



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

# **THE ASSOCIATION BETWEEN ABNORMAL DEVELOPMENTAL MILESTONES OF BABIES AND THE PREVALENCE OF SPINAL DEFORMITIES IN ADOLESCENCE**

by

**René Alberts**

**A dissertation submitted in fulfilment of the requirements for the  
Degree in Master of Physiotherapy  
Department of Physiotherapy  
Faculty of Health Sciences  
University of Pretoria**

**Promoter: AJ van Rooijen  
Co-promoter: M Eisenberg**

**July 2000**



## DECLARATION

I, René Alberts hereby declare that this dissertation is my own, unaided work under the guidance of my mentors, Ms AJ van Rooijen and Ms M Eisenberg. . It has not been submitted before for any degree or examination at any other University. This dissertation is being submitted for the degree of Master of Physiotherapy at the University of Pretoria

(Signature of candidate)

*René Alberts*

16<sup>th</sup> day of NOVEMBER, 2000.

Witness

*[Handwritten signature]*

## **ABSTRACT**

The purpose of this study was to investigate whether there is an association between developmental milestones of babies and the prevalence of spinal deformities in adolescents in Middelburg, Mpumalanga. The relationship between spinal deformities in a cross-sectional group of adolescents and parental recall was the focus of the study. One hundred and four adolescents were evaluated to determine if a spinal deformity was present. The subjects were then allocated to either the case ( those with spinal deformities ) or the control ( subjects without spinal deformities ) groups. The mothers of the subjects were then interviewed with regard to some of the developmental milestones of their offspring, and other factors which may have had an influence on the development of adolescent spinal deformities.

The results showed that a perfectly "normal spine" was seldom found and that even in the control group some minor deviations, within normal limits, were present. Most of the mothers of subjects from the case group did not realise that their offspring had a deformity. There was a non-significant trend for more crawlers to be present in the control group. Subjects who did not crawl, and who were also late walkers appeared to have an increased tendency to develop adolescent spinal deformities. Despite the fact that the schools approached were multi-racial, only white parents responded to the request for participation in this trial. The possible reasons for this should be investigated and a trial comparing the prevalence of spinal deformities amongst adolescents from all ethnic groups in South Africa should be conducted.

Due to the possible recall bias of this study, it is recommended that a longitudinal study, commencing with the babies attending baby clinics in South Africa (representative of the South Africa population), be conducted to determine the influence of developmental milestones on the prevalence of spinal deformities in adolescence.

**Key words:** Developmental milestones, spinal deformities, adolescent idiopathic scoliosis, Scheuermann's kyphosis, aetiology.



TABLE OF CONTENTS	PAGE
List of figures	I
List of tables	IV
<b>Chapter 1</b>	<b>1</b>
Introduction and problem statement	1
1.1. Introduction	1
1.2. Problem statement	5
1.3. Research question	5
1.4. Aim of study	6
1.4.1. Main aim	6
1.4.2. Sub aims	6
1.5. Hypothesis	7
1.6. Terminology	7
1.7. Summary	8
<b>Chapter 2</b>	<b>10</b>
Literature review	10
2.1. Introduction	10
2.2. Spinal deformities	11
2.2.1. Pathology	11
2.2.1.1. Idiopathic scoliosis	11
2.2.1.2. Kyphosis	18
2.2.2. Aetiology	22
2.2.3. Evaluation and instruments	27
2.2.4. Treatment of spinal deformities	38
2.2.4.1. Conservative treatment	38
2.2.4.2. Surgery	46
2.3. Posture	47
2.3.1. The development of posture	48
2.3.2. Postural control	49
2.3.3. Postural dysfunction	51
2.4. Neuromotor development	53
2.4.1. Normal developmental milestones	53
2.4.1.1. Sitting	54
2.4.1.2. Crawling	56



	<b>Page</b>
2.4.1.3. Walking	57
2.4.2. Other factors that influence development	58
2.4.2.1. Lying positions	58
2.4.2.2. Freedom to move	59
2.4.2.3. Developmental co-ordination disorders	60
2.5. Summary of literature review	60
<b>Chapter 3</b>	<b>62</b>
Research methodology	62
3.1. Introduction	62
3.2. Study design	62
3.3. Study population	63
3.4. Sampling	63
3.5. Sample criteria	64
3.6. Research procedure	65
3.6.1. Description of instruments	66
3.6.2. Physical evaluation	69
3.6.3. Questionnaire	80
3.7. Pilot study	81
3.8. Research bias	82
3.8.1. Validity	82
3.8.2. Reliability	82
3.8.3. Selection bias	83
3.8.4. Information bias	83
3.9. Statistical analysis	84
3.10. Summary	85
<b>Chapter 4</b>	<b>86</b>
Results	86
4.1. Introduction	86
4.2. Physical evaluation	87
4.2.1. Cases and controls	87
4.2.2. Gender	87
4.2.3. Age	89



	<b>Page</b>
4.2.4. Menarche	90
4.2.5. Height	91
4.2.6. Leg length discrepancy	92
4.2.7. Straight leg raise	93
4.2.8. Thomas test	94
4.2.9. Hump size	94
4.2.10. Angle of trunk rotation	95
4.2.11. Plumblines	96
4.2.12. Kyphosis and lordosis	98
4.2.13. Forward head posture	98
4.2.14. Winging of scapulae	99
4.2.15. Asymmetrical elevated shoulder	101
4.2.16. Arm distance from trunk	101
4.3. Questionnaire	103
4.3.1. Developmental milestones	103
4.3.1.1. Sitting	103
4.3.1.2. Crawling	104
4.3.1.3. Walking	108
4.3.2. Developmental aids	110
4.3.2.1. Sit chair	110
4.3.2.2. Walking ring	111
4.3.2.3. "Jolly jumper"	114
4.3.3. Other factors	116
4.3.3.1. Family history	116
4.3.3.2. Gestation	118
4.3.3.3. Birth method	119
4.3.3.4. Lying position	120
4.3.3.5. Defective hearing	120
4.3.3.6. Defective vision	121
4.3.3.7. Knowledge of deformity	121
4.3.3.8. Growth spurt	122
4.4. Summary	124



	<b>Page</b>
<b>Chapter 5</b>	<b>125</b>
Discussion of results	125
5.1. Introduction	125
5.2. Physical evaluation	126
5.2.1. Cases and controls	126
5.2.2. Ethnicity	127
5.2.3. Gender	127
5.2.4. Age	128
5.2.5. Menarche	128
5.2.6. Height	128
5.2.7. Leg length discrepancy	129
5.2.8. Straight leg raise	129
5.2.9. Thomas test	130
5.2.10. Hump size	130
5.2.11. Angle of trunk rotation	131
5.2.12. Plumbline	132
5.2.13. Kyphosis and lordosis	132
5.2.14. Forward head posture	133
5.2.15. Winging of scapulae	134
5.2.16. Asymmetrical elevated shoulder	134
5.2.17. Arm distance from trunk	135
5.3. Questionnaire	135
5.3.1. Developmental milestones	136
5.3.1.1. Sitting	136
5.3.1.2. Crawling	136
5.3.1.3. Walking	138
5.3.2. Developmental aids	139
5.3.2.1. Sit chair	139
5.3.2.2. Walking ring	139
5.3.2.3. "Jolly jumper"	140
5.3.3. Other factors	140
5.3.3.1. Family history	140
5.3.3.2. Gestation	141
5.3.3.3. Birth method	141



	<b>Page</b>
5.3.3.4. Lying position	141
5.3.3.5. Defective hearing	142
5.3.3.6. Defective vision	142
5.3.3.7. Knowledge of deformity	143
5.3.3.8. Growth spurt	143
5.4. Summary	143
<b>Chapter 6</b>	<b>145</b>
Conclusion and recommendation	145
6.1. Introduction	145
6.2. Conclusion	146
6.2.1. Developmental milestones	146
6.2.2. Developmental aids	147
6.2.3. Other factors	147
6.3. Critical evaluation of study	150
6.4. Recommendation	152
6.5. Summary	153
References	154
Appendix A: Lecture at school	166
Appendix B: Information letter	168
Appendix C: Informed consent	172
Appendix D: Physical evaluation	175
Appendix E: Questionnaire	178
Appendix F: Protocol	183
Appendix G: Addendum to results	198





(i)

<b>LIST OF FIGURES</b>	<b>PAGE</b>
Figure 1: Subject dressed in a pair of shorts and halter neck top	66
Figure 2: Baseline digital inclinometer	67
Figure 3: Measuring tape, spirit level and metal ruler	68
Figure 4: Plumbline	69
Figure 5: Measurement of height	70
Figure 6: Measurement by means of straight leg raise	72
Figure 7: Measurement of hip flexor tightness	73
Figure 8: Measurement of hump size	74
Figure 9: Measurement of trunk rotation	75
Figure 10: Measurement by means of plumbline	76
Figure 11: Measurement of kyphosis and lordosis	77
Figure 12: Measurement of forward head posture	78
Figure 13: Postural observations	79
Figure 14: Distribution of cases and controls	87
Figure 15: Comparison of the ages of the case and control subjects	89
Figure 16: Percentage of cases and controls who had reached their menarche	90
Figure 17: Mean height for the cases and controls indicating mean height for boys and girls	91
Figure 18: Mean height for cases in each specific plane of deformity	92
Figure 19: Percentage of cases and controls who presented with a straight leg raise of less than 50 degrees	93
Figure 20: Percentage of cases who presented with a hump size of more than six millimetres in the different areas of the spine indicating side of the hump	94
Figure 21: Percentage of the cases and controls who presented with left and right sided deviations from centre of the gluteal cleft	96
Figure 22: Percentage of cases and controls who presented with a deviation from the midline of the spine	97
Figure 23: Percentage of cases who presented with forward head posture as well as a hyperkyphosis	99
Figure 24: Comparison between the left and right sides regarding winging of scapula	100



(ii)

	<b>PAGE</b>
Figure 25: Comparison between left and right sided elevated shoulders	101
Figure 26: Comparison of left and right arm hanging further from the trunk than the other	102
Figure 27: Comparison of percentage of cases and controls who sat at a specific age	103
Figure 28: Comparison of percentage of cases and controls who crawled	104
Figure 29: Comparison between percentage of case and control subjects who crawled to indicate age at which they crawled	105
Figure 30: Comparison between case and control subjects who crawled indicating the period of crawling	106
Figure 31: Percentage of case and control subjects who moved forward in an alternative method to crawling	107
Figure 32: Comparison between case and control group subjects regarding the age at which they walked	108
Figure 33: Comparison between case and control subjects who were placed in a sit chair as babies	110
Figure 34: Percentage of case and control subjects placed in a sit chair indicating the periods spent in chair	111
Figure 35: Comparison between percentage of case and control subjects who were placed in a walking ring as babies	112
Figure 36: Comparison between percentage of case and control subjects who were placed in a walking ring, indicating the period of time	113
Figure 37: Percentage of case and control group subjects who were placed in "jolly jumpers" as babies	114
Figure 38: Comparison between case and control subjects indicating time period they spent in the "jolly jumper"	115
Figure 39: Percentage of cases and controls who presented with a family history	116
Figure 40: Percentage of cases and controls according to gestation periods	118

(iii)

	<b>PAGE</b>
Figure 41: Method of birth indicating percentage of cases and controls	119
Figure 42: Comparison of percentage of cases and controls who preferred a specific lying position	120
Figure 43: Percentage of case and control subjects who presented with a sudden growth spurt	122
Figure 44: Comparison between cases and controls indicating the age at which sudden growth spurt occurred	123
 <b>Addenda</b>	
Figure 45: Mean leg length discrepancy for the case and control subjects	198
Figure 46: Presence of a longer leg indicating the side of longest leg	199
Figure 47: Mean straight leg raise for the case and control subjects comparing the left and right side	200
Figure 48: Comparison of percentage of cases and controls with hip flexor tightness	201
Figure 49: Mean hip flexor tightness for case and control subjects	201
Figure 50: Percentage of case and control subjects who presented with defective hearing	203
Figure 51: Percentage of case and control subjects who presented with defective vision	205

(iv)

<b>LIST OF TABLES</b>	<b>PAGE</b>
Table 1: Percentage of girls and boys	88
Table 2: Distribution of boys and girls of the case group in different planes of deformities	88
Table 3: Correlation between the hump size measured and the angle of trunk rotation	96
Table 4: Percentage of case and control subjects who made use of alternative methods of locomotion	107
Table 5: Maximum likelihood of crawling and walking influencing the development of spinal deformities	109
Table 6: Comparison between the case and control groups of those subjects who presented with a direct family history of deformities	117
Table 7: Comparison between cases and controls of those subjects who presented with a family history	117
 <b>Addenda</b>	
Table 8: Mean straight leg raise for different planes of deformities	200
Table 9: Different deformities in the direct family	202
Table 10: Different deformities on the maternal side	202
Table 11: Presence of different deformities on the paternal side of the cases	203
Table 12: Side of the defective hearing in cases and controls who presented with defective hearing	204
Table 13: Percentage of cases and controls who presented with defective hearing indicating the age at which defective hearing was noticed	204
Table 14: Side of defective vision in all affected subjects	205
Table 15: Age at which defective vision was first noticed	206
Table 16: Type of visual problem in affected subjects	206