spine.

The normal range of kyphosis is related to both age and gender (Fon *et al.*, 1980:979). The degree of kyphosis increases with age and the rate of increase is higher in females than in males. This appears to be more obvious after age 40 (Fon *et al.*, 1980:979). A study done by Fon *et al.* (1980:982) shows the range of 20° - 40° (Bradford, 1979 in Fon *et al.*, 1980:982) that has been reported as a reasonable range for kyphosis, is inadequate because this range of values would have resulted in false “normals” and false “abnormals” for the younger and older age groups, respectively. However in the absence of any control study where the sample is a true random sample of from the general population these

results should serve as useful guidelines for prediction of normal thoracic kyphosis (Fon *et al.*, 1980:982). The normal range of thoracic kyphosis is 20 -60° (Calliet, 1975:21). Sorenson's criteria include wedging of three or more vertebrae, each exceeding 5 degrees. Scheuermann accepted wedging of single vertebrae, together with structural changes of the secondary ossification centers, as positive evidence. The wedging may involve the superior or inferior surface of the body or both (Domisse, 1998:50).

Kyphosis and scoliosis prevent the ribs and lungs from expanding properly so the person breathes with their diaphragm. The chest eventually becomes stiff from lack of movement and that makes breathing difficult. Lung problems, breathlessness similar to bronchitis, and a cough with sputum can eventually occur (Banfield, 2000:84).

In older children more pronounced shoulders are the commonest which causes a compensating arch in the small of the back. This causes the abdomen to project forward and results in flattening of the chest and deficient expansion of the lungs (Banfield, 2000:57).

Diagnosis



Figure 2.2: Kyphosis accompanied by flattened chest and forward head posture (PLAY-project, 2004)

Diagnostic procedures may include the following:

- ❖ *Physical evaluation:* According to Sherrill (1993:384), a flattened chest appearance of the anterior thoracic wall (flat chest) usually accompanies kyphosis.
- ❖ *X-rays:* With the use of a full-spine x-ray and the Cobb technique, as previously mentioned, the physician or radiologist measures the angle of the spinal curve (White *et al.*, 1977:9; Fon *et al.*, 1980:980; Willner, 1981:525).
- ❖ *Computed tomography scan (Also called a CT or CAT scan):* A diagnostic imaging procedure that uses a combination of x-rays and computer technology to produce cross-sectional images. A CT scan shows detailed images of any part of the body, including the bones, muscles, fat, and organs. CT scans are more detailed than general x-rays and useful in patients with congenital deformities (Goh *et al.*, 2000:310; Ricq & Laroche, 2000:528).

- ❖ *Spinal pantograph*: This device is a pantograph mounted on a tripod provided with a drawing table. At the end of the pantograph arm a low-frictioned wheel is mounted. The child stands in front of the spinal pantograph, relaxed, equally balanced on both feet and looking straight ahead. By having the pantograph wheel lightly following the spinal processes, the contour line of the thoracic and lumbar curves is registered on the paper roll of the pantograph, on a scale of 1:4. The ranges of kyphosis and lordosis are determined as follows:

By allowing a ruler to follow the registered contour line of the spine, the three tangents of the curves, which deviate maximally from the vertical, are marked. The proximal angle is a measure of the thoracic kyphosis and the distal angle of the lumbar lordosis (Willner & Johnson, 1983:875). According to Willner (1981:525), the spinal pantograph seems to be as accurate as the X-ray.

Lumbar lordosis

Definition

Kendall *et al.* (1977:15) define lordosis as an increased anterior curve of the spine, usually found in the lumbar region and associated with an anterior pelvic tilt.

Lordosis, also called swayback or hollow back, is an exaggeration of the normal posterior concave curve in the lumbar region. It not only affects the five lumbar vertebrae but also throws the pelvis out of the correct alignment (Shrecker, 1965:29; Sherrill, 1993:375).

Etiology

The abdominal muscles and gluteal muscles are typically lengthened and weak, which allow the pelvis to tilt anteriorly, moving the anterior superior iliac spine (ASIS) forward and downward in relation to the pubic bone (Bloomfield, 1994:99; Sherrill, 1993:375; Magee, 1987:380). This can either cause the hip flexors to shorten or the pelvic tilt can be caused by over developed hip flexors (Norris, 2000:145). Overly tight lumbar extensors add to an anterior tilt (Sherrill, 1993:375; Magee, 1987:380). In addition to the problem described above, the hamstrings attempt to compensate for the weak gluteal muscles during walking (Norris, 2000:145). The degree of anterior pelvic tilt is often associated with marked shortness of iliopsoas (hip flexors) muscles e.g. the weakness of the anterior abdominal and the shortness of the hip flexors cause a muscle imbalance, which can result in an anterior pelvic tilt (Kendall *et al.*, 1993:80).

In a study done by Watson (1983:237) on a group of athletes it showed that lordosis is due to the forward movement of the lumbar spine, accompanied by forward rotation of the pelvis. Such changes would be brought about by excessive tightness of the psoas and iliacus muscles, which originate respectively from the lower six vertebrae and the medial surface of the ilium, and insert into the lesser trochanter of the femur. Tightness of the quads also tends to rotate the pelvis forward, especially if the hamstrings and abdominals are relatively weak.

Lordosis is commonly seen in obese people (Magee, 1987:380; Norris, 2000:145), where the lumbar spine rest in extension with the lumbar facet joints impacted; the elastic recoil of the hamstring allows the pelvis to hang (Norris, 2000:145).

According to Norris (2000:236), lordotic posture can be seen as a requirement of certain sports e.g. gymnastics and dancing (Junghanns, 1986:291; Bloomfield *et al.*, 1994:104; Norris, 2000:236). The lordotic posture in some figures in thousands of training hours is constantly repeated and is deliberately gradually increased through relaxation of the intervertebral motor segments. The compensatory posture is not physiological since it results in a strong pressure on the posterior portion of the lumbar intervertebral discs (Junghanns, 1986:291). It may also develop in pregnant women (Norris, 2000:236; Magee, 1987:380). It is the posture most noticeable in women after childbirth, especially multiple births (Norris, 2000:236).

A study by Watson (1983:236) investigating the incidence of postural deviations in a group of young male sportsmen found the incidence of lumbar lordosis to be significantly higher amongst individuals specializing in soccer and football. In a separate study it was shown that the degree of lumbar lordosis of a group of soccer players and footballers increased during 21 months of participation in these activities (Watson, 1983:236).

Failure of segmentation of the neural arch of the facet joint segment can also cause lordosis. In this case the fibrous bond that bridges this defect in the pars interarticularis of the neural arch is under considerable stress during weight bearing and other movements. When it is damaged or even gives way through injury or repeated stress, pain and a resulting deformity of lordosis may develop (Helfet & Gruebel Lee, 1978:83). According to Moe *et al.* (1978:325), the normal range of lumbar lordosis is 40° - 60°.

Diagnosis



Figure 2.3: Severe lordosis, with compensating kyphosis and anterior pelvic tilt (PLAY-project, 2004)

Diagnostic procedures may include the following:

- ❖ *Physical evaluation:* According to Sherrill (1993:375), true lordosis usually has the following characteristics:
 1. Anterior pelvic tilt.
 2. Tight lower back muscles, tight lumbodorsal fascia, tight hip flexors, tight iliofemoral (Y) ligaments, weak abdominals, weak hamstrings, and weak gluteals.
 3. Knees may be hyperextended.
 4. Kyphosis may develop to compensate for increased concavity. In this case the pectorals and intercostals may be tight.
 5. The upper body tends to shift backward and causes the weight of the bodies of the vertebrae to shift onto the neural arches. This causes the spinous processes to move closer together and in some cases it pinches the nerve.

6. Lower back pain.
7. Inhibits normal organ function, including digestion, elimination, and reproduction. This characteristic is also described by Banfield (2000:54,84).
8. Increased incidence of back strain and back injuries.

Abdominal protrusion is usually accompanied by lordosis and is normal in the young child, but tends to disappear during adolescence. This posture defect is almost always present in adolescents and adults who lead sedentary lifestyles, especially if they are overweight (Sherrill 1993:375).

Lumbar lordosis is measured with a flexible curve molded to the contour of the subject's lumbosacral spine. Sites along the flexible curve that intersected with adhesive dots marking the spinous process of T-12, L-4 and S-2 are marked with twist ties attached to the flexible curve. The shape of the curve's outline is traced on a piece of posterboard and marks corresponding to the spinous process were made along the curve's contour. Quantification of the curve (in degrees) is done with a technique that involves drawing a tangent line to the curve at the points representing the spinous process of T-12, L-4, and S-2. Intersections of the 3 tangent lines to the curve at the points representing the spinous process are measured with a protractor, and the sum of the 2 angles are the estimate of the magnitude of lumbar lordosis (Youdas *et al.*, 2000:265).

- ❖ *X-rays & the Cobb Angle Method:* The Cobb technique, which measures vertebral endplate is frequently used for measuring lordosis of the lumbar spine and is described earlier in this chapter (Chen, 1999:1786).

Flat feet and Claw feet

Congenital and acquired foot deformities are common in children (Malan & Heyns, 1997:133,140; Jackson & Stricker, 2003:133) and can be either flexible or rigid. Rigid foot deformities do not correct without treatment and will eventually resolve in foot pain. Flexible foot deformities generally resolve spontaneously and are passively correctable (Jackson & Stricker, 2003:133). Developmental flat feet (*pes planus*) are more common in children at the walking age while claw-feet (*pes cavus*) often go unnoticed in childhood and may cause foot pain in adults (Malan & Heyns, 1997:133,140).

Definition

Claw-foot can be defined as an excessively arched foot, giving an unnatural high instep (Malan & Heyns, 1997:133).

While an accepted definition of flexible flat foot is lacking, definitions always include flattening of the medial longitudinal arch of the foot with weight-bearing (Jackson & Stricker, 2003:139).

Scougall (1977:23) and Shrecker (1971:59) defined *flat feet* as the flattening of the longitudinal arch of the foot when standing or walking. Flat feet are seen as a flexible deformity, which implies that the flat arch is correctable. In more severe cases of flat feet there may be severe eversion of the heel as well as fore foot abduction (Jackson & Stricker, 2003:139)

Etiology

Claw foot (pes cavus): This deformity is far less often observed than flat feet. The foot structure is altered with the heel in varus, an increased

medial longitudinal arch and often forefoot varus. Claw toes may develop later. The foot may become painful as a result of pressure effects on the limited area of the skin that has to handle weight bearing. A neurological cause could be found with neurological examination e.g. spinal dysraphism, or familial neuromuscular disease (Malan & Heyns, 1997:138).

Flat foot (pes planus): The etiology of flat feet is usually benign familial laxity, which allows the ligament support of the arch of the foot to stretch under weight bearing loads (Jackson & Stricker, 2003:139). According to Sherrill (1993:390) and Magee (1987:328), flat feet may be congenital or postural. If the muscle of the legs and feet are strong and flexible and the body is in good alignment, congenital flat foot is not considered as a postural deviation. Infants are born with varying degrees of flat foot, due to the presence of fatty tissue in the arch (Sherrill, 1993:390; Jackson & Stricker, 2003:139). Vigorous kicking and strenuous locomotor activities cause strong arches to develop as a natural consequence (Sherrill, 1993:390). Parents often complain that their toddlers' feet appear flat. This is observed when standing or walking commences. At this age the medial fat pad of the foot sole usually disappears. Any pre-existing of the arch becomes more noticeable. On examination most feet are normal for that age (Scougall, 1977:23; Malan & Heyns, 1997:133). According to (Scougall, 1977:23), when a child's foot is unusually flat when he first stands, or when the flattening persists even after the age of 6 years, then he probably has generalized familial ligamentous laxity, all his joints sharing in this increased flexibility. The prevalence of flat foot decreases with age, but may remain 10-23% by adulthood (Rao & Joseph, 1992:525)

The normal medial longitudinal arch of the foot is formed by the anatomical relationship of the ossicles represented on the medial side of

the foot. Weight bearing tends to flatten this arch. The force is counteracted by muscle action of normal stance and gait that reduces the stresses on stabilizing ligaments (Malan & Heyns, 1997:133).

Imbalance in muscle strength is caused by faulty body mechanics and improper alignment of the foot and leg, which in turn prevents maintenance of the longitudinal arch in the correct position (Sherrill, 1993:390; Scougall, 1977:23). The flat foot deformity increases foot/ankle range-of-motion and causes distraction and compression of various joints, therefore, altering normal foot/ankle biomechanics and kinematics (Patterson *et al.*, 2003).

The physician often prescribes special shoes (Sherrill, 1993:390). *Pes planus* may also be due to trauma, for example the fracture of the calcaneus (Magee, 1987:329).

African and Aboriginal children often present with flat feet, which is culturally and genetically normal for them (McCoy & Dickens, 1997). In a study done by Roa and Joseph (1992:525-527) on the influence of footwear on feet, the findings suggested that shoe wearing in early childhood is damaging to the development of a normal longitudinal arch. In Europe and America flat foot is a common reason for the attendance at a children's orthopaedic clinic, but in India children are seldom brought for treatment of flat foot. The few children who do complain are from wealthy urban families and they all wear shoes (Roa & Joseph, 1992:525-527). According to Charette (2003), the tendency to develop flat feet is inherited and the source of many children's flat feet can be traced to a parent or relative.

Diagnosis

Flat feet

- ❖ *Physical examination:* The Feiss line method evaluates the severity of the flat foot. With this method an imaginary line is drawn from the knee joint to the metatarsophalangeal of the big toe. The distance that the navicular is from the Feiss line determines whether the condition is first, second or third degree as follows (Sherrill, 1993:390):

- ❖ First degree – navicular 1 inch below
- ❖ Second degree – navicular 2 inch below
- ❖ Third degree – navicular 3 inch below.

Foot deformities can also be measured by stepping into powdered white chalk and then onto a black board to check for foot abnormalities (flat feet) (Reedco Inc. 2001; Stroebel, 2002:58).

- ❖ *Radiographic:* Foot X-rays of the patient standing illustrates abnormal bony relations in flat feet. Dorsoplantar views show the angle formed by the long axis of the talus and calcaneus to be increased above normal 30 degrees. Views from the lateral side of normal feet show the longitudinal axis of the talus in line with the first metatarsal. In flat feet this line falls below the line of the first metatarsal (Malan & Heyns, 1997:133).

2.5 Posture and pathology

Skeletal malalignment causes pathology of structures within the musculoskeletal system. Pathology is defined as *anatomic or physiologic deviations from normal that cause physical functional limitations* (Riegger-Krugh & Keysor, 1996:164). If postural deformities were simply an

aesthetic problem the concern about them might be limited to appearance. However, it may be recognized that postural faults that persist into adulthood may cause discomfort, pain or permanent deformity (Kuhns, 1962:64; Kendall *et al.*, 1977:1). Many posture problems of school-aged children are indications of health problems that could become serious if not treated early (Brower & Nash, 1997:58).

According to the literature there is a definite relationship between bad posture and back pain (Kuhns, 1962:68; Taimela *et al.*, 1997:1132-1136; Watson *et al.*, 2002:87-92; Murphy *et al.*, 2004:113-120). Low back pain is a common and costly problem in young people and has a marked impact on daily life. The prevalence of back pain in school children varies from 10 – 71% depending on the back pain definition, cultural differences and age (Nissinen *et al.*, 1994:1367; Burton *et al.*, 1996:2323; Taimela *et al.*, 1997:1134; Leboeuf-Yde & Kyvik, 1998:228; Harreby *et al.*, 1999:447; Watson *et al.*, 2002:91). Previously considered as minor and non-limiting, back pain in this age group may have both immediate and long-term consequences for an important proportion of children (Watson *et al.*, 2002:91). Several factors such as gender, smoking, age, load carrying (Harreby *et al.*, 1999:448; Trevelyan & Legg, 2006:46–49), sports activities, sitting position, family history, flexibility, television, anthropometry and psychological reasons have been associated with non-specific lower back pain in young people (Trevelyan & Legg, 2006:46–49). According to Harreby *et al.* (1999:444) and Mackenzie *et al.* (2003:78), children with back pain are at increased risk for experiencing back pain as adults. According to Taimela *et al.* (1997:1132), a significant part of back pain in a 14-year-old adolescent is already chronic or will occur again at a later stage. An agreement is observed in the literature with the reporting of lower back pain increasing relatively with age (Burton *et al.*, 1996:2323; Leboeuf-Yde & Kyvik, 1998:228; Taimela *et al.*, 1997:1134; Watson *et al.*, 2002:91). In the UK at least five million adults

consult their GP annually concerning back pain. The economic impact of back pain affects the industry, where back problems are the most expensive type of injury claim (Maniadakis & Gray, 2000:95-103; Troup in Murphy *et al.*, 2004:113).

Conditions like flat feet, ankle pronation, bow legs, abnormal stride length, leg length differences, pelvic tilt (normal 30°) spinal abnormalities, weak asymmetric muscle strength and loss of flexibility can disrupt the normal function of the back and lower extremities producing strain, pain and eventually irreversible postural deformities (Magee, 2002:875).

Poor posture can result in hypermobilities and hypomobilities, increased compression and increased tension. Compensations occur throughout the kinetic chain in an attempt to overcome the difference within (Moss, 2001:39).

When poor posture is present, the spinal curves increase, the chest flattens and the abdomen's circumference increases greatly and protrudes (Banfield, 2000:128; Kuhns, 1962:68). Poor alignment can affect the body's inner workings by hampering the function of organs (Kuhns, 1962:65; Rhodes, 1996:44; Banfield, 2000:57) through displacement of the thoracic and abdominal viscera (Kuhns, 1962:65). In the thoracic cavity cardiac function is disturbed by downward placement of the heart, which causes the heart to work against greater pressure, with gradual strain to the heart (Kuhns, 1962: 65). According to Kuhns (1962:66), poor posture alone cannot cause heart disease but the functional disturbances accompanied with poor posture can aggravate the disease (Kuhns, 1962:65). Slouching forward can restrict the movement of the lungs, which in turn inhibits breathing (Kuhns, 1962:65; Rhodes, 1996:44; Banfield, 2000:57,84). Abdominal organs also show many disturbances when poor posture is present. Both the nutrition of the organ and

absorption of food become impaired (Kuhns, 1962:68; Banfield, 2000:128).

Conclusion

A definition of posture eludes everyone who has much to do with children and according to Goff (1953:78), school-aged children offer the greatest challenge to those directing their growth and development. Since normal postural alignment is age specific, health professionals need to know normal alignment for different stages of development to assess linkage of skeletal alignment to present or future pathology (Riegger-Krugh & Keysor, 1996:165). The severity and constancy of poor posture are both factors in how serious a problem it is (Moss, 2001:39) and pre-adolescents and adolescent youths may have serious disorders affecting their posture (Goff, 1953:78). Overall screening for postural deformities with the use of simple tests appears to be an effective method for the early detection and non-operative treatment of postural deformities. Furthermore, school screening programmes generate invaluable data regarding, not only prevalence, but also the natural history of postural deformities. Such data are essential to understand the progress of postural faults and ultimately, their treatment (Soucacos *et al.*, 1997:1503).

List of References

ALEXANDER, C.B. 1999. "The American Academy of Orthopedic Surgeons". The American Academy of orthopedic Surgeons Bulletin News. <http://www.aaos.org/wordhtml/bulletin/dec99/acdnws8.htm> Date of access: 10 Apr. 2004.

AMENDT, L.E., AUSE-ELLIAS K.L. & EYBERS, J.L. 1990. Validity and reliability testing of the scoliometer. *Physical therapy*, 70(2):108-117.

ARNHEIM, D.D. & PRENTICE, W.E. 2000. Principles of athletic training. 10th ed. Boston, Mass: McGraw-Hill. 868 p.

ASHER, C. 1975. Postural variations in childhood. London & Boston: Butterworths. 122 p.

BANFIELD, M.A. 2000. The posture theory: some additional considerations illustrated. 11th edition. The physical basis for hypochondria. South Australia, Adelaide: Banfield Publisher. 1004 p.

BLOOMFIELD, J., ACKLAND, T.R. & ELLIOT, B.C. 1994. Applied anatomy and biomechanics in sport. Melbourne: Blackwell Scientific Publication. 374 p.

BOACHIE-ADJEI, O. & LONNER, B. 1996. Spinal deformity. *Pediatric Clinics of North America*, 43(3):883-897.

BOWER, B. 1999. Minds on the move. Babies extend their reach into the world of thought and action, 155(12):184, Mar. <http://www.sciencenews.org/pages/pdfs/data/1999/155512/15512-14.pdf> Date of access: 12 Jan. 2006.

BROWER, E.W. & NASH, C.L. 1979. Evaluating growth and posture in school-age children. *Nursing*, 9(4):58-63, Apr.

BURTON, A.K., CLARKE, R.D., MCCLUNE, T.D. & TILLOTSON, K.M. 1996. The natural history of low back pain in adolescents. *Spine*, 21(20):2323-2328.

CALLIET, R. 1975. Scoliosis: diagnosis and management. Philadelphia: FA Davis. 121 p.

CARDON, G., DE CLERCQ, D., DE BOURDEAUDHUIJ, I. & BREITHECKER, D. 2004. Sitting habits in elementary schoolchildren: a traditional versus a "moving school". *Patient education and counseling*, 54(2):133-142, Dec.

CHANG, T. 2003. The relationship between touch and infants' upright posture during the first year of walking. Maryland: University of Maryland. (Thesis – M.Sc.) <https://drum.umd.edu/dspace/bitstream/1903/1362/1/umi-umd-1286.pdf>
Date of access: 13 Apr. 2006.

CHARETTE, M. 2003. Do children need corrective footwear? *Dynamic chiropractic*, 21(12), Jun. <http://www.chiroweb.com/archives/21/12/03.html> Date of access: 2 Jun. 2006.

CHANSIRINUKOR, W., WILSON, D., GRIMMER, K. & DANSIE, B. 2001. Effects of backpacks on students: measurement of cervical and shoulder posture. *Australian journal of physiotherapy*, 47(2):110–116.

CHEN, Y.L. 1999. Vertebral centroid measurement of lumbar lordosis compared with the Cobb technique. *Spine*, 24(17):1786-1790, Sep.

CHRISTMAN, J. 1999. Power Posture. (Progress report on a proposal to add specific stretching and strengthening exercises to prescribed military physical

training to improve the load carrying capacity of the head and upper body at the 5th Annual Uniformed Services Recruit and Trainee Health care symposium at the Beaufort Island, South Carolina Naval Hospital)
<http://www.powerposture.com/index.html> Date of access: 15 Apr. 2006

COLGAN, M. 2002. Perfect posture: the basis of power. Canada: Apple Publishing. 63 p.

DEKEL, Y., TENEBBAUM, G. & KUDAR, K. 1996. An exploratory study on the relationship between postural deformities and body-image and self-esteem in adolescents: the mediating role of physical activity. *Journal of sport psychology*, 27:183-196.

DOMISSE, G.F. 1998. Scheuermann's disease and postural kyphosis. *South Africa journal of bone and joint surgery*, 8(3):48-51, Aug.

FON, G.T., PITT, M.J. & THIES, A.C. 1980. Thoracic kyphosis: range in normal subjects. *American journal of roentgenology*, 134:979-983, May.

GOFF, C.W. 1953. Posture in children. *Clinical orthopaedics and related research*, 1:66-79.

GOH, S., PRICE, R.I., LEEDMAN, P.J. & SINGER, K.P. 2000. A comparison of three methods for measuring thoracic kyphosis: implications for clinical studies. *Rheumatology*, 39(3):310-315, Mar.

GOODGOLD, S., MOHR, K., SAMANT, A., PARKE, T., BURNS, T. & GARDNER, L. 2002. Effects of backpack load on task demand on trunk forward lean: Pilot findings on two boys. *Work*, 18:213-220.

HARREBY, M., NYGAARD, B., JESSEN, T., LARSEN, E., STORR-PAULSEN, A., LINDAHL, A., FISKER, I. & LAEGAARD, E. 1999. Risk factors for low back pain in a cohort of 1389 Danish school children: an epidemiologic study. *European spine journal*, 8:444-450.

HAWES, M.C. 2003. The use of exercise in the treatment of scoliosis: an evidence-based critical review of the literature. *Pediatric rehabilitation*, 6(3-4):171-182, Aug.

HAZEBROEK-KAMPSCHREUR, A.A.J.M., HOFMAN, A., VAN DIJK, A.Ph. & LINGE, B. 1992. Prevalence of trunk abnormalities in eleven-year-old schoolchildren in Rotterdam, the Netherlands. *Journal of pediatric orthopedics*, 12:480-484.

HELFET, A.J. & GRUEBEL LEE, D.M. 1978. Disorders of the lumbar spine. Philadelphia: J.B. Lippincott. 262 p.

HERMAN, M.J. & PIZZUTILLO, P.D. 2002. Treating idiopathic scoliosis. Management options to straighten the spine. *Women's health in primary care*, 5(6):361-367.

HOWE, T. & OLDHAM, J. 2001. Posture and balance. (In Trew, M. & Everett, T., eds. Human movement: An introductory text. 4thed. New York: Churchill Livingstone. p. 225 - 239.)

HOWORTH, B. 1946. Dynamic posture. *Journal of the American Medical association*, 131(17):1398-1404.

INTERNATIONAL CHIROPRACTIC PEDIATRIC ASSOCIATION. 1998. Backpacks... your child's spine is at stake. (Newsletter for

November/December.) <http://www.icpa4kids.com/articles/nov98a.htm>. Date of access: 22 February 2002.

JACKSON, J.F. & STRICKER, S.J. 2003. Pediatric foot notes: a review of common congenital foot deformities. *International Pediatrics*, 18(3):133-140. [http://int-peadiatrics.org/PDF/Volume 18/18-3/133 140 ip1803.pdf](http://int-peadiatrics.org/PDF/Volume%2018/18-3/133%20140_ip1803.pdf). Date of access: 14 Apr. 2007.

JACOBS, K. 2002. Are backpacks making our children beasts or burden? (The proceedings of the XVI annual international Occupational Ergonomics and Safety conference '2002 in Boston. 4 p.) http://www.isbe.state.il.us/pdf/carrying_Backpacks_physical_Effects.pdf. Date of access: 14 Apr. 2007.

JUNGHANNS, H. 1986. Clinical implications of normal biomechanical stresses on spinal function. Philadelphia: Aspen Publishers. 395 p.

KENDALL, H.O., KENDALL, F.P. & BOYNTON, D.A. 1977. Posture and pain. 9th ed. New York: Williams & Wilkens. 204 p.

KENDALL, E.R., MCCREARY E.K. & PROVANCE, P.G. 1993. Muscles testing and function. 4th ed. Baltimore: Williams and Wilkins. 450 p.

KENDALL, E.R., MCCREARY E.K., PROVANCE, P.G., RODGERS, M.M. & ROMANI, W.A. 2005. Muscles testing and function: with posture and pain. 5th ed. Baltimore: Williams and Wilkins. 480 p.

KOROVESSIS, P.G. & STAMATAKIS, M.V. 1996. Prediction of scoliotic cobb angle with the use of the scoliometer. *Spine*, 21(14):1661-1669, Jul.

KRISTJANSDDOTTIR, G. & RHEE, H. 2002. Risk factors of back pain frequency in schoolchildren: a search for explanations to a public health problem. *Acta paediatrica*, 91(7):849-854, Jul.

KUHNS, J.G. 1962. Diseases of posture. *Clinical orthopedics and related research*, 25:64–70.

LEBOEUF-YDE, C. & KYVIK, K.O. 1998. At what age does low back pain become a common problem? A study of 29,424 individuals aged 12-14 years. *Spine*, 23(2):228 – 234.

LOOTS, M. 1999. A multi-variate approach to posture. Pretoria: University of Pretoria. (Thesis – D.Phil.) 348 p.

MACKENZIE, W.G., SAMPATH, J.S., KRUSE, R.W. & SHEIR-NEISS, G.J. 2003. Backpacks in children. *Clinical orthopaedics and related research*, 409:78-84.

MAGEE, J.D. 1987. Orthopedic physical assessment. Philadelphia: W.B. Saunders. 423 p.

MAGEE, J.D. 2002. Orthopedic physical assessment. 4th ed. Philadelphia: W.B. Saunders. 1020 p.

MALAN, M.M. & HEYNS, M.D. 1997. The foot of the child – what is normal and what is not. *Continuing medical education*, 15(2):129 - 141.

MANIADAKIS, A. & GRAY, A. 2000. The economic burden of back pain in the UK. *Pain*, 84:95–103.

MARTIN, J.P. 1977. A short essay on posture and movement. *Journal of neurology, neurosurgery and psychiatry*, 40:25-29.

McCOY, A. & DICKENS, B. 1997. Understanding normal variations in childhood, gait and posture, 17 Apr. http://www.nevdgp.org.au/info/std_misc/Gait_hcs.htm. Date of access: 16 Sep. 2005.

MCMASTER, M.J. & SINGH, H. 1999. Natural history of congenital kyphosis and kyphoscoliosis. A study of one hundred and twelve patients. *American journal of bone and joint surgery*, 81(10):1367-1383, Oct.

MILNE, J.S. & LAUDER, I.J. 1974. Age effects in kyphosis and lordosis. *Annals of human biology*, 1(3):327-337.

MOSS, R.I. 2001. Posture and pathology. *Athletic therapy today*, 6(5):38-39.

MOE, J.H, WINTER, R.B., BRADFORD, D.S. & LONSTEIN, J.E. 1978. Scoliosis and others spinal deformities. Philadelphia, London, Toronto: WB Saunders Co. 325 p.

MURPHY, S., BUCKLE P. & STUBBS, D. 2004. Classroom posture and self-reported back and neck pain in schoolchildren. *Applied ergonomics*, 35:113-120.

NEGRINI, S. & CARABALONA, R. 2002. Backpacks on! Schoolchildren's perception of load, associations with back pain and factors determining the load. *Spine*, 27(2):187-195, 15 Jan.

NISSINEN, M., HELIÖVAARA, M., SEITSAMO, J., ALARANTA, H. & POUSSA, M. 1994. Anthropometric measurements and the incidence of low back pain in a cohort of pubertal children. *Spine*, 19(12):1367-1370.

NORRIS, C.M. 2000. Back stability. Champaign, IL: Human Kinetics. 272 p.

NUSSINOVITCH, M., FINKELSTEIN, Y., AMIR, J., GREENBAUM, E. & VOLOVITZ, B. 2002. Adolescent screening for orthopedic problems in high school. *Public health*, 116:30-32.

PATTERSON, R.M., TREVINO, S.G., WRIGHT, A.J., NAKAMURA, T., LONGO T. & BUFORD, W.L. 2003. Foot/ankle kinematics: comparative analysis of normal foot vs. flat. (Lecture given during the Summer Bioengineering Conference on June 25-29, 2003 at Sonesta Beach Resort in Key Biscayne, Florida.) <http://www.tulane.edu/~sbc2003/pdfdocs/0227.PDF> Date of access: 23 Sep. 2004.

PETERSON, L. & RENSTRÖM, P. 2001. Sports injuries. Their prevention and treatment. 3rd ed. London: Thompson publishing services. 534 p.

RAO, U.B. & JOSEPH, B. 1992. The influence of footwear on the prevalence of flat foot: a survey of 2300 children. *Journal of bone joint surgery*, 74-B:525-527.

RATHBONE, J.L. & HUNT, V.V. 1965. Corrective Physical education. London: W.B. Saunders. 267 p.

REEDCO INC. 2001. "Anatomical measuring advices". info@ccccmi-reedco.com Date of access: 12 Jan. 2004.

RHODES, M. 1996. Back in balance. *Women's Sport & Fitness*, 18(1):44-48, Feb.

RIEGGER-KRUGH, C. & KEYSOR, J.J. 1996. Skeletal malalignments of the lower quarter: correlated and compensatory motions and posture. *Journal of science and technology*, 23(2):164-170, Feb.

RICQ, G. & LAROCHE, M. 2000. Acquired lumbar kyphosis caused in adults by primary paraspinal myopathy. Epidemiology, computed tomography findings, and outcomes in a cohort of 23 patients. *Joint bone spine*, 67(6):528-532.

ROAF, R. 1977. Posture. London: Academic press. 100 p.

SAUNDERS, H.D., SAUNDERS R.B. 1993. Spine: Evaluation, treatment and prevention of musculoskeletal disorders. 3rd ed. Minnesota: Saunders Group. 396 p.

SCOUGALL, J. 1977. Knock-knees, in-toeing and other common problems. *The medical journal of Australia*, 1:21-23.

SEGIL, C.M. 1974. The incidence of idiopathic scoliosis in the Bantu and white population groups in Johannesburg. *South African journal of bone and joint surgery*, 56(B), 393.

SHARRARD, W.J.W. 1976. Problems of childhood. Knock-knees and bow legs. *British medical journal*, 1:826-827.

SHERILL, C. 1993. Adapted physical activity, recreation and sport. 4th ed. Dubuque: Brown & Benchmark. 714 p.

SHRECKER, K.A. 1965. Corrective gymnastics for schools. Cape Town: Balkema Academic and Technical Publication. 73 p.

SHRECKER, K.A. 1971. Corrective gymnastics for schools. 3rd ed. Cape Town: Balkema Academic and Technical Publication. 73 p.

SOUCACOS, P.N., SOUCACOS, P.K., ZACHARIS, K.C., BERIS, A.E. & XENAKIS, T.A. 1997. School-screening for scoliosis. A prospective epidemiology study in Northwestern and Central Greece. *The journal of bone and joint surgery*, 79(A):1498-1503.

STROEBEL, S. 2002. The prevalence of postural deformities among children age 11 – 13 years in some Western Cape schools. Stellenbosch: University of Stellenbosch. (Thesis – M.Sc.) 130 p.

TAIMELA, S.M., KUJALA, U.M., SALIMINEN, J.J. & VILJANEN, T. 1997. The prevalence of low back pain among children and adolescents. A nationwide, cohort-based questionnaire survey in Finland. *Spine*, 22(10): 1132-1136.

TATTERSALL, R. & WALSHAW, M.J. 2003. Posture and cystic fibrosis. *Journal of the Royal Society of medicine*, 96(43):18-22.

TREVELYAN, F.C. & LEGG, S.J. 2006. Back pain in schoolchildren – where to from here? *Applied ergonomics*, 37:45-54.

WARNER, J.J.P., MICHELI, L.J., ARSLANIAN, L.E., KENNEDY, J. & KENNEDY, R. 1992. Scapulothoracic motion in normal shoulders and shoulders with glenohumeral instability and impingement syndrome. A study using Moirè topographic analysis. *Clinical orthopaedics and related research*, 285:191-199, Dec.

WATSON, A.S.W. 1983. Posture and participation in sport. *Journal of sports medicine and physical fitness*, 3:231-239, Sep.

WATSON, K.D., PAPAGEORGIOU, A.C., JONES, G.T., TAYLOR, S., SYMMONS, D.P.M., SILMAN, A.J. & MACFARLANE, G.J. 2002. Low back pain in schoolchildren: Occurrence and characteristics, *Pain*, 97:87-92.

WHITE, A.A., PANJABI, M.M. & THOMAS, C.L. 1977. The clinical biomechanics of kyphotic deformities. *Clinical orthopaedics and related research*, 128:8-17.

WILLNER, S. 1981. Spinal pantograph - a non-invasive technique for describing kyphosis and lordosis in the thoraco-lumbar spine. *Acta paediatrica Scandinavica*, 52(2):525-529, Oct.

WILLNER, S. & JOHNSON, B. 1983. Thoracic kyphosis and lumbar lordosis during the growth period in children. *Acta paediatrica Scandinavica*, 72:873-878.

WINTER, R.B. 1977. Congenital kyphosis. *Clinical orthopedic related research*, 128:26-32, Oct.

WHITNEY, E.N., CATALDO, C.B. & ROLFES, S.R. 1998. Understanding normal and clinical nutrition 5th ed. Belmont, CA: West/Wadsworth. 932 p.

YODAS, J.W., GARRET, T.R., EGAN, K.S. & THERNEAU, T.M. 2000. Lumbar lordosis and pelvic inclination in adults with chronic low back pain. *Physical Therapy*, 80(3):261-275.

**The prevalence of posture deformities in black African children in
selected schools in the North-West Province.**

Authors: Isabeau Van Biljon (B.Sc. Honn) Biokinetics & Cilas.J.Wilders
(B.Jur; Ph D) Biokinetics

School for Biokinetics, Recreation and Sport Science, North-West
University (Potchefstroom Campus), P/Bag x 6001, Potchefstroom,
South Africa.

Corresponding author:

Email: Cilas.Wilders@nwu.ac.za

Tel/Fax: +2718-2991801

Short title: Posture Deformities in African Children

Article presented to the African ***Journal for Physical, Health
Education, Recreation & Dance***

Word count: 3377

Abstract

Posture deformities are a common problem in school children. There has been an extensive discussion in the lay literature on posture deformities and their causes in schoolchildren, although only one study could be found on the incidence of idiopathic scoliosis in the black African population groups in Johannesburg (Segil, 1974). Few studies, however, have included the entire musculoskeletal system. The purpose of this study was to determine the incidence of musculoskeletal deviations among black African children in the North West Province. The study was part of the PLAY study (Physical Activity in the Young) and a total of 251 children who were thirteen to seventeen years old, were screened for posture deformities. Posture screening was done according to the New York Posture test (Bloomfield et al., 1994; Magee, 2002) and a posture grid. Posture deformities in this black African population could be related to their socio-economic status, lifestyle, culture, tradition, environmental factors, as well as activity levels. A high prevalence of postural deformities was reported amongst the children. The highest incidence of anomaly was lordosis (84%) and protruding abdomen (67%) and the lowest incidence was twisted head, with 8% being only slightly abnormal.

Keywords: posture, posture deformities, adolescence, children

Introduction

The reality is that postural deformities and poor body mechanics are a world wide problem. With the discussion on body alignment the first question that arises with the issue of posture deformities is what definition to use for a 'posture'. According to Kendall, McCreary, Provance, Rodgers and Romani (2005), Howe and Oldham (2001) and Bloomfield, Acland and Elliot (1994), the term posture means simple position or alignment of body parts.

Since the 1970's, among the ethnic groups in South Africa, populations may be observed in many stages of transition from primitiveness to sophistication. With the rise in socio-economic circumstances, numerous changes have occurred which include mortality rate and age structure, diet, growth, blood pressure, physical activity and disease pattern (Walker, 1972). In this study it was determined that black African children living in rural areas were more physically active and fitter than those living in urban areas, despite poor nutrition and infections. There were also increases in weight and height with increase in urbanization (Walker, 1972). Environmental factors influencing man's posture, with their adaptations and dispositions, are related internally to physical growth and externally to special activities conditioned by cultural demands (Tremblay & Willms, 2000). This may result in posture deformities. These are further directed by the individual's inherited body matrix with its tendency to grow in a certain manner as well as the stresses and strains the bone has to endure during normal activities to produce numerous varieties of posture (Roaf, 1977; Banfield, 2000). The current behaviour patterns of children and youth remain a growing cause for concern as thus may accelerate lifestyle related diseases and result in higher incidence in obesity and postural problems (Tremblay & Willms, 2000). Children spend substantial amounts of time watching television, surfing the Internet and playing computer games (du Randt, Baranowski, Johnson & Thompson, 1994; Tremblay & Willms, 2000;

Sallis, 2000).

The relationship between poor posture and physiology and psychological factors was reported in Banfield (2000), which included lung and heart defects (Banfield, 2000), indigestion (Banfield, 2000) and back pain (Taimela, Kujala, Salminen, & Viljanen, 1997; Banfield, 2000; Watson, Papageorgiou, Jones, Taylor, Symmons, Silman & Macfarlane, 2002; Murphy, Buckle & Stubbs, 2004).

One of the most common disabilities associated with bad posture is back pain (Taimela *et al.*, 1997; Watson *et al.*, 2002; Murphy *et al.*, 2004) and many studies have highlighted the high prevalence of back pain that exists among schoolchildren (Burton, Clarke, McClune & Tillotson, 1996; Taimela *et al.*, 1997; Leboeuf-Yde & Kyvik, 1998; Harreby, Nygaard, Jessen, Larsen, Storr-Paulsen, Lindahl, Fisker, & Laegaard, 1999; Watson *et al.*, 2002). The economic impact of back pain affects the industry, where back problems are the most expensive type of injury claim (Maniadakis & Gray, 2000; Murphy *et al.*, 2004). Epidemiologic studies have identified risk factors associated with back pain and postural discomfort in adolescents and daily use of heavy backpacks (Grimmer & Williams, 2000; Sheir-Neiss, Kruse, Rahman, Jacobson & Pelli, 2001; Chansirinukor, Wilson, Grimmer, & Dansie, 2001; Mackenzie, Sampath, Kruse & Sheir-Neiss, 2003) sitting postures in classrooms and school furniture (Cardon, De Clercq, De Bourdeaudhuij & Breithecker, 2004; Murphy *et al.*, 2004).

The main purpose of the study is to determine the prevalence of postural deformities among black school children in the North-West Province. According to Stroebel (2002) the majority of screening programmes are aimed at the detection of scoliosis only and there is a lack of comparable research in the broad spectrum of postural deformities and the increase in spinal problems, such as lower back pain in adolescents, points to the

need for continued screening (Stroebel, 2002). The study aims to include almost the entire musculoskeletal system.

Experimental methods and procedures

Subjects

The group selected formed part of the PLAY study. Children in the first year of high school from a public school in a township in the North West Province, South Africa were invited to participate in this study. The schools were selected purposefully, because they were situated in the living areas where the lowest income per household could be expected. Many people in the township live in informal housing without water supply and electricity. It was, therefore likely, that some of the children would be chronically undernourished and could be stunted. The children that were part of the study were all Grade 8 pupils of Seiphemelo Secondary School, as well as Boitshoko Secondary School, Ikageng, Potchefstroom, with an average age of 14.6. A total of 251 African children participated in the study.

Design of the study

A baseline study that forms part of the PLAY (Physical Activity in the Young) project in 2004 (project number 04M01), was approved by the Ethics Committee of the North-West University. The measurements were completed in March 2004 during scheduled times. An informed consent form with a questionnaire was sent to children's parents prior to the screening programme.

Measurement procedure

The children came in class groups and on arrival they were divided in groups according to gender. The measurement procedures were explained to them. With the help of an assistant their names, age and gender were recorded. The posture evaluation followed thereafter.

Postural evaluation

The children were dressed in underwear or shorts and vests. Boys and girls were evaluated separately. Privacy is considered to be essential for reducing children's anxiety.

The use of still photography was selected as a proper tool to gather the data in a reasonable time with acceptable accuracy and convenience for the subjects. A camera fixed on a tripod, aligned with its axis vertical to the filming plane was used to record the normal standing posture of each subject. Positional markers for subjects were placed on the floor behind the grid. The subjects assumed their typical standing postures behind a vertical grid and were photographed from the lateral and posterior directions. A "see-through posture grid" was used for postural evaluations. The posture grid comprises 12.5cm "big blocks", which are further subdivided into 2.4cm "small blocks". The vertical and horizontal strings are attached onto a frame. The vertical lines are at right angles to the horizontal lines. A plumb line is set to hang through the central vertical line of the grid to represent the gravity line (Althoff, Heyden & Robertson, 1988). These lines provide reference points for ascertaining the correct alignment of body parts. The use of gridlines to evaluate posture is described in many textbooks (Kendall, Kendall & Boynton, 1977; Arnheim & Prentice, 2000). The photographs were digitised and the alignment of the body segments were analysed using the New York Posture test. The test is described in many textbooks (Bloomfield, Acland & Elliot, 1994; Magee, 2002) and a well recognized company in the United States (Reedco Inc.) that manufactures anatomical measuring devices uses this test as a posture evaluation tool (Reedco Inc., 2001). Subjects were evaluated in the rear view for the following deformities: forward head, flat chest, winged scapulae, kyphosis, inclined trunk, protruding abdomen and lordosis. The subjects then had to stand with their sides towards the posture grid for the evaluation of twisted head, uneven

shoulders, scoliosis, uneven hips and foot pronation. Next to the grid, the subject was asked to step into powdered white chalk and then onto a black board to check for foot abnormalities (flat feet).

There are thirteen items in the test. Each item is scored on a 5 (normal posture), 3 (slightly abnormal), 1 (abnormal) basis. The score is based on the criteria and drawings located on the score sheet. To reduce the degree of subjectivity, the following criteria were used provided by the New York Posture Test to score uneven shoulders (Stroebe, 2002): The most superior-lateral edge of the acromions was measured for lateral asymmetry by counting the number of blocks the one shoulder is lower than the other one. The examiner and camera were placed 3m from the posture grid. Using a goniometer, the number of degrees for each block was measured beforehand. Subjects with a broader chest (greater bi-acromial width) will exhibit a greater angle of asymmetry. To account for these differences, three bi-acromial widths were used. A subject would either be 2, 3 or 4 "large blocks" wide, which will be 25, 37.5 and 50cm respectively. For example, a bi-acromial width of 37,5cm (3 large blocks):

- 1 $\frac{1}{2}$ block deviation = 2 degrees
- 2 1 block deviation = 4 degrees
- 3 $1\frac{1}{2}$ block deviation = 6 degrees
- 4 2 blocks deviation = 8 degrees.

According to The New York Posture Test, uneven shoulders are scored as follows: 5 (0 – 2 degrees); 3 (2.1 – 4 degrees); 1 (> 4 degrees). For example, a subject with an acromion height difference of "1 block" and a bi-acromial width of approximately "3 large blocks wide" will have an angular deviation of 4 degrees, and thus a score of 3. The following mathematical calculation was used to determine the reliability of the

goniometer measurements:

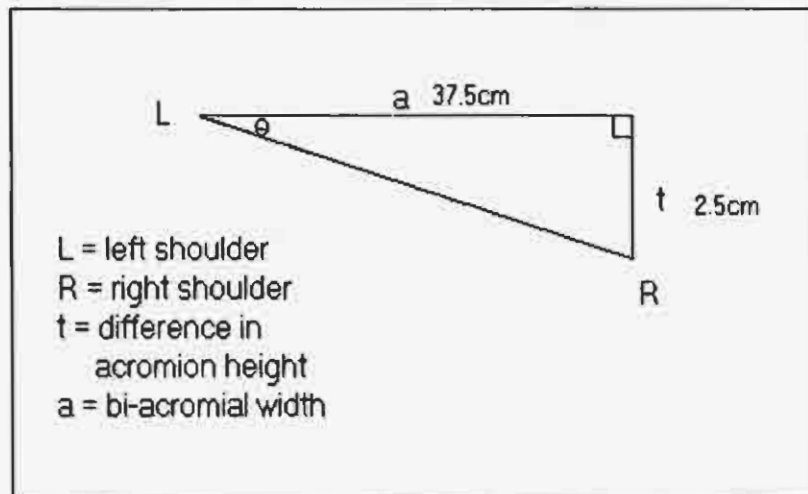


Figure 3.1: Asymmetry of acromial height (Stroebe, 2002)

$\tan \theta = t/a$, where t = difference in acromion height; a = bi-acromial width.

E.g. acromion height difference of "1 block" (2.5cm) and a bi-acromial width of "3 large blocks" (37.5 cm):

$\theta = 4$ degrees (rounded to nearest whole number)

Thereafter, the "Adam's test" (forward bending test) was performed for further scoliosis evaluation (Nussinovitch, Finkelstein, Amir, Greenbaum, & Volovitz, 2002; Herman & Pizzutillo, 2002). Each subject was asked to stand erect with weight on both feet, feet slightly apart and parallel. As subjects were bending forward upon request, reaching their fingers towards the floor, the bony prominences of the spine was marked with a pencil marker. An apparent rib hump or any prominence was recorded as the test to be positive and the position of the rib hump was also recorded (left/right). The alignment of the dots was observed as soon as the subject came erect. After the postural evaluation, the scores on each item were added and recorded.



Figure 3.2: Assistant performing the “Adams forward bending test”

Assistants

The assistants in the study were certified Biokinetics students in training, who were familiar with the protocols and equipment being used. The researcher was a certified Biokinetics intern accompanied by a qualified Biokineticist. To ensure reliability of the study the researcher did all postural evaluations. Where possible, the same assistants were used for all the measurements.

Statistical analysis

A STATISTICA-computer program (Statsoft, Inc., 2003) at North West University, Potchefstroom Campus, was used for analyzing the data. For the purpose of this study descriptive data and different percentages within different categories were calculated.

Results

The final sample of the study consisted of 251 children from a selected high school. Of the 13 different deviations of the musculoskeletal system examined, only 9 were considered for statistical purposes in this study.

Table 1: Incidence rates for posture deviations of 251 subjects

Deviations	Slightly Abnormal (%)	Abnormal (%)	Normal (%)
<i>Forward head</i>	50	26	24
<i>Flat chest</i>	9	0	91
<i>Kyphosis</i>	74	10	16
<i>Protruding abdomen</i>	30	67	3
<i>Lordosis</i>	14	84	2
<i>Twisted head</i>	8	0	92
<i>Scoliosis</i>	12	0	88
<i>Pronated feet</i>	87	11	2
<i>Flat feet</i>	73	15	12

The highest incidence of abnormality was lordosis (84%) and the lowest incidence was twisted head, with 8% being only slightly abnormal. The postural evaluation in the sagittal plane (Figure 3.2) showed a high incidence of postural deviations. A total of 26% of the subjects had forward head syndrome, while 50% were classified a slightly abnormal. With kyphosis 186 subjects were noted being slightly abnormal, while only 24 subjects reported with an existing kyphosis. The overall rate for the prevalence of flat chest was 9% (only slightly abnormal). A high incidence of lordosis, 84% was reported, with only 14 % being rated as slightly abnormal. The prevalence of protruding abdomen was also high rating at 67%, with 30% of the subjects rating slightly abnormal.

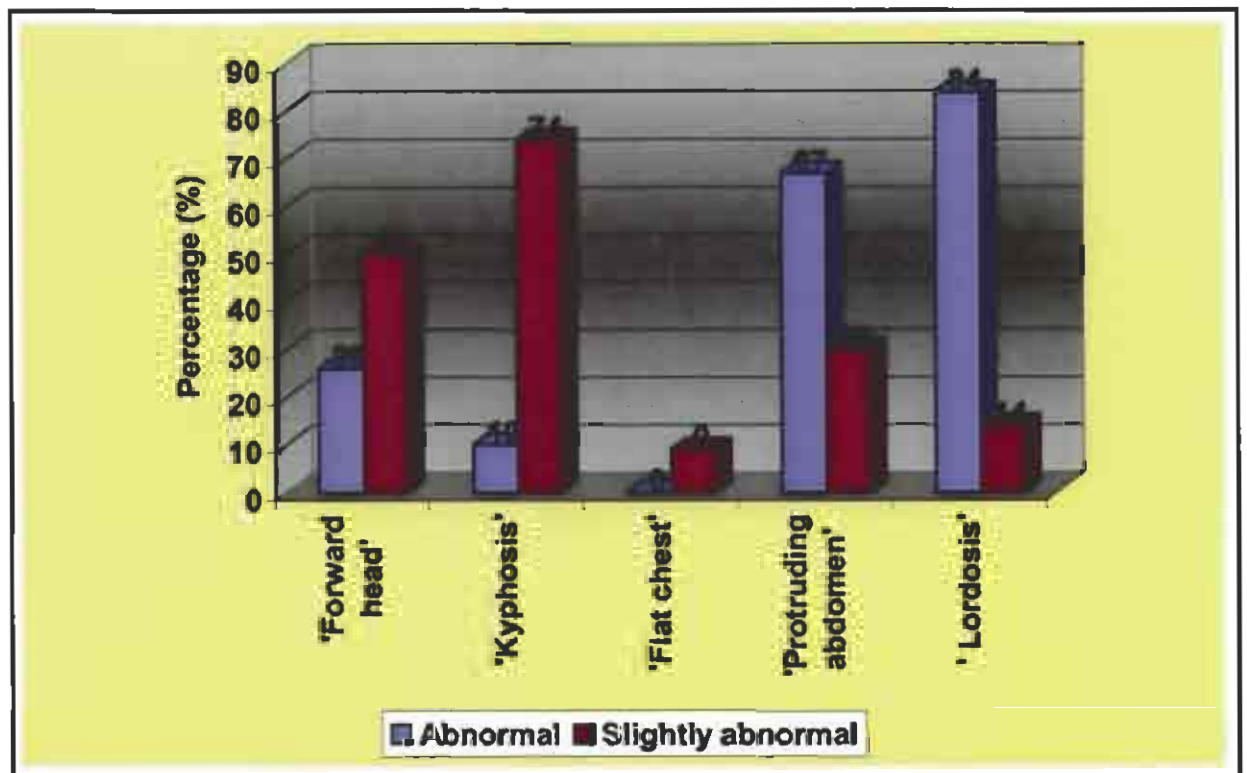


Figure 3.3: Posture deviations in the sagittal plane (n = 251)

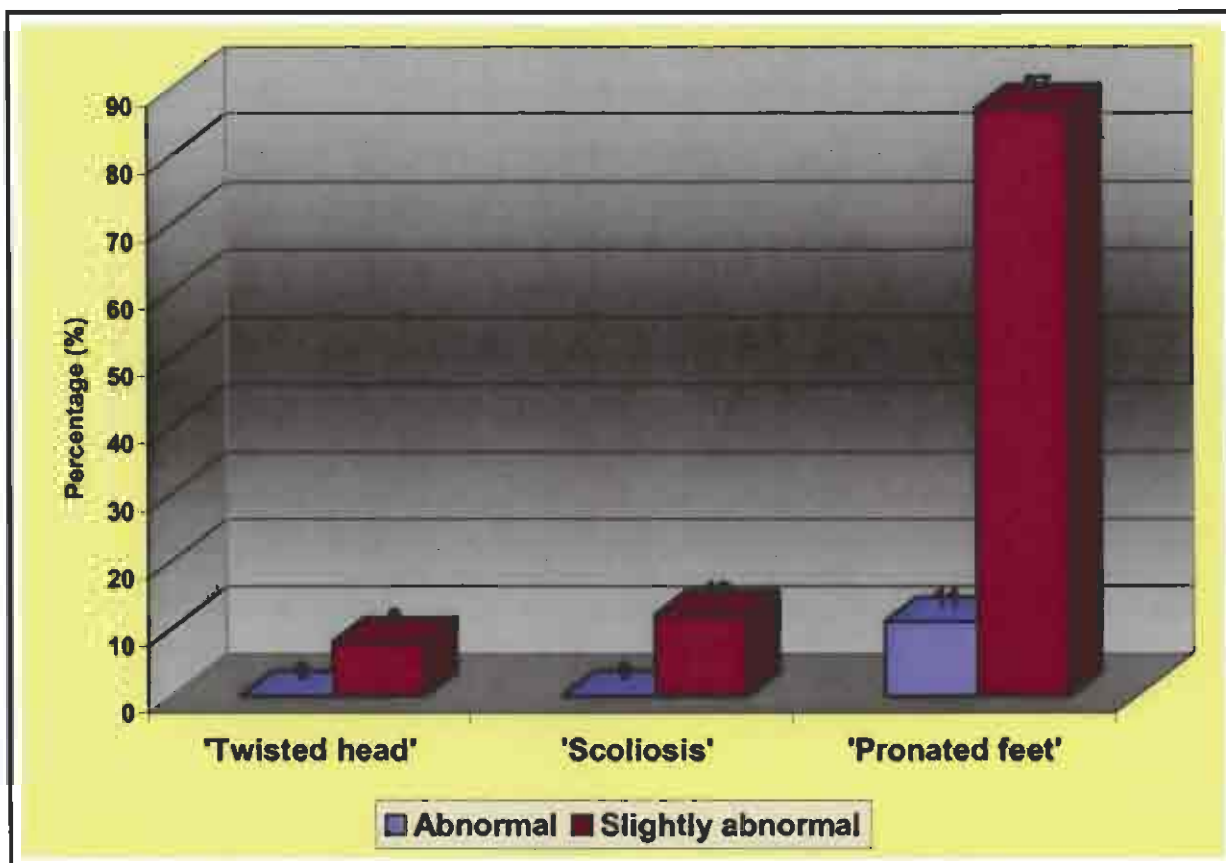


Figure 3.4: Posture deviations in the posterior plane (n = 251)

When viewing subjects from the posterior side (Figure 3), the only poor ratings were in the ankle joint (pronation). A very high percentage (87%) of pronated feet were rated slightly abnormal, with 11% rated abnormal. Only 30 subjects reported with a single scoliotic curve and 20 subjects reported with a partially twisted head. With the screening for flat feet (Figure 3.5) 73% were rated slightly abnormal and 11% was abnormal.

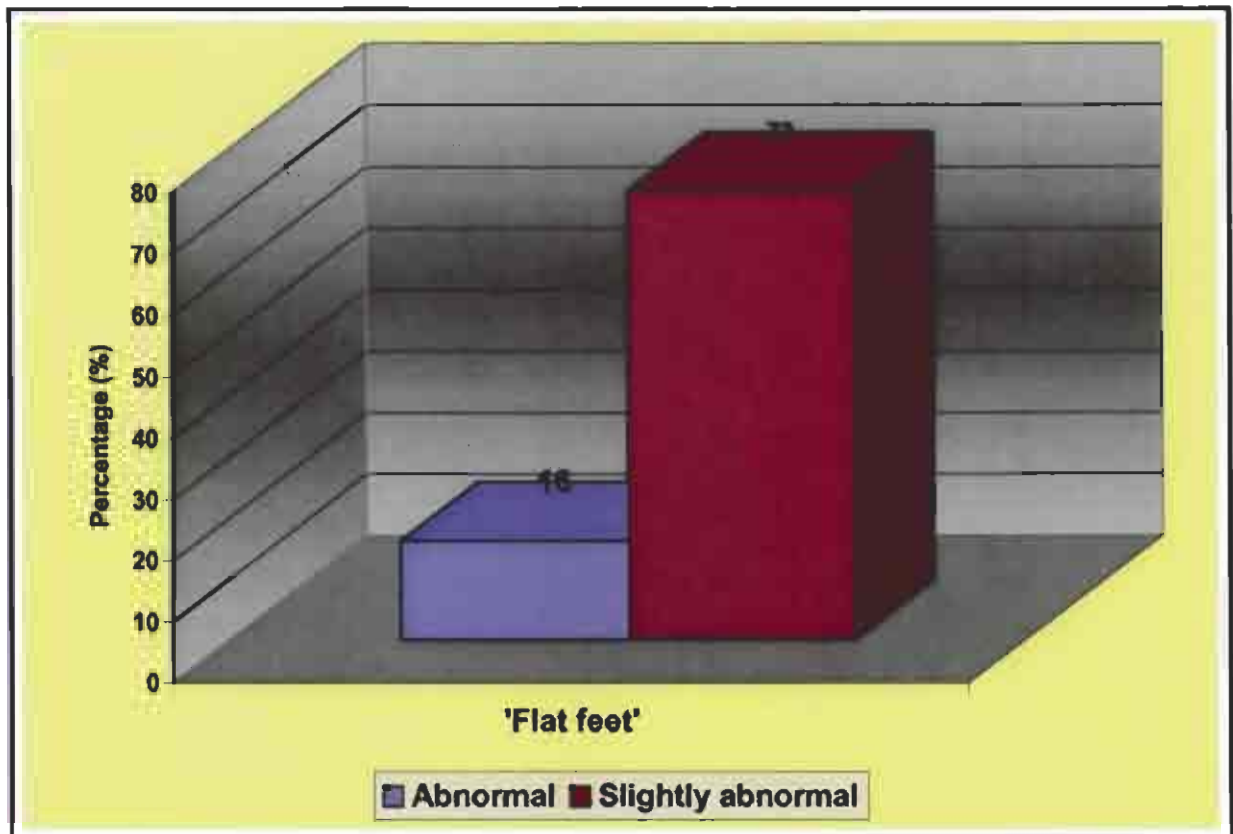


Figure 3.5: The incidence of flat feet (n = 251)

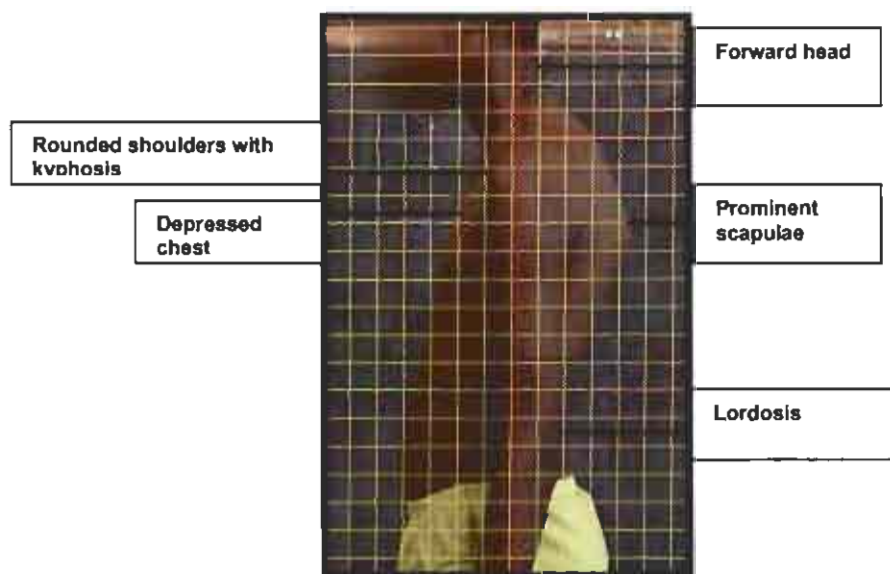


Figure 3.6: Poor posture of a Grade 8 child. There is a forward head, kyphosis, depressed chest, prominence of the scapulae and marked lordosis present.

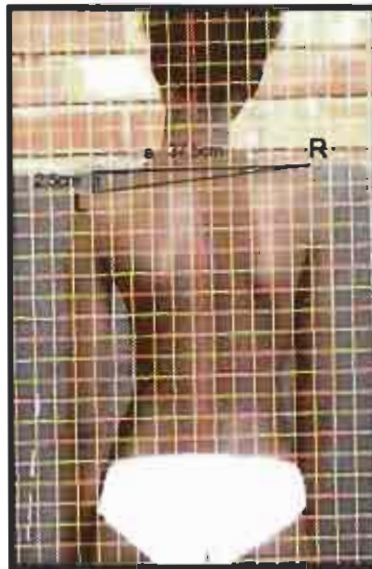


Figure 3.7: Asymmetry of acromial height with scoliosis

Discussion

School screening for posture deformities have been the subject of many studies over the past 20 years. The majority of the programmes are for the detection of one or a selection of posture deformities only, and does not include the entire musculoskeletal system (Fon, Pitt & Thies, 1980; Karachalios, Sofianos, Roidis, Sapkas, Korres & Nikolopoulos, 1999). Only three studies reporting the entire musculoskeletal system could be found (Francis & Bryce, 1987; Ragheb & Gregory, 1993; Stroebel, 2002). Comparison between studies is difficult because of a difference in age and race. In this study one was able to compare the figures between the study by Francis and Bryce (1987), although the race weren't the same.

The purpose of this study was to determine the prevalence of posture deformities in black African children. The findings of the present study indicate the incidence of posture deformities to be high. As previously mentioned, the subjects were selected with having very low socio-economic standards, and were likely to be stunted and malnourished.

Because of the lack of comparable research in this broad spectrum the researcher makes no attempt to compare the incidence of the various deviations among the general population.

The frequency of lordosis was the greatest, and was observed in 84% of the subjects, while protruding abdomen was reported in 67% of the subjects. According to Watson et al. (2002) and Lafond, Descarreax, Normand and Harrison (2007) abdominal protrusion relates directly to lordosis and pelvic anteversion in an attempt to correct the anteroposterior balance that is compromised. Weak gluteal and hamstring muscles cannot counteract the anterior tilt (Nussinovitch et al., 2002). These children cannot financially afford to play specific sports and most of them lead a sedentary lifestyle. Although some of these children have to walk far distances each day to school or carrying water and firewood, this in time can cause specific compensatory posture deformities, including lordosis. As many of these subjects were stunted and malnourished due to low income and ignorance, one can assume that some of them suffered from protein deficiency. Lacking sufficient protein or infection can lead to illnesses such as kwashiorkor, which can also cause protruding abdomen (Whitney, Cataldo & Rolfes, 1998).

A fair percentage (26%) of subjects reported with forward head. A reason for this could be traced back to infancy where it is tradition for this black African group to carry their babies on their backs. Forward head and trunk posture also increase when carrying a backpack (International Chiropractic Pediatric Association, 1998; Chansirinukor et al., 2001). This prevents the neck muscles from developing adequately, as the head of the baby rests on the back of the mother.

In this study, the frequency of pronated ankles was the lowest (11%), however the frequency of partial pronated ankles was very high (87%).

Francis and Bryce (1987) reported a prevalence of 31.4%. According to Penha, Joao, Casarotto, Amino and Penteado (2005), pronated ankles are related to increased weight loading on the medial aspect of the foot, tending to flat foot. In this study flat foot was reported in 15%, which is higher compared to the 10% in Francis and Bryce (1987) and 5% in noted Nussinovitch et al. (2002). African and Aboriginal children often present with flat feet, which is culturally and genetically normal for them (McCoy & Dickens, 1997). In a study done by Dunn, Link, Felson, Crincoli, Keysor and Mckinlay (2004) on foot conditions in older adults, the prevalence of flat feet was the greatest in African Americans.

Studies of school screening for scoliosis show a wide range of prevalence from 1.6% - 72% (Hazebroek-Kampschreur, Hofman, Of Dijk & Linge, 1992; Soucacos, Soucacos, Zacharis, Beris & Xenakis, 1997; Loots, Loots & Steyn, 2001; Nussinovitch et al., 2002). According to Hazebroek-Kampschreur et al. (1992) these differences are due to difference in age groups, definition of scoliosis and different detection methods. A variation in prevalence of scoliosis between ethnic groups has also been reported (Hazebroek-Kampschreur et al., 1992; Segil, 1974). In the present study scoliosis was observed in only 12% of the subjects having only a one-sided curve.

Kyphosis was reported in 10% of the subjects. A high percentage (74%) of subjects was rated slightly abnormal. The findings could be related to periods of rapid growth, and can occur in subjects during the growth spurt of puberty (Mellin, Harkonen & Poussa, 1988; McMaster & Singh, 1999; Widhe, 2001) which is very important in girls, since there is a tendency to adopt this posture as a manner of hiding breast development (Penha et al., 2005). In studies done by Widhe (2001) and Poussa, Heliovaara, Seitsamo, Kononen, Hurmerinta & Nissinen (2005) respectively, it also showed that kyphosis in relation to lordosis

decreases with age in girls, but not in boys, which could explain the higher incidence in boys. Mellin et al. (1988) also reported that kyphosis was less in girls compared to boys. The study was done on boys and girls, aged 13 to 14 years (Mellin et al., 1988). Other possible causes for kyphosis could be tuberculosis. In a hospital-based study, angular kyphosis proved a valuable marker for spinal tuberculosis (Ogle, Wilson & Mcconnachie, 1994). According to Banfield (2000), poor sleeping habits, fatigue and poor nutrition related to poor socio-economics can also cause kyphosis (Banfield, 2000).

Although some of the subjects were stunted and malnourished, most of the boys, according to their chronological age, were supposed to be on average in growth spurt whereas the girls were in retarded growth.

Summary

In summary the findings, suggest that posture deformities are a common problem in black African children, aged 13 – 17 years. The children are growing steadily more immobile, malformed and clumsy. One fails to address the importance of good posture and body mechanics effectively. Posture deformities in this black African population could be related to their socio-economic status, lifestyle, culture, tradition, environmental factors, as well as activity levels. Good posture is difficult to establish once one is used to bad postural habits for many years (Stroebe, 2002). The failure to practice proper posture can lead to various health complications, including lower back pain, indigestion, heart and lung defects and headaches. These factors result in expenditures related to healthcare fees and diminished individual income and productivity. These potential health problems resulting from poor posture highlight the importance of good posture. It also shows the need for continued screening for posture deformities in schools.

List of References

- Althoff, S.A., Heyden, S.M. & Robertson, L.D. (1988). Posture screening. A program that works. *Journal of Physical Education, Recreation and Dance*, 76, 26-32.
- Arnheim, D.D. & Prentice, W.E. 2000. *Principles of athletic training* (10th ed.) (pp.708). Boston, Mass: McGraw-Hill.
- Banfield, M.A. (2000). *The Posture Theory: Some Additional Considerations. The Physical Basis for Hypochondria* (11th ed.) (pp. 59-129). South Australia Adelaide: Banfield Publisher.
- Bloomfield, J., Acland, T.R. & Eliot, B.C. (1994). *Applied Anatomy and Biomechanics in Sport* (pp. 96-320). Melbourne: Blackwell Scientific Publication.
- Burton, A.K., Clarke, R.D., McClune, T.D. & Tillotson, K.M. (1996). The natural history of low back pain in adolescents. *Spine*, 21(20), 2323-2328.
- Cardon, G., De Clercq, D., De Bourdeaudhuij, I. & Breithecker, D. (2004). Sitting habits in elementary schoolchildren: A traditional versus a "moving school". *Patient Education and Counselling*, 54(2), 133-142, December, at <http://www.sciencedirect.com/science>. November 2005.
- Chansirinukor, W., Wilson, D. Grimmer, K. & Dansie, B. (2001). Effects of backpacks on students: Measurement of cervical and shoulder posture. *Australian Journal of Physiotherapy*, 47(2), 110–116, at http://www.chiro.org/Links/abstracts/Effects_of_Backpacks.shtml. April 2005.

Dunn, J.E., Link, C.L., Felson, D.T., Crincoli, M.G., Keysor, J.J. & Mckinlay, J. (2004). Prevalence of foot and ankle conditions in a multiethnic community sample of older adults. *American Journal of Epidemiology*, 159(5), 491-498.

Du Randt, R.H., Baranowski, T., Johnson, M. & Thompson, W.O. (1994). The relationship among television watching, physical activity, and body composition of young children. *Pediatrics*, 94(4), 449-455.

Fon, G.T., Pitt, M.J. & Thies A.C. (1980). Thoracic kyphosis: Range in normal subjects. *American Journal of Roentology*, 134, 979-983.

Francis, S.R. & Bryce, G.R. (1987). Screening for musculoskeletal deviations – A challenge for the physical therapist. *Physical Therapy*, 67(8), 1221-1225.

Grimmer, K. & Williams, M. (2000). Gender-age environmental associates of adolescent low back pain. *Applied Ergonomics*, 31(4), 343-360.

Hazebroek-Kampschreur, A.A.J.M., Hofman, A., Of Dijk, A.Ph. & Linge, B. (1992). Prevalence of trunk abnormalities in eleven-year-old schoolchildren in Rotterdam, the Netherlands. *Journal of Pediatric Orthopedics*, 12, 480-484.

Harreby, M., Nygaard, B., Jessen, T., Larsen, E., Storr-Paulsen, A., Lindahl, A., Fisker, I. & Laegaard, E. (1999). Risk factors for low back pain in a cohort of 1389 Danish school children: An epidemiologic study. *European Spine Journal*, 8, 444-450.

Herman, M.J. & Pizzutillo, P.D. (2002). Treating idiopathic scoliosis. Management options to straighten the spine. *Women's Health in Primary Care*, 5(6), 361-367.

Howe, T. & Oldham, J. 2001. *Posture and balance*. In Trew, M. & Everett, T. (Eds.) *Human movement: An introductory text* (4th ed.) (pp.225-239). New York: Churchill Livingstone.

International Chiropractic Pediatric Association. (1998). *Backpacks... your child's spine is at stake*, Newsletter, November/December, at <http://www.icpa4kids.com/articles/nov98a.htm>. February 2002.

Karachalios, T., Sofianos, J., Roidis, N., Sapkas, G., Korres, D. & Nikolopoulos, K. (1999). Ten-Year follow-up evaluation of a school-screening program for scoliosis. *Spine*, 24(22), 2318-2324.

Kendall, H.O., Kendall, F.P. & Boynton, D.A. (1977). *Posture and Pain* (9th ed.) (pp.20). New York: Williams & Wilkens.

Kendall, E.R., McCreary E.K., Provance, P.G., Rodgers, M.M. & Romani, W.A. (2005). *Muscles Testing and Function: with Posture and Pain* (5th ed.) (pp. 51). Baltimore: Williams and Wilkins.

Lafond, D., Descarreaux, M., Normand, M.C. & Harrison, D.E. (2007). Postural development in schoolchildren: A cross-sectional study. *Chiropractic & Osteopathy*, 15(1), at <http://www.chiroandosto.com/content/15/1/1> April 2007.

Leboeuf-Yde, C. & Kyvik, K.O. (1998). At what age does low back pain become a common problem? A study of 29,424 individuals aged 12-14 years. *Spine*, 23(2), 228-234.

Loots, M., Loots, J.M. & Steyn, J.M. (2001). An investigation into essential aspects of posture in primary school boys and male senior executives. *South*

African Journal for research in Sport, Physical education and Recreation, 23(1), 39–49.

Mackenzie, W.G., Sampath, S.J., Kruse, R.W. & Sheir-Neiss, G.J. (2003). Backpacks in children. *Clinical Orthopaedics and Related Research*, 409, 78–84.

Magee, D.J. (2002). *Orthopedic Physical Assessment* (4th ed.) (pp. 890–893). Philadelphia: W.B. Saunders.

Maniadakis, A. & Gray, A. (2000). The economic burden of back pain in the UK. *Pain*, 84, 95–103.

Mccoy, A. & Dickens, B. 1997. Understanding normal variations in childhood gait and posture. *Victorian Government Department of Human Services*, 17 April at http://www.nevdgp.org.au/geninf/std_misc/Gait_hes.htm. September 2005.

Mcmaster, M.J. & Singh, A.H. (1999). Natural history of congenital kyphosis and kyphoscoliosis: A study of one hundred and twelve patients. *Journal of Bone and Joint surgery*, 81(10), 1367-1383.

Mellin, G., Harkonen, H. & Poussa, M. (1988). Spinal mobility and posture and their correlations with growth velocity in structurally normal boys and girls aged 13 – 14 years. *Spine*, 13(2), 152-154.

Murphy, A., Buckle, P. & Stubbs, D. (2004). Classroom posture and self-reported back and neck pain in schoolchildren. *Applied Ergonomics*, 35, 113–120.

Nussinovitch, M., Finkelstein, Y., Amir, J., Greenbaum, E. & Volovitz, B. (2002). Adolescent screening for orthopaedic problems in high school. *Public Health*, 116, 30-32.

Ogle, J.W., Wilson, F.C. & Mcconnachie, C.C. (1994). Angular kyphosis as an indicator of the prevalence of Pott's disease in Transkei. *South African Medical Journal*, 84(9), 614-618.

Penha, P.J., Joao, S.M., Casarotto, R.A., Amino, C.J. & Penteado, D.C. (2005). Postural assessment of girls between 7 and 10 years of age. *Clinics*, 60(1), 9-16.

Poussa, M.S., Heliovaara, M.M., Seitsamo, J.T., Kononen, M.H., Hurmerinta, K.A. & Nissinen, M.J. (2005). Development of spinal posture in a cohort of children from the age of 11 to 22 years. *European Spine Journal*, 14(8), 738-742.

Ragheb, M.A. & Gregory, W.B. (1993). Postural deviations of Bahraini Schoolboys: Ages 6 – 8. *International Journal on Health, Physical Education and Recreation*, 30(2), 32-35.

Reedco Inc. 2001. *Anatomical measuring devices*. <http://www.info@ccmi-reedco.com> January 2004.

Roaf, R. 1977. *Posture*. London: Academic press.

Sallis, J.F. (2000). Overcoming inactivity in young people. *The Physician and Sportsmedicine*, 28(10), 31-32.

Segil, C.M. (1974). The incidence of idiopathic scoliosis in the Bantu and white population groups in Johannesburg. *South African journal of Bone and Joint Surgery*, 56(B), 393.

Sheir-Neiss, G., Kruse, R., Rahman, T. Jacobson, L. & Pelli, J. (2001). Back pack use as a risk factor in children's back pain. (In SpineUniverse: Abstract from SpineUniverse 2001 Annual Meeting.), at <http://spineuniverse.com/displayarticle.php/article1754.html>. September 2005.

Soucacos, P.N., Soucacos, P.K., Zacharis, K.C., Beris, A.E. & Xenakis, T.A. (1997). School-screening for scoliosis. A prospective epidemiology study in Northwestern and Central Greece. *The Journal of Bone and Joint surgery*, 79(A), 1498-1503.

Statsoft, Inc. 2003. *STATISTICA* (data analysis software system, Version 6).

Stroebe, S. (2002). *The prevalence of postural deformities among children age 11 –13 years in some Western Cape schools* (pp. 4-6). Master of Science thesis. Stellenbosch: University of Stellenbosch.

Taimela, S., Kujala, U.M., Salminen, J.J. & Viljanen, T. (1997). The prevalence of low back pain among children and adolescents. A nationwide, cohort-based questionnaire survey in Finland. *Spine*, 22(10), 1132-1136.

Tremblay, M.S. & Willms, J.D. (2000). Secular trends in body mass index of Canadian children. *Canadian Medical Association Journal*, 163(11),1429–1433.

Walker, A.R.P. (1972). Biological and disease patterns in South African Inter-racial population as modified by rise in privilege. *South African Medical Journal*, 46,1127 –1132.

Watson, K.D., Papageorgiou, A.C., Jones, G.T., Taylor, S., Symmons, D.P.M., Silman, A.J. & Macfarlane, G.J. (2002). Low back pain in schoolchildren: occurrence and characteristics. *Pain*, 97,87-92.

Widhe, T. (2001). Spine: posture, mobility pain. A longitudinal study from childhood to adolescence. *European Spine Journal*, 10,118–123.

Whitney, E.N., Cataldo, C.B. & Rolfes, S.R. (1998). *Understanding normal and clinical nutrition* (5th ed.) (pp.199). Belmont, CA: West/Wadsworth.

The difference in the prevalence of posture deformities in black African boys and girls in selected schools in the North West Province.

Authors: Isabeau Van Biljon (B.Sc. Honn) Biokinetics &
Cilas.J.Wilders (B.Jur; Ph D) Biokinetics

School for Biokinetics, Recreation and Sport Science, North-West
University (Potchefstroom Campus), P/Bag x 6001, Potchefstroom,
South Africa.

Corresponding author:

Email: Cilas.Wilders@nwu.ac.za

Tel/Fax: +2718-2991801

Short title: Posture Difference in African Boys and Girls

Article presented to the ***The International Council of Health, Physical Education, Recreation, Sport & Dance Research Journal***

Word count: 2310

Abstract

Posture deformities in children are relatively common and frequently observed in boys and girls. The purpose of this study was to determine the difference in posture deformities between black African boys and girls aged 13 – 17 years in the North West Province. During these ages children are undergoing growth spurt and some children develop posture problems (Brower & Nash, 1979). The study was part of the PLAY study (Physical Activity in the Young) and a total of 251 children, 136 girls and 115 boys were screened for posture deformities. Posture screening was done according to the New York Posture test (Bloomfield et al., 1994; Magee, 2002) and a posture grid. The difference in posture deformities in the black African boys and girls could be mainly related to growth spurt, puberty, stunting and age. A high prevalence of postural deformities was reported amongst the children. The prevalence of posture deformities was reported to be higher in girls than in boys. There was an 8% difference in the prevalence of posture deformities recorded in boys (46%) and girls (54%).

Keywords: posture, posture deformities, alignment, gender

Introduction

This paper describes the difference in posture deformities among boys and girls age 13 – 17 years.

Between ages 12 and 14 years, most children are undergoing puberty with the starting of growth spurt starts that will continue into adolescence. Boys usually start puberty at an age of 13 – 14 years while girls start at 12 – 13 years (Brower & Nash, 1979).

During these growing years children are prone to a variety of health problems that include postural deformities. Most of these postural problems could become serious if not detected early (Brower & Nash, 1979).

According to literature sex and age do have a influence on spinal deformities (Tanner, Whitehouse, Marubini & Resele, 1976; Mellin, Harkonen & Poussa, 1988; Lafond, Descarreax, Normand & Harrison, 2007).

It is reported that more girls than boys have scoliosis while more boys were reported to have kyphosis (Brower & Nash, 1979; Francis & Bryce, 1987; Mellin et al., 1988).

Magee (2002) and Banfield (2000) identify the following structural factors that cause posture to change: genetic deformities, developmental problems, trauma or illness. Accordingly this can cause various abnormalities and deformities. Some other factors also play a part in postural changes namely body type, height, weight, fitness, disability, age, clothing, shoes, occupation, and body image/self-concept (Sherrill, 1993; Starnes, 2001).

This study was an investigation of children aged 13 to 17 years to determine the gender difference in postural deviations using an objective procedure for detection.

According to Stroebel (2002) the majority of screening programmes are aimed at the detection of scoliosis only and there is a lack of comparable research in the broad spectrum of postural deformities. The study aims to include almost the entire musculoskeletal system.

The main purpose of the study is to determine the difference in prevalence of postural deformities among black schoolboys and schoolgirls in the North West Province. Selected studies on the difference of postural deformities between boys and girls were reported (Francis & Bryce, 1987; Mellin et al., 1988; Widhe, 2001; Lafond et al., 2007). Unfortunately none could be found on black African boys and girls.

Experimental methods and procedures

Subjects and design of the study

A total of 251 posture analyses of boys and girls between the ages of 13 years to 17 years were performed. The subjects were part of the PLAY (Physical Activity in the Young) project (project number 04M01), which was approved by the Ethics Committee of the North West University. This cross-sectional study was concerned with a complete postural analysis of almost the entire musculosystem. The children that were part of the study were all Grade 8 pupils of Seiphemelo Secondary School and Boitshoko Secondary School, Ikageng, Potchefstroom, with an average age of 14.6. A total of 251 African children, 115 boys and 136 girls, participated in the study. The measurements were completed in March 2004 during scheduled times. An informed consent form with a questionnaire was sent to children's parents prior to the screening programmes.

Measurement procedure

Postural evaluation

The children were dressed in underwear or shorts and vests. Boys and girls were evaluated separately. Privacy is considered to be essential for reducing children's anxiety.

The New York posture test (Bloomfield, Acland & Elliot, 1994; Reedco Inc., 2001; Magee, 2002) and a posture grid (Kendall, Kendall, & Boynton, 1977; Arnheim & Prentice, 2000) were used to evaluate and identify posture deformities of the children. Digital photographs were taken from the lateral and posterior (side and back) view and postures were analysed from high quality digitised pictures. Subjects were evaluated in the side view for the following deformities: forward head, flat chest, winged scapulae, kyphosis, inclined trunk, protruding abdomen and lordosis. Twisted head, uneven shoulders, scoliosis, uneven hips and foot pronation were evaluated from the back. Next to the posture grid, the subject was asked to step into powdered white chalk and then onto a black board to check for foot abnormalities (flat feet).

There were thirteen items in the test. Each item was scored on a 5-3-1 basis with a score of 5 being 'normal', 3 being slightly abnormal with a moderate deformity and 1 being abnormal with a definite posture deformity. The score was based on the criteria and drawings located on the score sheet.

To reduce the degree of subjectivity, the following criteria were used provided by the New York Posture Test (Reedco Inc., 2001) to score uneven shoulders:

The most superior-lateral edge of the acromions was measured for lateral asymmetry by counting the number of blocks the one shoulder is lower than the other one. The examiner and camera were placed 3m from the posture grid. Using a goniometer, the number of degrees for each block was measured beforehand. Subjects with a broader chest (greater bi-acromial width) will exhibit a greater angle of asymmetry. To account for these differences, three bi-acromial widths were used. A subject would either be 2, 3 or 4 "large blocks" wide, which will be 25, 37.5 and 50cm respectively. For example, a bi-acromial width of 37,5cm (3 large blocks):

- ½ block deviation = 2 degrees
- 1 block deviation = 4 degrees
- 1½ block deviation = 6 degrees
- 2 blocks deviation = 8 degrees.

According to The New York Posture Test (Reedco Inc., 2001), uneven shoulders are scored as follows: 5 (0 – 2 degrees); 3 (2.1 – 4 degrees); 1 (> 4 degrees). For example, a subject with an acromion height difference of “1 block” and a bi-acromial width of approximately “3 large blocks wide” will have an angular deviation of 4 degrees, and thus a score of 3. The following mathematical calculation was used to determine the reliability of the goniometer measurements.

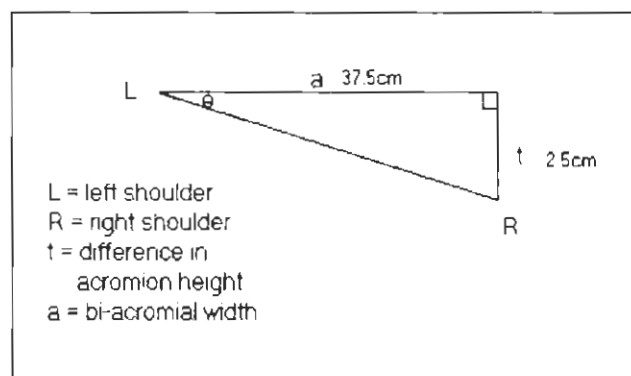


Figure 4.1: Asymmetry of acromial height (Stroebe, 2002)

$\tan \theta = t/a$, where t = difference in acromion height; a = bi-acromial width.

E.g. acromion height difference of “1 block” (2.5cm) and a bi-acromial width of “3 large blocks” (37.5 cm):

$\theta = 4$ degrees (rounded to nearest whole number)

Thereafter, the "Adam's test" (forward bending test) was performed to identify scoliosis (Nussinovitch, Finkelstein, Amir, Greenbaum, & Volovitz, 2002; Herman & Pizzutillo, 2002). An apparent rib hump or any prominence was recorded as the test to be positive and the position of the rib hump was also recorded (left/right). After the postural evaluation, the scores on each item will be added and recorded.

Assistants

The assistants in the study were certified Biokinetics students in training, who were familiar with the protocols and equipment being used. The researcher was a certified Biokinetics intern accompanied by a qualified Biokineticist. To ensure reliability of the study, the researcher did do all the postural evaluations. Where possible, the same assistants were used for all the measurements.

Statistical analysis

A STATISTICA-computer program (Statsoft, Inc., 2003) at North West University, Potchefstroom Campus, was used for analyzing the data. For the purpose of this study descriptive data and different percentages within different categories were calculated.

Results

Table 4.1: Gender differences in the prevalence of posture deformities

	<i>Girls (n=136)</i>		<i>Boys (n=115)</i>	
<i>Posture deformity</i>	<i>Slightly abnormal (%)</i>	<i>Abnormal (%)</i>	<i>Slightly abnormal (%)</i>	<i>Abnormal (%)</i>
<i>Forward head</i>	49	21	49	32
<i>Flat chest</i>	10	0	8	0
<i>Kyphosis</i>	73	9	76	10
<i>Lordosis</i>	12	87	16	81
<i>Protruding abdomen</i>	26	72	33	63
<i>Twisted head</i>	7	0	9	1
<i>Scoliosis</i>	13	0	10	0
<i>Pronated feet</i>	90	9	84	14
<i>Flat feet</i>	73	15	73	16

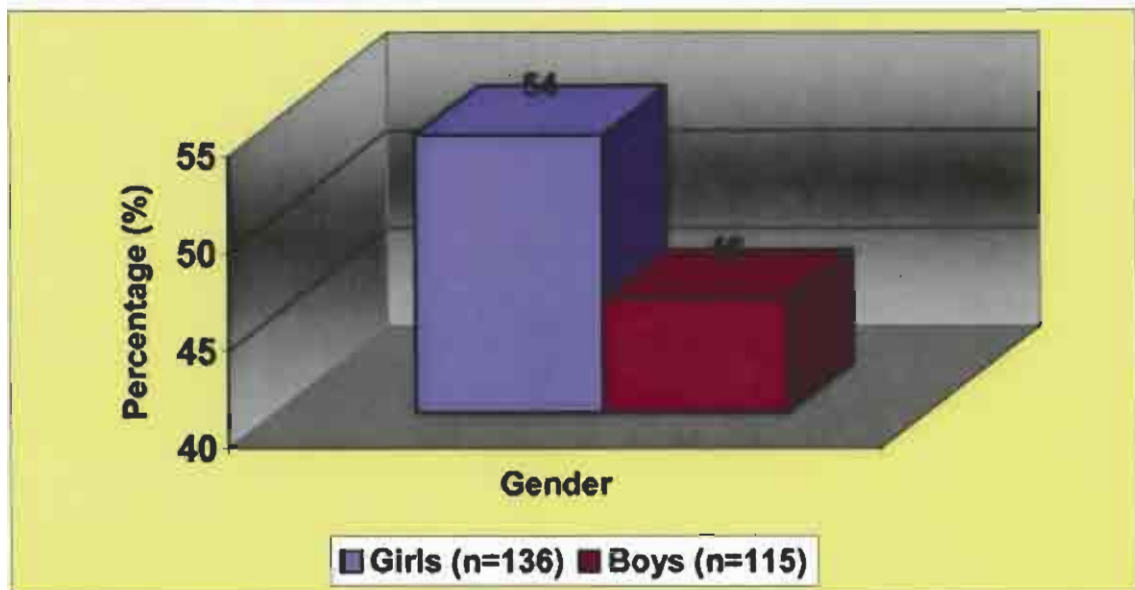


Figure 4.2: The prevalence of posture deformities among boys and girls

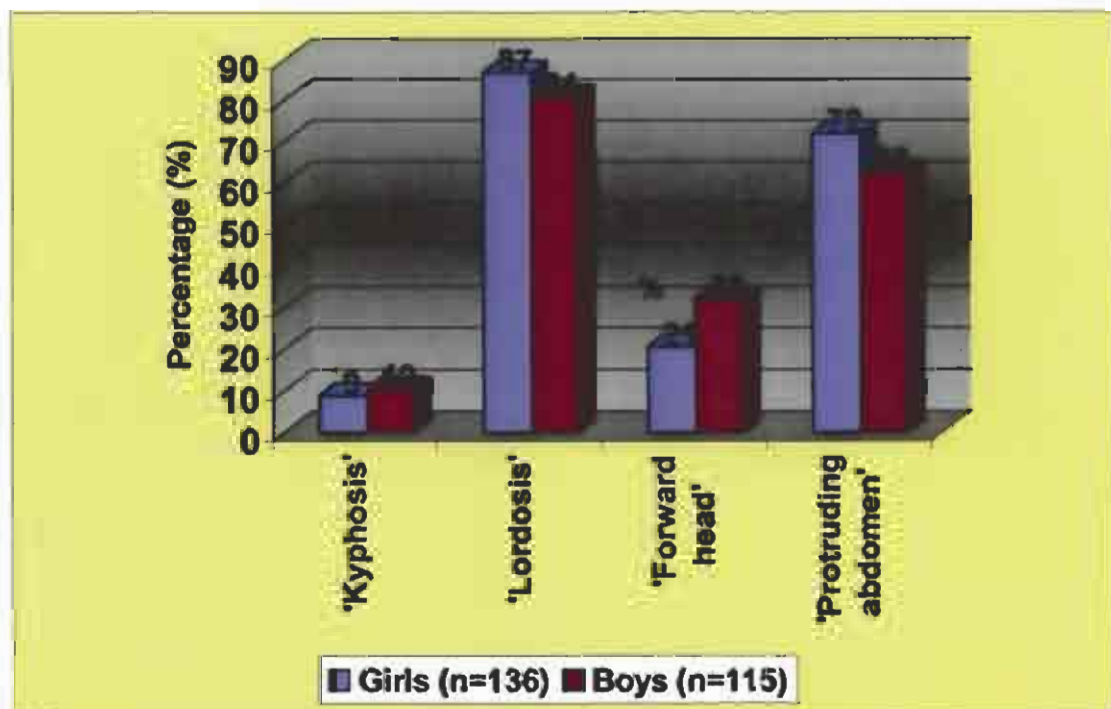


Figure 4.3: The prevalence of posture deformities according to gender (Sagittal plane)

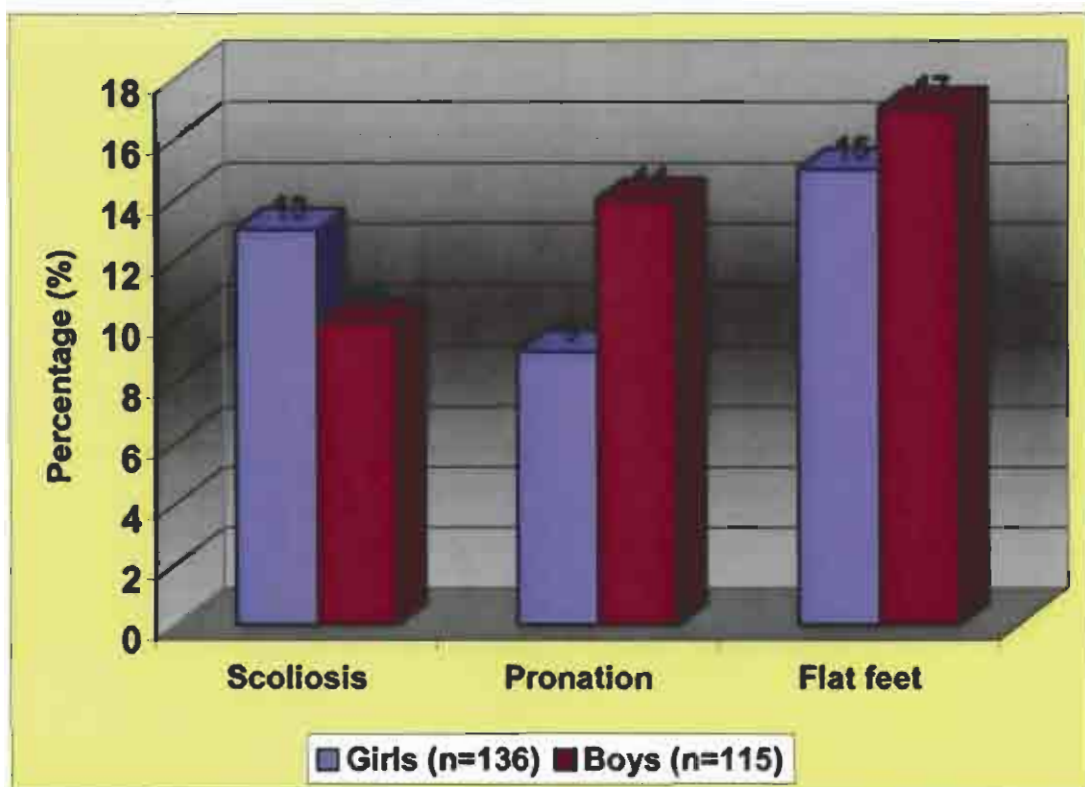


Figure 4.4: The prevalence of posture deformities according to gender (other)

More girls (54%) reported with posture deformities than boys (46%). A higher incidence of lordosis (87%) and protruding abdomen (72%) was reported in girls compared to boys with lordosis of 81% and protruding abdomen of 63%. The frequency of kyphosis (10%), forward head (32%), pronated ankles (14%) and flat feet (17%) was greater in boys while the girls reported a frequency of 9%, 21%, 9% and 15% respectively.

Discussion

School screening for posture deformities has been the subject of many studies over the past 20 years. Only a few studies could be found that reported on the gender difference of posture deformities between boys and girls. (Francis & Bryce, 1987; Mellin et al., 1988; Widhe, 2001; Poussa, Heliovaara, Seitsamo, Kononen, Hummerinta & Nissinen, 2005; Lafond, Descarreax, Normand & Harrison, 2007), but no study could be found on black African boys and girls. Comparison between studies is

difficult because of a difference in age and race. In this study one was able to compare the figures between the study by Francis and Bryce (1987) and Mellin et al. (1988), although the race was not the same.

The purpose of this study was to determine the difference of posture deformities in black African boys and girls. The findings of the present study indicate the incidence of posture deformities to be higher in girls than in boys. The subjects were selected with having very low socio-economic standards, and were likely to be stunted and malnourished.

Because of the lack of comparable research in this broad spectrum the researcher makes no attempt to compare the incidence of the various deviations among the general population.

The prevalence of both lordosis and protruding abdomen deformities was greater in females. According to Watson et al. (2002) and Lafond et al. (2007), abdominal protrusion relates directly to lordosis and pelvic anteversion in an attempt to correct the anteroposterior balance that is compromised. Weak gluteal and hamstring muscles cannot counteract the anterior tilt (Nussinovitch, Finkelstein, Amir, Greenbaum, & Volovitz, 2002). There was a higher prevalence in both flat feet (17%) and pronated reported ankles (14%) in boys. A reason for these posture differences in gender could be due to the boys being more physically active at virtually all ages (Sallis, 2000), playing sports and doing chores, and the girls leading a more sedentary lifestyle. Some of these boys have to walk far distances carrying water and firewood, while the girls stay at home helping with cooking and washing of clothes. According to Sherrill (1993), lordosis could also be caused by genetic predisposition.

Studies of school screening for scoliosis show a wide range of prevalence from 1.6% - 72% (Hazebroek-Kampschreur, Hofman, Of Dijk & Linge, 1992; Soucacos, Soucacos, Zacharis, Beris & Xenakis, 1997; Loots, Loots & Steyn, 2001; Nussinovitch et al., 2002). According to Hazebroek-

Kampschreur et al. (1992), these differences are due to difference in age groups, definition of scoliosis and different detection methods. Incidences of scoliosis in females (13%) were higher than in males (10%), which correlate well with the study by Francis and Bryce (1987).

Kyphosis was reported in 10% of the subjects, 9% was reported in girls, while 10% was reported in boys. A high percentage (74%) of subjects were rated slightly abnormal. The findings could be related to periods of rapid growth and can occur in subjects during the growth spurt of puberty (Mellin et al., 1988; McMaster & Singh, 1999; Widhe, 2001). This is very important in girls, since there is a tendency to adopt this posture as a manner of hiding breast development (Penha, 2005). In studies done by Widhe (2001) and Poussa et al. (2005) respectively, it also showed that kyphosis in relation to lordosis decreases with age in girls, but not in boys, which could explain the higher incidence in boys. Mellin et al. (1988) also reported that kyphosis was less in girls compared to boys. The study was done on boys and girls, aged 13 to 14 years (Mellin et al., 1988).

The incidence of forward head was higher in girls (32%) than in boys (21%).

There was an 8% difference in the prevalence of posture deformities recorded in boys (46%) and girls (54%). The incidence of kyphosis, pronated ankles, forward head and flat feet was higher in boys than in girls. These findings could have been affected by stunting as well as the different pubertal phases of the subjects, (Mellin et al., 1988). In a study by Lafond et al. (2007) it was found that postural modifications are the result of normal musculoskeletal maturation throughout childhood and puberty. Although some of the subjects were stunted and malnourished, most of the boys, according to their chronological age, were supposed to be on average in growth spurt whereas the girls were in retarded growth.

Summary

The reality is that postural deformities and poor body mechanics are epidemic in both schoolboys and schoolgirls. In summary the findings, suggest that there is a difference in the prevalence of posture deformities between black African boys and girls, with a higher incidence reported among girls. It also shows certain posture deformities to be gender specific. One can assume that the findings were greatly influenced by the age difference and different phases of growth spurt and puberty.

List of References

Arnheim, D.D., & Prentice, W.E. (2000). *Principles of athletic training. Principles of athletic training* (10th ed.). Boston, Mass: McGraw-Hill.

Banfield, M.A. (2000). *The posture theory: some additional considerations. The physical basis for hypochondria* (11th ed.). South Australia, Adelaide: Banfield Publisher.

Bloomfield, J., Acland, T.R., & Elliot, B.C. (1994). *Applied anatomy and biomechanics in sport*. Melbourne: Blackwell Scientific Publication.

Brower, E.W., & Nash, C.L. (1979). Evaluating growth and posture in school-age children. *Nursing*, 9(4) (April), 58 – 63.

Francis, S.R., & Bryce, G.R. (1987). Screening for musculoskeletal deviations – a challenge for the physical therapist. *Physical Therapy*, 67(8), 1221-1225.

Hazebroek-Kampschreur, A.A.J.M., Hofman, A., Of Dijk, A.Ph., & Linge, B. (1992). Prevalence of trunk abnormalities in eleven-year-old schoolchildren in Rotterdam, the Netherlands. *Journal of Pediatric Orthopedics*, 12,480-484.

Herman, M.J., Pizzutillo, P.D. (2002). Treating idiopathic scoliosis. Management options to straighten the spine. *Women's Health in Primary Care*, 5(6), 361–367.

Kendall, H.O., Kendall, F.P., & Boyton, D.A. (1977). *Posture and pain* (9th ed.). New York: Williams & Wilkens.

Lafond, D., Descarreaux, M., Normand, M.C., & Harrison, D.E. (2007, January). Postural development in schoolchildren: a cross-sectional

study. *Chiropractic & Osteopathy*, 15,1. Retrieved April 9, 2007, from <http://www.chiroandosto.com/content/15/1/1>

Loots, M., Loots, J.M., & Steyn, J.M. (2001). An investigation into essential aspects of posture in primary school boys and male senior executives. *South African Journal for Research in Sport, Physical Education and Recreation*, 23(1), 39–49.

Magee, D.J. (2002). *Orthopedic physical assesment* (4th ed.). USA: Saunders.

McMaster, M.J., & Singh, A.H. (1999). Natural history of congenital kyphosis and kyphoscoliosis: a study of one hundred and twelve patients. *Journal of Bone and Joint Surgery*, 81(10), 1367-1383.

Mellin, G., Harkonen, H., & Poussa, M. (1988). Spinal mobility and posture and their correlations with growth velocity in structurally normal boys and girls aged 13 – 14 years. *Spine*, 13(2), 152-154.

Nussinovitch, M., Finkelstein, Y., Amir, J., Greenbaum, E., & Volovitz, B. (2002). Adolescent screening for orthopaedic problems in high school. *Public Health*, 116, 30-32.

Penha, P.J., Joao, S.M., Casarotto, R.A., Amino, C.J., & Penteado, D.C. (2005). Postural assessment of girls between 7 and 10 years of age. *Clinics*, 60(1), 9-16.

Poussa, M.S., Eliovaara, M.M., Seitsamo, J.T., Kononen, M.H., Humerinta, K.A., & Nissinen, M.J. (2005, October). Development of spinal posture in a cohort of children from the age of 11 to 22 years. *European Spine Journal*, 14(8), 738–742.

Reedco Inc. 2001. Anatomical measuring devices. Retrieved January 12, 2004, from <http://www.info@ccmi-reedco.com>

Sallis, J.F. (2000, October). Overcoming inactivity in young people. *The Physician and Sportsmedicine*, 28(10), 31-32.

Sherrill, C. (1993). *Adapted physical activity, recreation and sport* (4th ed.). Dubuque: Brown & Benchmark.

Starnes, D. 2001. Back posture problems. Retrieved April 10, 2002, from http://wa.essortment.com/postureproblems_rmaf.html

Statsoft, Inc. 2003. *STATISTICA* (data analysis software system, Version 6).

Stroebel, S. (2002). *The prevalence of postural deformities among children age 11 – 13 years in some Western Cape schools* (Thesis – M.Sc.). Stellenbosch: University of Stellenbosch.

Soucacos, P.N., Soucacos, P.K., Zacharis, K.C., Beris, A.E., & Xenakis, T.A. (1997). School-screening for scoliosis. A prospective epidemiology study in Northwestern and Central Greece. *The Journal of Bone and Joint Surgery*, 79(A), 1498-1503.

Tanner, J.M., Whitehouse, R.H., Marubini, E., & Resele, L.F. (1976). The adolescent growth spurt of boys and girls of the Harpenden Growth Study. *Annals of Human Biology*, 3(2), 109-126.

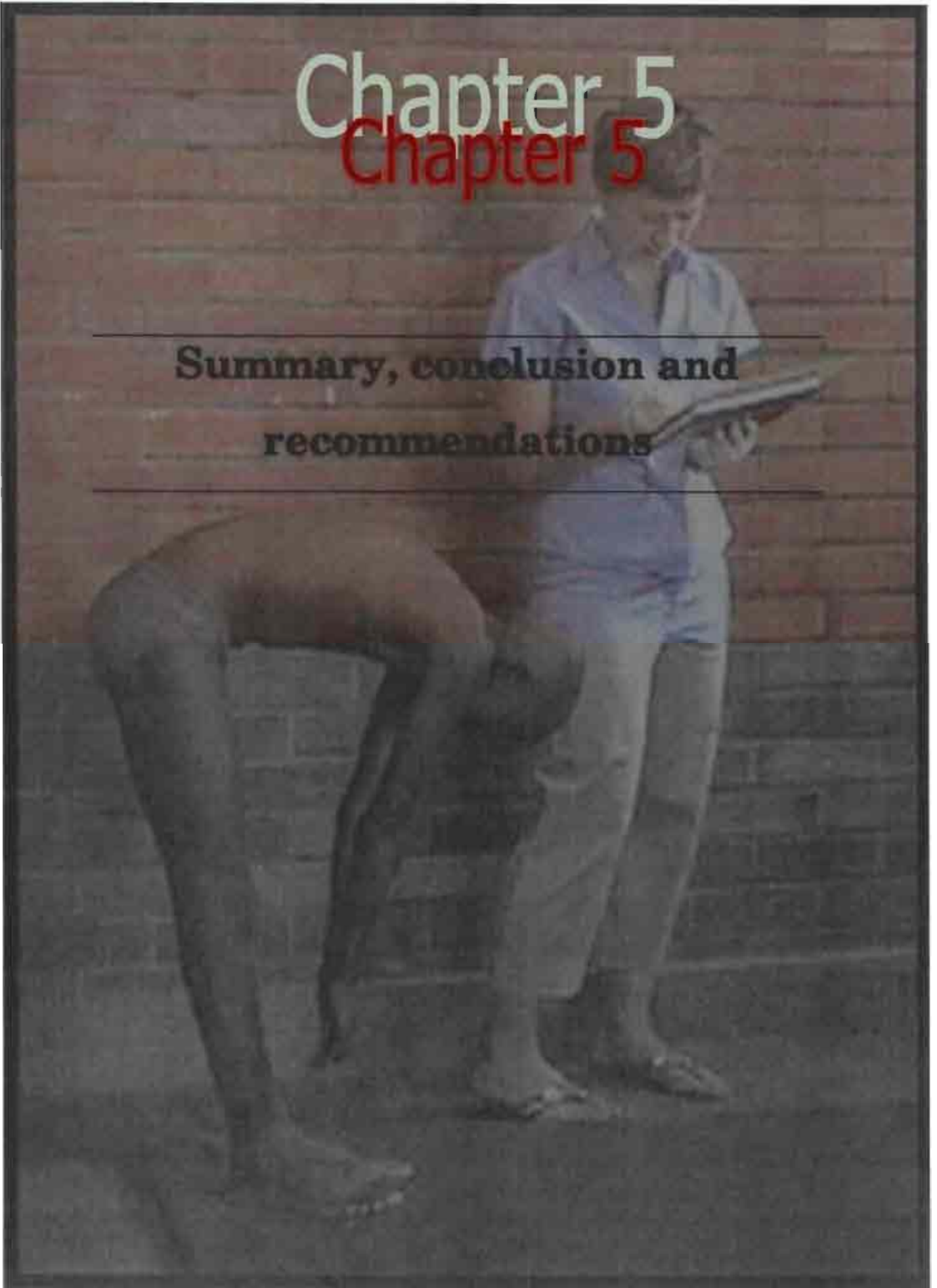
Watson, K.D., Papageorgiou, A.C., Jones, G.T., Taylor, S., Symmons, D.P.M., Silman, A.J. & Macfarlane, G.J. (2002). Low back pain in schoolchildren: occurrence and characteristics. *Pain*, 97,87-92.

Widhe, T. (2001). Spine: posture, mobility pain. A longitudinal study from childhood to adolescence. *European Spine Journal*, 10,118 – 123.

Chapter 5

Chapter 5

Summary, conclusion and recommendations



“Future health is based on prevention” – Anon

Chapter 5: Summary, conclusion and recommendation

5.1 Summary	108
5.2 Conclusion	109
5.3 Recommendation.....	110
5.4 Limitations.....	111

5.1 Summary

Posture has become an important field of interest because of its influence on health. Posture deformity in children is relatively common and various studies have evaluated the prevalence of spinal deformities among children (Fon *et al.*, 1980:979-983; Willner & Johnson, 1983:873-878; Francis & Bryce, 1987:1221-1225; Nissinen *et al.*, 1994:8-13; Ragheb & Gregory, 1993:32-35; Karachalios *et al.*, 1999:2318-2324; Stroebel, 2002; Lafond *et al.*, 2007:1). The objectives of this study (Chapter 1) were firstly to determine the prevalence of posture deformities among black African children in the North West Province and secondly to determine gender difference in the prevalence of posture deformities.

In order to substantiate the goal of this study, Chapter 2 included a literature study involving specific aspects regarding posture. In the first part of the chapter, definitions of posture, normal posture and poor posture, as well as the causes of poor posture were investigated. In the second part of Chapter 2 the focus was on posture development according to age, back pain in children and risk factors in school that affects posture. For the purpose of this study the following deformities were described namely, forward head syndrome, scoliosis, kyphosis, lordosis, flat feet and claw feet.

Many factors can contribute to poor posture including: domestication, cultural demands and longevity (Centre for Disease Control quoted by Colgan, 2002:5); hypermobilities and hypomobilities (Moss, 2001:39); disease and infection (Banfield, 2000:54) and sitting position (Murphy *et al.*, 2004:118; Cardon *et al.*, 2004:133-142). Posture is also affected by body type, height, weight, fitness, disability, age, clothing, shoes, occupation and body image/self-concept (Sherrill, 1993:366; Stames, 2001). In schoolchildren risk factors like sitting position during lessons (Murphy *et al.*, 2004:118; Cardon *et al.*, 2004:133-142), school furniture (Murphy *et al.*, 2004:118) and backpack use (Goodgold *et al.*, 2002:214; Negrini & Carabalona, 2002:187–195; Mackenzie *et al.*, 2003:79), can also have adverse effects on posture. Postural patterns in childhood vary with age, sex and stage of development and body type (Asher, 1975:13).

Two research articles are presented in Chapter 3 and Chapter 4 respectively. In the first article (Chapter 3) the prevalence of posture deformities among black African Grade 8 children in the North West Province of selected schools was investigated. The findings indicated posture deformities to be high among these children with the highest incidence of anomaly being lordosis (84%) and protruding abdomen (67%) and the lowest incidence being twisted head, with only 8% being slightly abnormal. The second article “The difference in the prevalence of posture deformities among black African boys and girls in selected schools in the Northwest Province” is presented in Chapter 4. There was an 8% difference in the prevalence of posture deformities recorded in boys (46%) and girls (54%). The incidence of kyphosis, pronated ankles, forward head and flat feet was higher in boys than in girls.

5.2 Conclusions

The conclusion was formed according to the assumed hypotheses stated in Chapter 1.

Hipothese:

- 1. There is a high incidence of postural deformities among black African Grade 8 children in selected schools in the North West Province.**
- 2. The prevalence of postural deformities is higher among girls, in black African Grade 8 children in selected schools in the North West Province.**

The present study included 251 black African children and evaluated the prevalence of 13 postural deformities, including spinal deformities. In this study the importance of posture deformities in black African children was confirmed. Comparison between studies was difficult because of a difference in age and race. This study reported postural deformities to be high which is similar compared to studies done on children the same age. Lordosis and protruding abdomen occurred commonly among these black African children. Gender differences in the prevalence of posture deformities was also found, with a higher incidence of posture deformities reported among girls. The incidence of kyphosis, pronated ankles, forward head and flat feet was higher in boys than in girls, while scoliosis, lordosis and protruding abdomen occurred more often in girls. One study in the existing literature also reported kyphosis to be less in girls compared to boys.

Both hypotheses are thus accepted, as the prevalence of posture deformities among black African schoolchildren is high and the prevalence of postural deformities is higher among girls.

5.3 Recommendations

Many of these children are unaware that their posture is incorrect and may in fact be contributing to their physical symptoms. According to Howe and Oldham (2001:237), patient, parent and teacher education in terms of good and poor posture is essential for the correction of habitual posture. As soon as the patient becomes aware of the problem, correction may begin to take place. This education may include advice on correct sitting posture at a desk,

television and computer, height of furniture and work surfaces, and backpack carriage.

It is also necessary that parents and teachers are well informed. If the child's development is within normal variations for gait and posture then the parents can expect normal development in this area to proceed through mid-and-later childhood and adolescence (McCoy & Dickens, 1997).

The body of the growing child requires a steady flow of oxygen and nutrients through adequate blood supply. Physical activity and movement is crucial for this process. Children spend significantly more time sitting. The child should be encouraged to pursue physical activities that he or she enjoys. A child could successfully modify his/her posture by performing special exercises to improve muscle balance and repair poor posture.

This shows the need for specific physical activity programmes or physical education in schools and using classroom curriculum to increase physical activity.

More research is needed to document posture deformities among schoolchildren of different races and ages. Interventions for schoolchildren with continued school-screening programmes should be implemented.

5.4 Limitations

- ❖ Although the study was done on Grade 8 pupils of the selected schools, chronological ages varied from 13 – 17 years, which influenced the second hypothesis on gender differences, as biological ages were not considered.
- ❖ A longitudinal study design would have increased the number of subjects and random inclusion would have been possible. The small sample size and age differences resulted in a loss of statistical power.

- ❖ The "posture grid" hindered identifying some of the posture deformities, especially scoliosis. Through means of a different test procedure, e.g. the scoliometer or Moiré topography the outcome would have been different and more scoliosis ratings might have been reported. The same assistant was responsible for administering the forward bending test, which reduced the degree of subjectivity.
- ❖ Limitations regarding the geographic location could have influenced findings, as children were from selected schools from different rural areas in the same district/township.

List of References

ASHER, C. 1975. Postural variations in childhood. Boston: Butterworths. 122 p.

BANFIELD, M.A. 2000. The posture theory: some additional considerations. The physical basis for hypochondria. 11th ed. South Australia, Adelaide: Banfield Publisher. 1004 p.

CARDON, G., DE CLERCQ, D., DE BOURDEAUDHUIJ, I. & BREITHECKER, D. 2004. Sitting habits in elementary schoolchildren: a traditional versus a "moving school". *Patient education and counselling*, 54(2):133-142, December. <http://www.sciencedirect.com/science> Date of access: 14 Nov. 2005.

COLGAN, M. 2002. Perfect posture: the basis of power. Canada: Apple Publishing. 63 p.

FON, G.T., PITT, M.J. & THIES, A.C. 1980. Thoracic kyphosis: range in normal subjects. *American journal of roentgenology*, 134:979-983, May.

FRANCIS, R.S. & BRYCE, G.R. 1987. Screening for musculoskeletal deviation – A challenge for the physical therapist. *Physical therapy*, 67(8):1221-1225.

GOODGOLD, S., MOHR, K., SAMANT, A., PARKE, T., BURNS, T. & GARDNER, L. 2002. Effects of backpack load on task demand on trunk forward lean: Pilot findings on two boys. *Work*, 18:213-220.

HOWE, T. & OLDHAM, J. 2001. Posture and balance. (In Trew, M. & Everett, T., eds. Human movement: An introductory text. 4thed. New York: Churchill Livingstone. p. 225 - 239.)

LAFOND, D., DESCARREAUX, M., NORMAND, M.C. & HARRISON, D.E. 2007. Postural development in schoolchildren: a cross-sectional study. *Chiropractic & Osteopathy*, 15:1, Jan. <http://www.chiroandosto.com/content/15/1/1> Date of access: 9 Apr. 2007.

KARACHALIOS, T., SOFIANOS, J., ROIDIS, N., SAPKAS, G., KORRES, D. & NIKOLOPOULOS, K. 1999. Ten-Year follow-up evaluation of a school screening program for scoliosis. *Spine*, 24(22):2318-2324.

MACKENZIE, W.G., SAMPATH, S.J., KRUSE, R.W. & SHEIR-NEISS, G.J. 2003. Backpacks in children. *Clinical orthopaedics and related research*, 409:78 – 84.

McCOY, A. & DICKENS, B. 1997. Understanding normal variations in childhood, gait and posture, 17 April. <http://www.hna.ffh.vic.gov.au/yaf/cis> Date of access: 16 Sep. 2005.

MOSS, R.I. 2001. Posture and pathology. *Athletic therapy today*, 6(5):38-39.

MURPHY, A., BUCKLE, P. & STUBBS, D. 2004. Classroom posture and self-reported back and neck pain in schoolchildren. *Applied ergonomics*, 35:113 – 120.

NEGRINI, S. & CARABALONA, R. 2002. Backpacks on! Schoolchildren's perception of load, associations with back pain and factors determining the load. *Spine*, 27(2):187-195, 15 Jan.

NISSINEN, M., HELIÖVAARA, M., SEITSAMO, J. & POUSSA, M. 1994. Trunk asymmetry, posture, growth, and risk of scoliosis. A three year follow-up of Finnish prepubertal school children. *Spine*, 18(1):8-13.

RAGHEB, M.A. & GREGORY, W.B. 1993. Postural deviations of Bahraini Schoolboys: Ages 6–8. *International journal on health, physical education and recreation*, 30(2):32–35.

SHERRILL, C. 1993. Adapted physical activity, recreation and sport. 4th ed. Dubuque: Brown & Benchmark. 714 p.

STROEBEL, S. 2002. The prevalence of postural deformities among children age 11 – 13 years in some Western Cape schools. Stellenbosch: University of Stellenbosch. (Thesis – M.Sc.) 130 p.

STARNES, D. 2001. Back posture problems. http://wa.essortment.com/postureproblems_rmaf.html Date of access: 10 Apr. 2002.

WILLNER, S. & JOHNSON, B. 1983. Thoracic kyphosis and lumbar lordosis during the growth period in children. *Acta paediatrica Scandinavica*, 72:873-878.

APPENDIX A

Guidelines for Authors

African journal for Physical, Health Education, Recreation and Dance

Guidelines for Authors

The African Journal for Physical, Health Education, Recreation and Dance (AJPHERD) publishes research papers that contribute to knowledge and develop theory either as new information, reviews, confirmation of previous findings, application of new teaching/coaching techniques and research notes. All manuscripts should be sent to the Editor-In-Chief. These must represent original works, which have not been submitted or published elsewhere. Authors are normally advised about the decision on their manuscripts within 60 days. Authors are, however, reminded to return revised edition soonest.

Preparation of Manuscripts

Authors should submit three copies of the manuscripts written in English and typed space on one side with generous margins. In general, manuscripts should not exceed 10 pages in A-4 size paper including a concise abstract of not more than 200 words. Diagrams, tables, charts and plates should be simple and appear at appropriate sections in the text. Longer manuscripts may be accepted for multiple studies and reviews. Key words must be included at the end of the abstract.

The first page of the paper should show the title, author's name/authors name and address(s). Authors are advised to include their telephone and fax numbers, and e-mail addresses. Multiple Authors should be listed in order of proportionate work commitment. The next page of the manuscript should begin with the, abstract and introduction in that order. All manuscripts must conform to the Publication Manual of the American Psychological Association (4th ed). Manuscripts deviating from the recommended form will neither be reviewed nor returned. On final acceptance of a manuscript, the author(s) will be requested to submit a computer disk with file stored in Microsoft Word 6.0. Manuscripts should be prepared in the following order: (1) title page (2) abstract (3) text including tables, figures etc., (4) references and (5) author notes (if any).

References

The American Psychological Association (APA) format should be used for referencing. Only references cited in the text should be alphabetically listed in the reference section at the end of the article. References should not be numbered either in the text or the reference list.

Proofreading

The author may receive page proofs for corrections when necessary before publication. In case of multiple authors, proofs will be sent to the first listed author unless otherwise advised. Proofreading of manuscripts should be thoroughly done.

Copyright and Permission to Reprint

LAP Publications Ltd. holds the copyright for AJPHERD. In keeping with copyright laws, authors may be required whenever legally possible, to assign the copyright of accepted manuscripts to LAP Publications Ltd. This ensures that both the publishers and the authors are protected from misuse of copyright materials. Permission for copyright requests should be addressed to the Editor-in-Chief.

Reprints

On publication, a copy of AJPHERD containing the article of the author will be sent to the author and in case of multiple authors, to the principal author.

Correspondence

All correspondence concerning manuscripts and editorial materials should be directed to the Editor-In-Chief, Professor L. O. Amusa, Centre for Biokinetics, Recreation and Sport Science, University of Venda for Science and Technology, P. Bag X5050, Thohoyandou 0950, South Africa; E-mail: amusalbw@yahoo.com

Submission Preparation Checklist (All items required)

- The submission has not been previously published nor is it before another journal for consideration; or an explanation has been provided in Comments to the Editor.

Copyright Notice

Copyright for articles published in this journal is retained by the journal.

Privacy Statement

The names and email addresses entered in this journal site will be used exclusively for the stated purposes of this journal and will not be made available for any other purpose or to any other party.

APPENDIX B

Guidelines for authors

***The International Council for Health, Physical Education, Recreation,
Sport & Dance Journal of Research***

ICHPER-SD

Manuscript Guidelines for Authors

Articles are invited in the areas of health, physical education, adapted physical education, recreation, dance, sport, human performance, coaching, sports medicine, and sport management. *This journal is international in scope in the sense that authors/researchers and topics can originate from any part of the world.*

All manuscripts must be submitted in English. An original hard copy of the manuscript plus a computer CD (virus free) containing the article and any tables and/or figures (as separate files, in Microsoft Word®), should be submitted to:

Editor
ICHPER-SD Journal of Research
or
Journal of ICHPER-SD
International Council for Health, Physical Education, Recreation,
Sport, & Dance (ICHPER-SD)
1900 Association Drive, Reston, Virginia 20191-1598, USA
Phone: (703) 476-3462 Fax: (703) 476-9527 Email:
ichper@aahperd.org

Each manuscript must be accompanied by a one-paragraph abstract (100 words or less). The APA (latest edition) format [*Publication Manual of the American Psychological Association*] must be used consistently throughout the entire manuscript. At least one of the authors (if there is more than one) should be members of ICHPER-SD. Authors should number pages and lines throughout the manuscript, including the references. Be sure and double check references for correct spelling of authors and publication dates as well as to insure that the names in the references and in the body of the manuscript match.

For manuscripts sent from the United States, a large, self-addressed, **stamped** envelope (9" by 12") must be included for the return of the manuscripts (with editor's and reviewers' comments) for possible revision. For manuscripts sent from outside the United States, only a large self-addressed envelope (9" by 12") must be included. Manuscripts should not be submitted to another journal while under review.

The first page of each manuscript should include only the title of the article. The senior author's name, affiliation, and full address (including phone number, fax number and e-mail address) should be provided on a separate cover sheet, along with identification of co-authors, if any. The manuscripts should be typed double-spaced with a 1½ -inch margin. Generally, manuscripts should be 15-20 pages in length, plus tables, figures and references, for a total of no more than 24-25 pages. The body of the manuscript should not contain any information identifying the author(s). Manuscripts longer than this will be reviewed, and if accepted, can be published – space permitting.

All graphs, tables as well as figures and drawings should be placed on separate pages. Tables should be double-spaced. Figures and drawings must be professionally prepared and camera ready. Final manuscripts, including all corrections and revisions, must be submitted on a computer CD in Microsoft Word® as well as two hard copies.

Submitted manuscripts are reviewed by at least three members of the "review board" and by the editor. The evaluation of manuscripts is by a blind review process. Authors are notified as to the disposition of their manuscripts as soon as all reviews are completed. Once a manuscript has been tentatively accepted, the author should return two hard copies of the revised manuscript and a computer CD (Microsoft Word®) containing the manuscript and any tables or figures as separate files, for a final review, prior to being scheduled for publication.

Galley proofs of accepted manuscripts are mailed to the author and are to be returned within one week following receipt from the editor. Only minor corrections are

acceptable on the galley proofs. No major additions or revisions are permitted at this stage in the publication process. The senior author receives two copies of the issue in which the article appears.

There are no page charges to authors. All authors must transfer copyright to International Council for Health, Physical Education, Recreation, Sport, & Dance (ICHPER-SD) by signing a copyright release document. At least one of the authors (if there is more than one) is expected to be a member of ICHPER-SD or willing to become a member.

Form a-2-2-25-06a

If you have any questions, please do not hesitate to contact me.

Sincerely

William F. Stier, Jr., Ed. D.
Editor: *ICHPER-SD Journal of Research*
Editor: *Journal of ICHPER-SD*

Distinguished Service Professor
Graduate Director
Director: Athletic Administration/Sport Management
Director: Coaching Education
State University of New York
Brockport, NY 14420

Office: 585-395-5331
FAX: 585-395-2771
bstier@brockport.edu
<http://www.acs.brockport.edu/~bstier>

APPENDIX C

Play Project Information on the study

PLAY PROJECT: INFORMATION ON THE STUDY

THE PROJECT HAS BEEN APPROVED BY THE ETHICS COMMITTEE OF THE NORTH WEST UNIVERSITY (Potchefstroom Campus).

I CONFIRM THAT:

It has been explained to me, that:

1. The purpose of the research study is to collect information on growth and activity among Grade 8 schoolchildren in Seiphemelo Secondary School, North West Province.
2. I have been told that the researchers will measure me. The participant will be weighed and his/her height as well as circumferences and skinfolds of his/her arm will be measured without causing any pain to the child. For those measurements boys and girls in separate groups will be asked to undress in privacy of a class-room, because some measurements must be taken with the children dressed in underwear only, or a light shirt and pants/skirt. The researchers will also ask me to indicate my own level of physical maturation from pictures. The different age groups will be measured separately. The researchers and fieldworkers will work in a professional way, not to embarrass the children.
3. Children will also be measured in an instrument, called the BODPOD to measure amount of muscle, bone and fat. These measurements will be done at the North West University and children will be transported to the laboratory and back.
4. Fitness testing will be done.
5. The measurements will be done at the beginning and end of the study. After the first measurements, an activity programme, based on fun games for children will be presented for two days per week at the school. The programme will run from about March to September during the school terms. The purpose of the measurements at the end of the study is to see if the participants improve physically after the activity programme. On at least one day I will be asked to wear a little measuring instrument on a waistband to measure my physical activity. The instrument cannot harm me in any way, all it does is to measure movement.
6. The researchers will ask me about my home environment, the food that I usually eat and activities that I do. None of these questions will be to see if I am clever, or know correct answers. I can just tell them what I usually do.
7. Guidelines for appropriate, culture sensitive, practical and sustainable intervention programmes for children will be developed.
8. The information I will give shall be kept confidential, only to be used anonymously for making known the findings to other scientists.
9. It was also clearly explained to me that I can refuse to participate in this research study or I can stop answering the questions at any time during the interviews.

The information in this consent form was explained to me by _____ (name of interviewer) in _____ (language) and I confirm that I have a good command in this language and understood the explanations, OR it was translated to me by _____ (Name of translator) in my language _____. I was also given the opportunity to ask questions on things I did not understand clearly.

I the participant (child) hereby agree voluntarily to take part in this research survey.

Signed/confirmed at _____ on _____ 2004

Witness _____

Representative of participant (parent/guardian) _____

APPENDIX D

Posture Evaluation Form

POSTURAL EVALUATION

POSTURE RATING CHART
SIDE VIEW POINTS

5	Neck erect chin is head in balance directly above shoulders	3	Neck slightly forward, chin slightly out	1	Neck markedly forward, chin markedly out
5	Chest elevated breast bone rested forward part of body	3	Chest slightly depressed	1	Chest markedly depressed (flin)
5	Shoulders squared	3	Shoulders slightly forward	1	Shoulders markedly forward (upper arm forming a 90°)
5	Upper back normally rounded	3	Upper back slightly more rounded	1	Upper back markedly rounded
5	Trunk erect	3	Trunk inclined to rear slightly	1	Trunk inclined to rear markedly
5	Abdomen flat	2	Abdomen protruding	1	Abdomen protruding and sagging
5	Lower back normally curved	3	Lower back slightly hollow	1	Lower back markedly hollow

SCORE

Forward Bending Test (V/M)

L/R

POSTURAL EVALUATION

POSTURE RATING CHART
BACK VIEW POINTS

5	Head erect, level ears directly through center	3	Head twisted or turned to one side slightly	1	Head twisted or turned to one side markedly
5	Shoulders level (horizontally)	3	One shoulder slightly higher than other	1	One shoulder markedly higher than other
5	Spine straight	3	Spine slightly curved laterally	1	Spine markedly curved laterally
5	Hips level (horizontally)	3	One hip slightly higher	1	One hip markedly higher
5	Feet pointed straight ahead	3	Feet pointed out	1	Feet pointed out markedly; ankles sag in fronting
5	Arches high	3	Arches low, feet slightly flat	1	Arches low, feet markedly flat

SCORE

Total: