CHAPTER 4

RESULTS

4.1. INTRODUCTION

Lectures on back care and / or written details of the study were given to three thousand scholars aged twelve to seventeen years at selected schools in the Middelburg area. Forms were handed out to three thousand scholars, requesting them to voluntarily participate in the study. One hundred and thirty two scholars responded. The respondents were telephoned to make an appointment for the evaluation. Fifteen of these volunteers then decided to withdraw from the study, while seven subjects had moved out of the Middelburg area. One hundred and ten (110) adolescents were evaluated. Data from five of these adolescents could not be used due to the fact that their mothers were not available to complete the questionnaire. One adolescent was excluded from the study group due to a previous fracture of the femur, which caused a leg length discrepancy of more than one centimetre. One hundred and four adolescents complied with the inclusion criteria for the study sample. Although most of the schools were multiracial, only white parents responded to the request for participation in this trial.

4.2. PHYSICAL EVALUATION OF SUBJECTS

4.2.1. CASES AND CONTROLS

The data of the 104 adolescents who complied with the inclusion criteria for the study group were processed and the subjects were allocated to either the case or control groups according to the specific criteria for each group, as described in section 3.5..

See figure 14 for the distribution of case and control subjects.

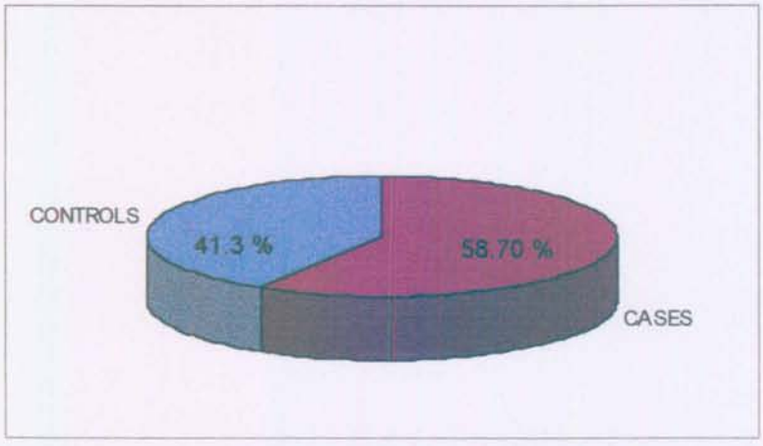

Figure 14: Distribution of cases and controls.

The higher number of cases can be attributed to the fact that mothers who thought their children had a deformity, were more eager to participate in the study.

4.2.2. GENDER

There was an uneven distribution of girls and boys in both the case and control groups. There were more girls than boys in the total study group. The case group, as well as the control group, had more girls than boys. (See table 1)

Table 1: Percentage of girls and boys.

Gender	Cases (N=61)	Controls (N=43)	Total (N=104)
Girls	73,77%	69,77%	72,1%
Boys	26,23%	30,23%	27,9%

This uneven distribution was probably due to the fact that all the volunteers who complied with the criteria for the study were used and this was a sample of convenience.

The distribution of boys and girls in the different planes in which the deformities were present, is reflected in table 2. It is interesting to note that deformities, especially in the coronal plane, occurred predominantly amongst female subjects.

Table 2: Distribution of boys and girls of the case group in the different planes of deformities.

Planes	Boys (N=16)	Girls (N=45)
Sagittal	4 (25,01%)	10 (22,22%)
Coronal	6 (37,51%)	25 (55,55%)
Combined sagittal and coronal	6 (37,51%)	10 (22,22%)

4.2.3. AGE

The ages of the adolescents in the case and control groups varied from 12 years to 17 years and 11 months. The mean age for the case group was 14,85 years, compared to the mean age for the control group, which was 13,84 years. See figure 15 for the line-diagram of the ages of the cases and controls.

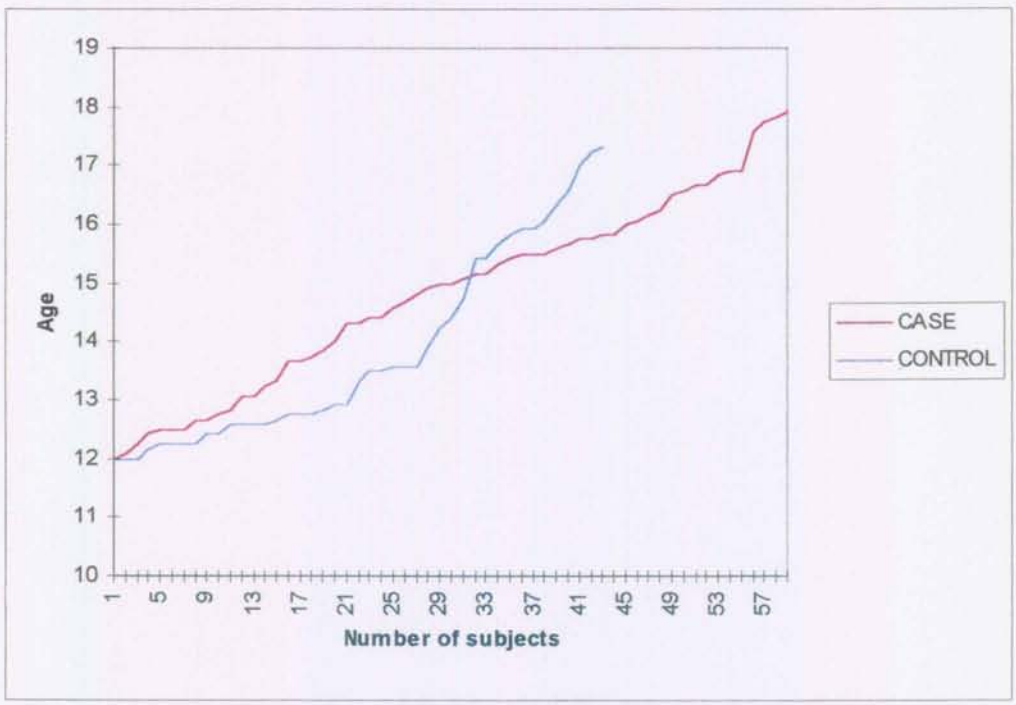

Figure 15: Comparison of the ages of the case and control subjects.

The line diagram showed a similar age distribution in the case and control groups.

4.2.4. MENARCHE

There was a larger percentage of adolescent girls who had reached their menarche in the total study group, than adolescent girls who had not reached their menarche.

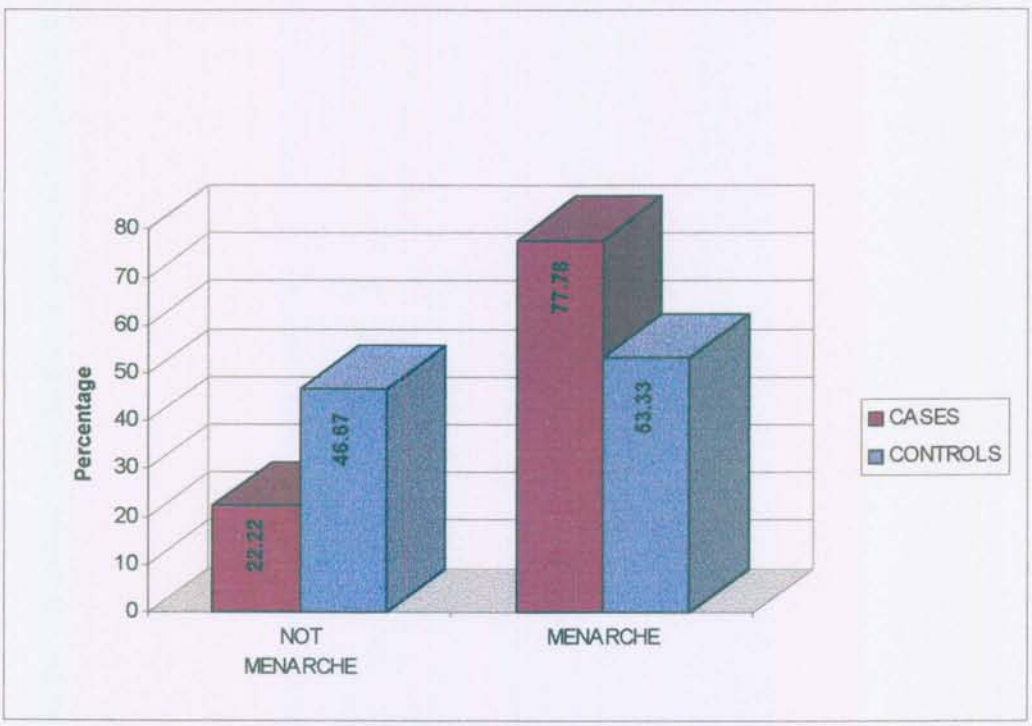

Figure 16: Percentage of cases and controls who had reached their menarche.

A significantly higher percentage of females in the case group than those in the control group had reached their menarche (p = 0,013). (See figure 16)

4.2.5. HEIGHT

The height of the total number of subjects varied from a minimum of 139,5 centimetres to a maximum of 191,0 centimetres, with a mean of 163,0 centimetres (standard deviation of 10). See figure 17.

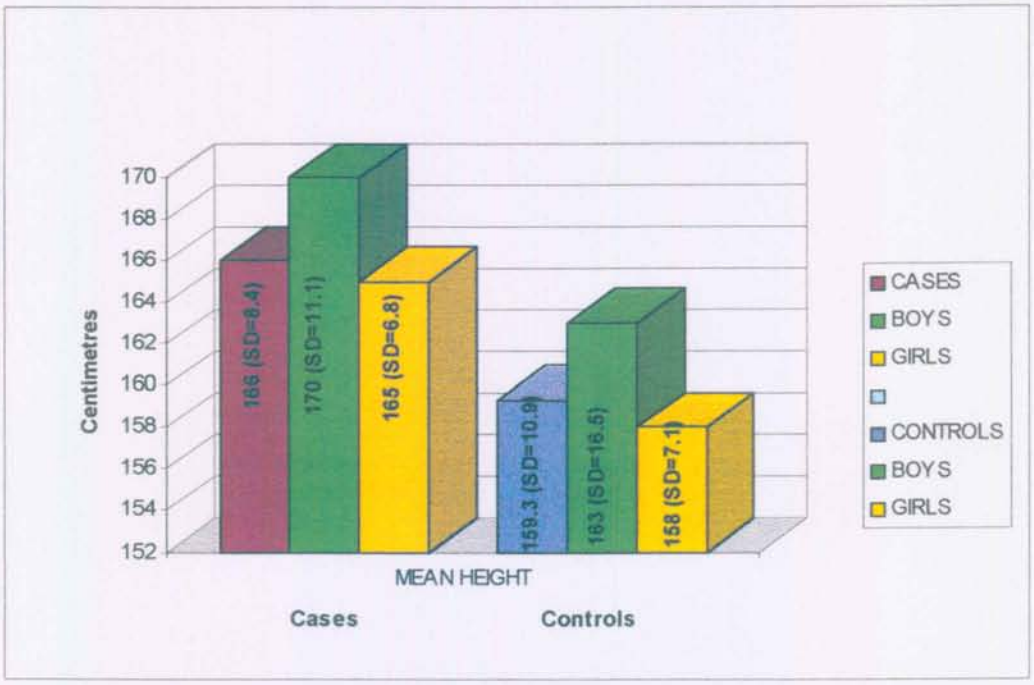

Figure 17: Mean height for cases and controls, indicating the mean height for boys and girls.

The height of the total number of subjects from the case group was highly significantly taller than those from the control group (p=0,0004). There was a trend for boys of the case group to be taller than boys from the control group (p=0,092), but girls from the case group were highly significantly taller than girls from the control group. (p< 0,0001)

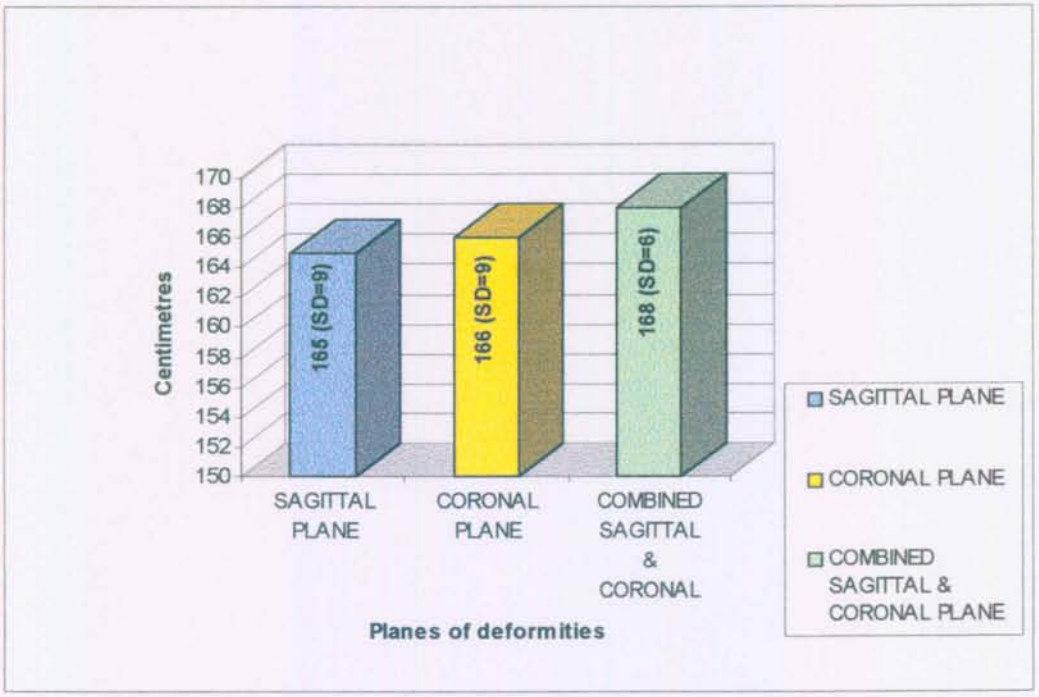

Figure 18: Mean height for the cases in each specific plane of deformity.

Subjects with combined sagittal and coronal plane deformities were significantly taller than those with sagittal plane deformities (p=0.02) and they also presented with a trend to be taller than those with coronal plane deformities (p=0,07). The comparison in height between the sagittal and the coronal plane deformities showed a non-significant difference (p=0,3). See figure 18.

4.2.6. LEG LENGTH DISCREPANCY

The mean leg length discrepancy for the control and case subjects did not differ much (appendix G figure 45). More left-sided than right-sided longer legs were found. (See appendix G figure 46)

4.2.7. STRAIGHT LEG RAISE

The range of motion of the hip joint was used in order to determine the degree of straight leg raise possible. There was no difference between the straight leg raise of the case and the control groups. There was also not much difference between the straight leg raise of the left and right side of all the subjects (appendix G figure 47). It was interesting to note that the mean average of hip flexion did not exceed 56 degrees. For the percentages of cases and controls who had either under or above 50 degrees of hip flexion, see figure 19.

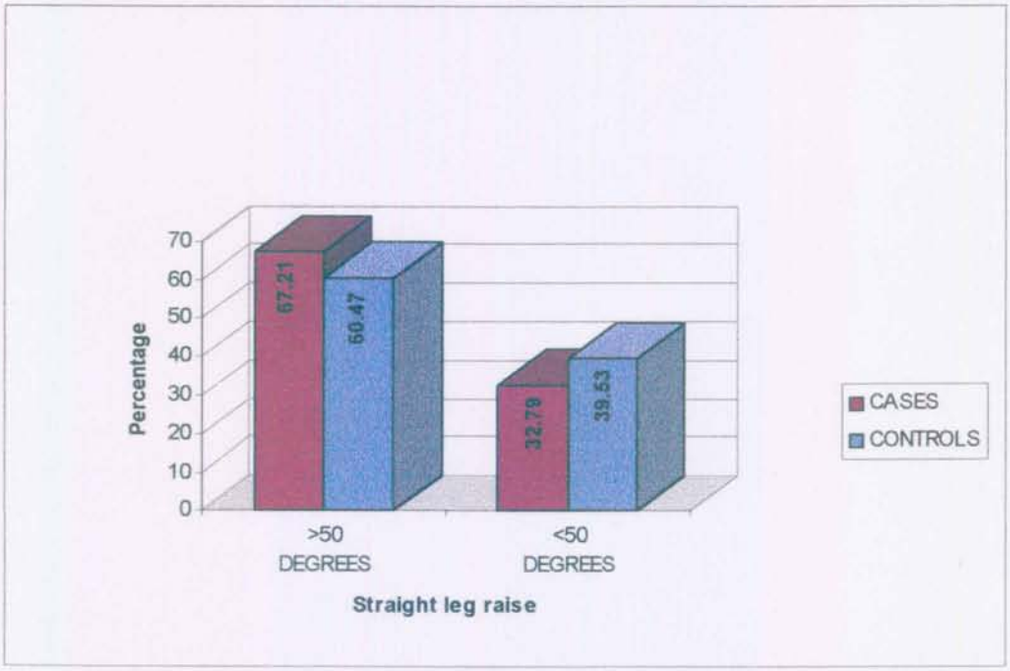

Figure 19: Percentage of cases and controls who presented with a straight leg raise of less than 50 degrees.

The control group presented with a higher percentage of subjects who had a straight leg raise of less than 50 degrees, but this was a non-significant value (p=0,24). The difference

of the straight leg raise test amongst the planes of deformities of the case group was also non-significant (appendix G table 8).

4.2.8. THOMAS TEST

It was interesting to note that the majority of subjects in this sample had a positive Thomas test. Hip flexor tightness was more or less equal in the case and control groups. A normal Thomas test was found in only six of the left hip flexors, and four of the right hip flexors of the total sample. No difference in the percentage of hip flexor tightness between the case and control groups was found (appendix G figure 48). More left-sided hip stiffness was seen in the case as well as the control group (appendix G figure 49).

4.2.9. HUMP SIZE

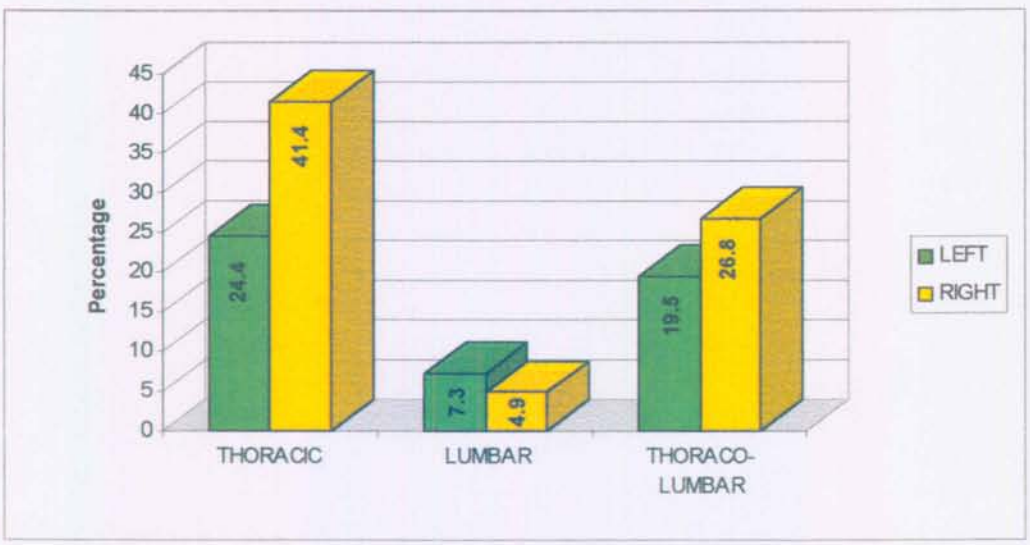

Figure 20: Percentage of the cases who presented with a hump size of more than six millimetres (N=41) in the different areas of the spine, indicating the side of the hump.

Thoracic humps of six millimetres or more were found significantly more than lumbar ($p<0,0001$), and thoraco-lumbar ($p=0,04$) humps. Thoraco-lumbar humps of six millimetres or more presented significantly more than lumbar humps ($p=0,0003$).

In the thoracic area more right- than left-sided humps of six millimetres or more were found. The difference between the percentages of left- and right-sided humps in the thoracic area was significantly higher on the right-hand side ($p=0,05$). No statistical difference was found between the left- and right-hand sides in the lumbar ($p=0,32$) and the thoraco-lumbar ($p=0,22$) areas with humps of six millimetres or more.(See figure 20)

Thoracic right- and left-sided humps of six millimetres or more were present significantly more frequently than lumbar humps of six millimetres or more (right side $p<0.0001$; left side $p=0,02$) Left-sided humps of six millimetres or more in the thoracic area were not significantly more frequent than humps seen in the thoraco-lumbar area ($p=0,3$) (See figure 20); but there was a trend for more right-sided thoracic humps of six millimetres and more than right sided thoraco-lumbar humps ($p=0,08$).

4.2.10. ANGLE OF TRUNK ROTATION

An angle of trunk rotation of more than five degrees was observed in 41 % of the subjects from the case group. A significant correlation between the angle of trunk rotation and the hump size in the thoracic, lumbar as well as the thoraco-lumbar areas, was found. The following table indicates the results, calculated by means of the Pearson correlation coefficient. (See table 3)

Table 3: Correlation between the humpsize measured and the angle of trunk rotation.

	Correlation coefficient : compared to angle of trunk rotation	Significant value of correlation with angle of trunk rotation
Thoracic hump	0,65	0,0001
Lumbar hump	0,42	0,0001
Thoraco-lumbar hump	0,71	0,0001

4.2.11. PLUMBLINE

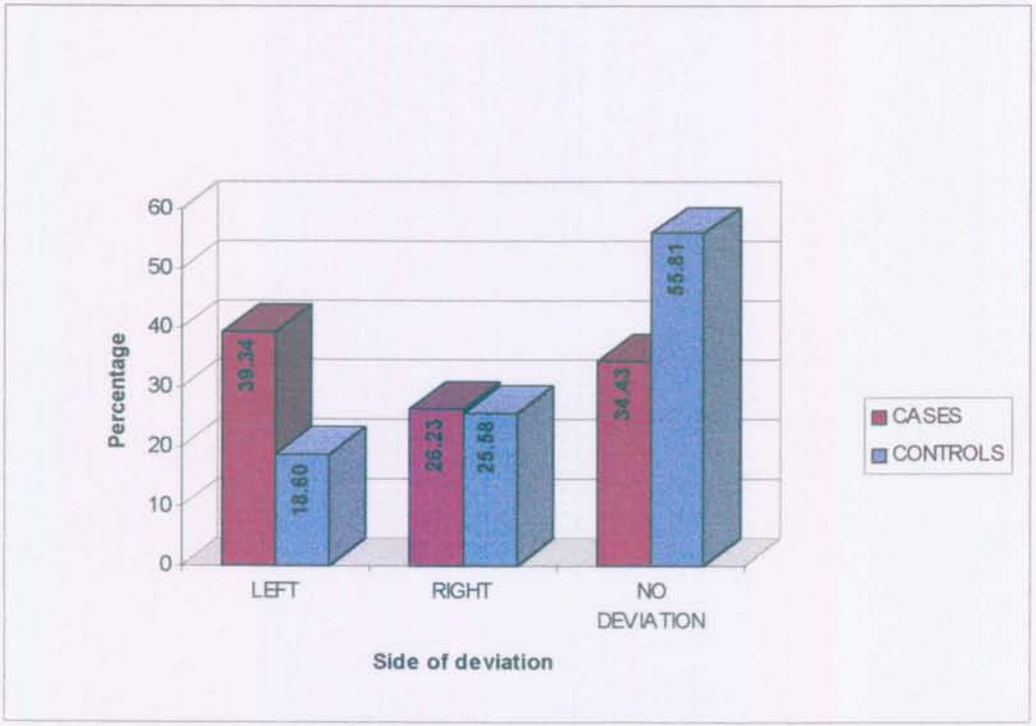

Figure 21: Percentage of cases and controls who presented with left and right sided deviations from the centre of the gluteal cleft.

In the case group the deviation of the plumbline from the gluteal cleft had a trend to occur more frequently to the left (p=0,06), while the plumbline in the control group had a tendency to be slightly more to the right (p= 0,4).(See figure 21)

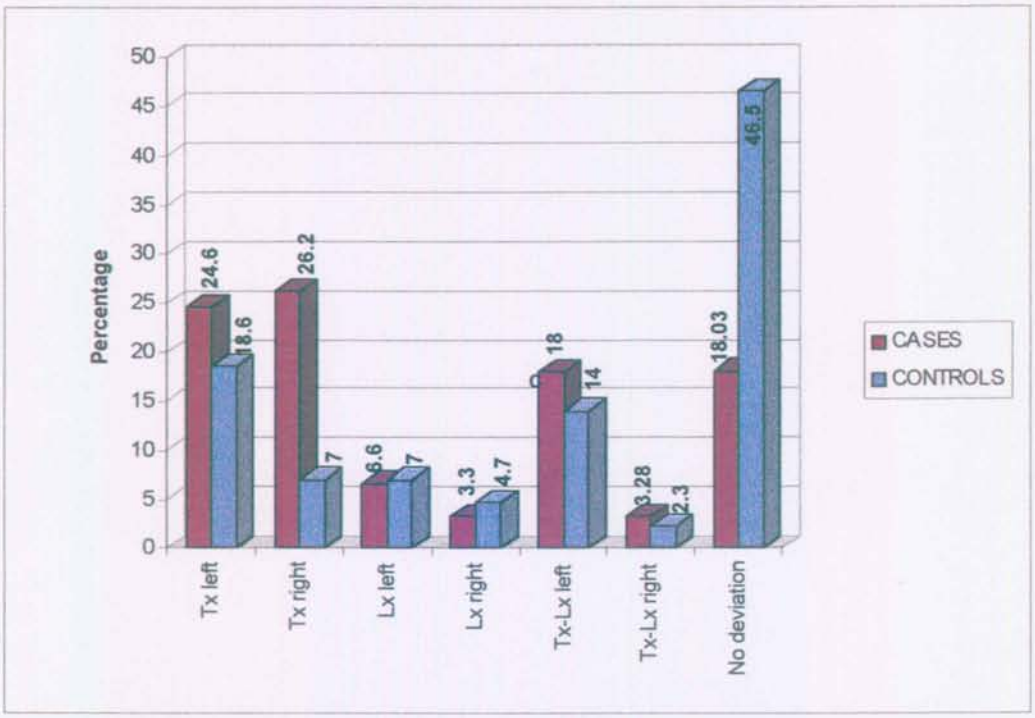

Figure 22: Percentage of cases and controls who presented with a deviation from the midline of the spine.

The spinal area most affected by deviation from the plumbline was the thoracic area.

The measurements of the distance of the plumbline from the gluteal cleft, as well as from the midline of the spine, were influenced by the slightest weight transfer and swaying of the upper body of the subject, and were therefore considered unreliable.

4.2.12. KYPHOSIS AND LORDOSIS

A hyperkyphosis (kyphosis of more than 45 degrees) was noted in 49,2 % of the case group. Four subjects from the case group (6,6 %) presented with a hypo-kyphosis (kyphosis of less than 20 degrees). The mean hypo-kyphosis was 16,65 degrees with a standard deviation of 4,3 , a minimum of 10,3 degrees and a maximum of 19,3 degrees. The mean thoracic kyphosis for the cases where a hyperkyphosis was present, was 53,1 degrees with a standard deviation of 6,15 , a minimum of 45,3 degrees and a maximum of 72 degrees. No subjects presented with a hyper-lordosis (exceeding 60 degrees), and only one subject presented with a hypo-lordosis (19 degrees).

4.2.13. FORWARD HEAD POSTURE

An abnormal forward head posture was observed in 45,9 % of the case subjects. Defective eyesight was reported in only 21,43 % of the subjects who presented with a forward head posture. Of the subjects who presented with a hyperkyphosis, 56,7 % also presented with a forward head posture. (See figure 23)

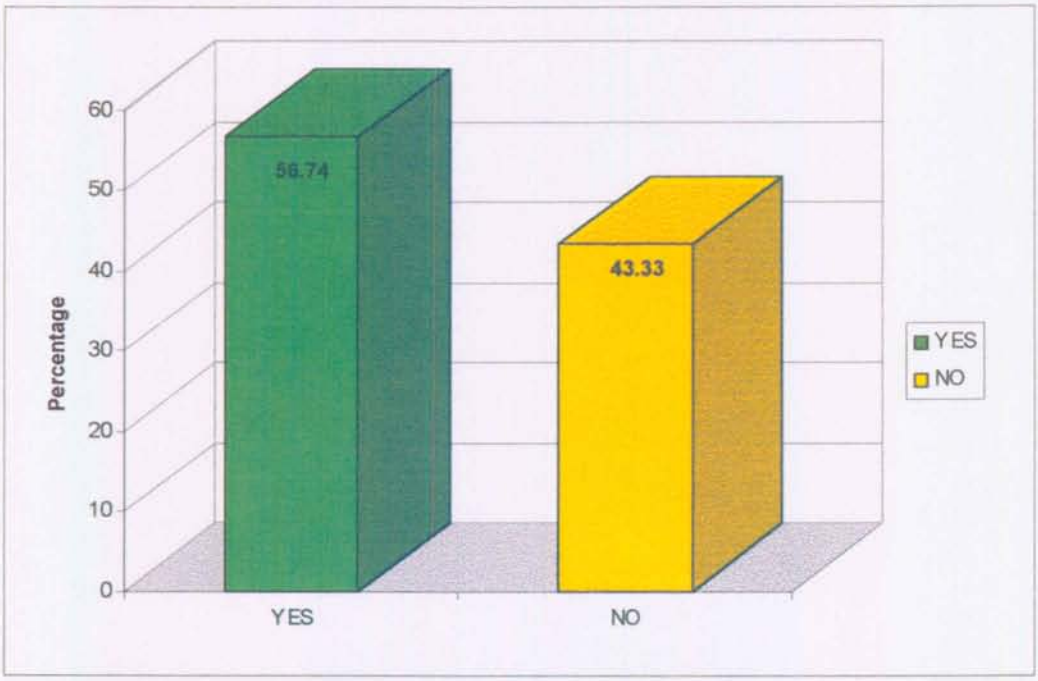

Figure 23: Percentage of cases who presented with a forward head posture as well as a hyperkyphosis.

There was a tendency for a forward head posture to be present in combination with a hyperkyphosis, but this was non-significant. (p=0,15)

4.2.14. WINGING OF SCAPULAE

Asymmetrical winging of the scapulae was seen in 55,74 % of the cases. It was interesting to note that 37,21 % of the control subjects also presented with an asymmetrical winging of the scapulae. The following graph (figure 24) indicates the side of the winging.

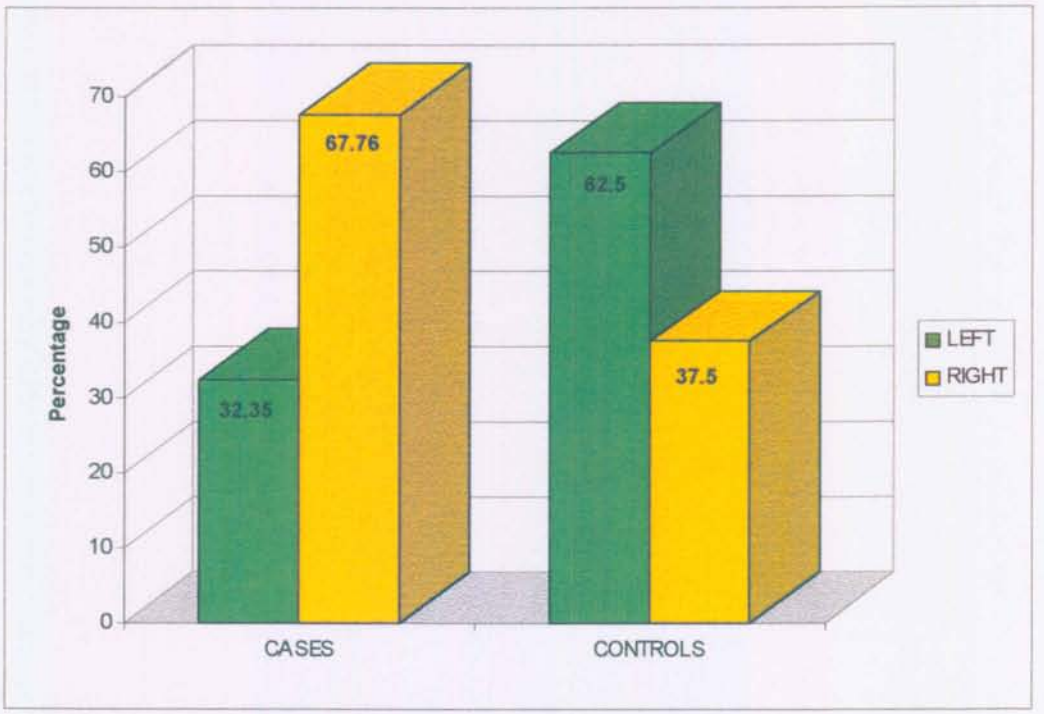

Figure 24: Comparison between the left and right sides regarding winging of the scapula.

Right-sided winging of the scapulae was seen significantly more frequently than left sided winging in the case group. (p=0,02) The opposite trend was present in the control group, where left sided winging was seen more often than right sided winging. (p=0,079)

4.2.15. ASYMMETRIC ELEVATED SHOULDER

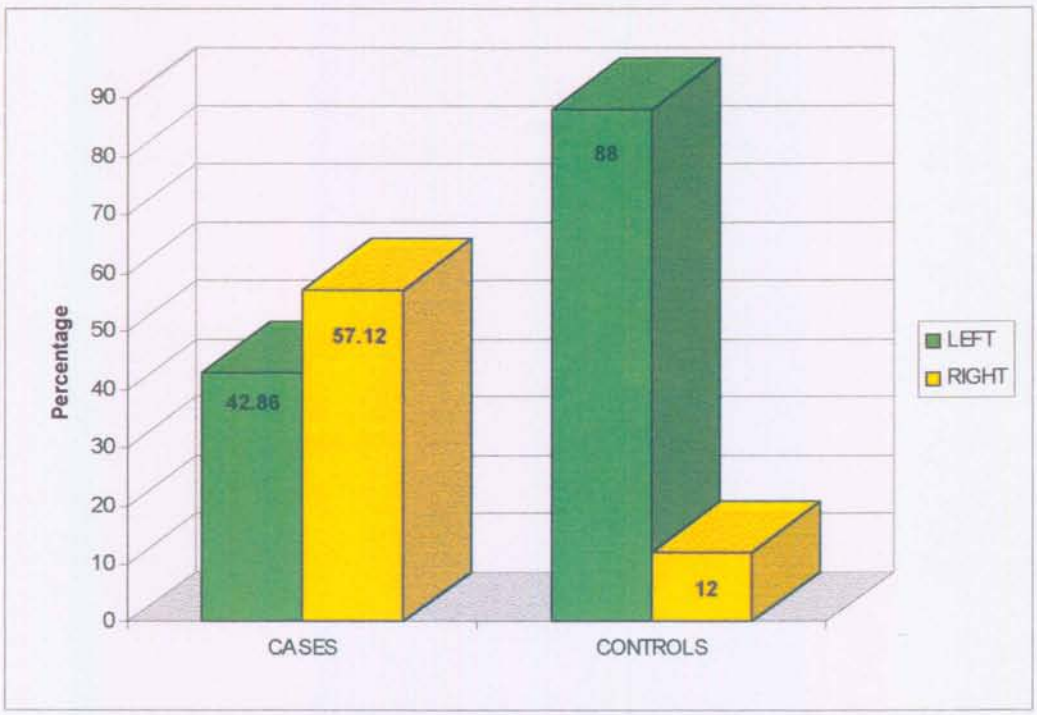

Figure 25: Comparison between the left- and right-sided elevated shoulders.

Those subjects in the case group who presented with an asymmetrical elevated shoulder, more frequently had right-sided than left-sided elevated shoulders (p=0,095). In the control group the opposite was observed (p<0001).

4.2.16. ARM DISTANCE FROM TRUNK

One arm hanging further from the trunk than the other was seen in 68,85 % of the case group, and in 51,16 % of the control group.

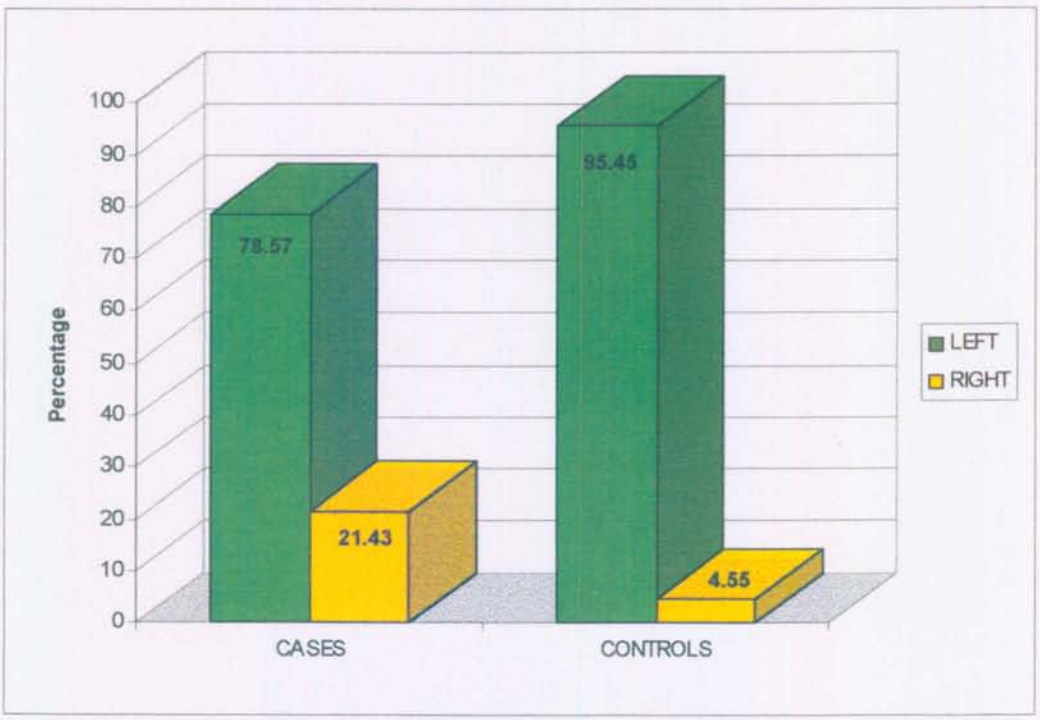

Figure 26: Comparison of the left and right arm hanging further from the trunk than the other.

A comparison between the left and the right arm hanging further from the body, of those subjects who presented with an asymmetrical hanging of the arms, showed the left arm was significantly further away from the body than the right arm in the case ($p<0,0001$) as well as in the control group ($p<0,0001$).

4.3. QUESTIONNAIRE

All the questionnaires were completed by the same researcher who also carried out the physical evaluations. The mothers of all volunteers were interviewed in order to obtain the relevant information.

4.3.1. DEVELOPMENTAL MILESTONES

4.3.1.1. SITTING

Most of the subjects sat at a normal developmental time, which is between six and nine months.

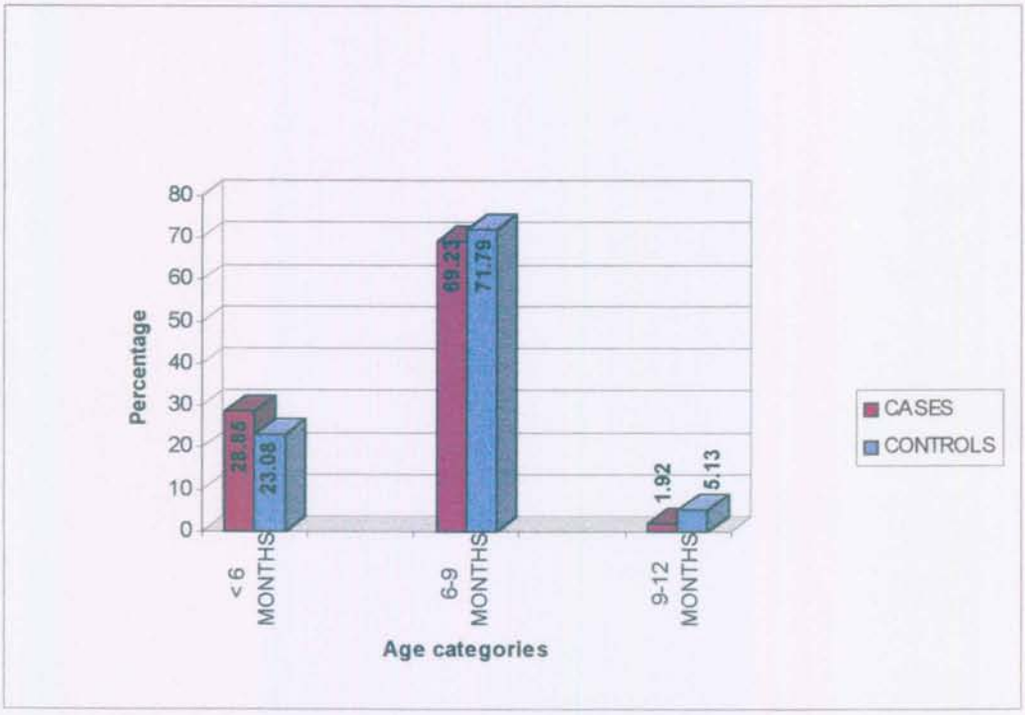

Figure 27: Comparison of the percentage of cases and controls who sat at a specific age.

Although the percentage of case group subjects who sat before six months was higher than the percentage in the control group, it was non-significant (p=0,27). In the age group of six to nine months, there were more subjects from the control group who sat, but this was also non-significant (p=0,4). The results from the Logit analysis showed that the age of sitting did not influence the likelihood of developing a spinal deformity (p=0,25).

4.3.1.2. CRAWLING

Only a small percentage of subjects from the case and control groups did not crawl. (Figure 28).

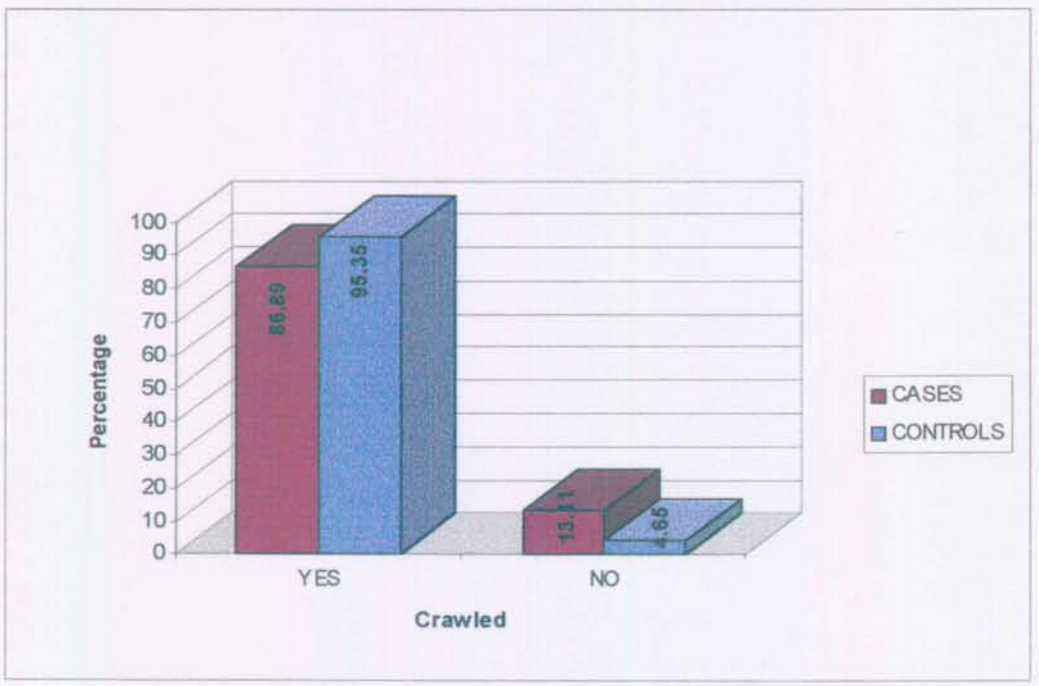

Figure 28: Comparison of percentage of cases and controls who crawled.

The control group presented with a trend for a higher percentage crawlers than the case group. (p=0,075)

The largest percentage (53,85 %) of subjects crawled at a developmental time of between six and nine months. Of those who crawled, the age at which the case and control subjects commenced crawling was compared. (See figure 29)

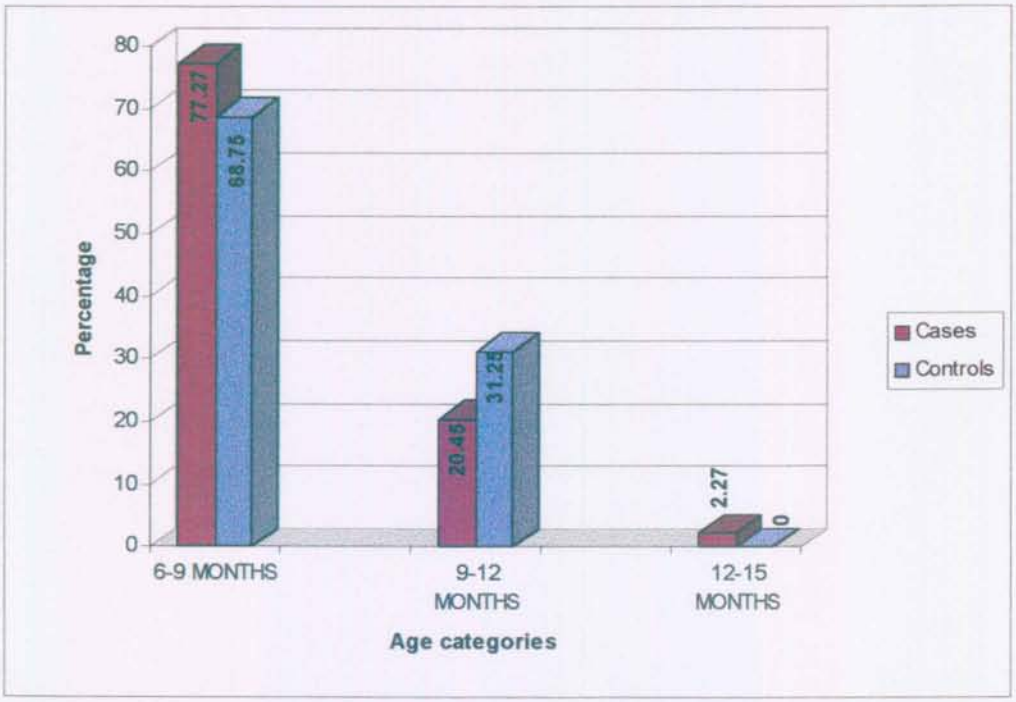

Figure 29: Comparison between percentage of case and control subjects who crawled indicate the age at which they crawled.

One subject in the case group crawled at a very late stage (12-15 months). In the category of six to nine months, there was a trend for more of case than control group subjects to have crawled; however it was not significantly higher (p=0,2). A higher tendency for crawling at the normal developmental period of nine to twelve months, was found in the control group (p=0,14). Most adolescents crawled for a period of two to three months as babies (figure 30).

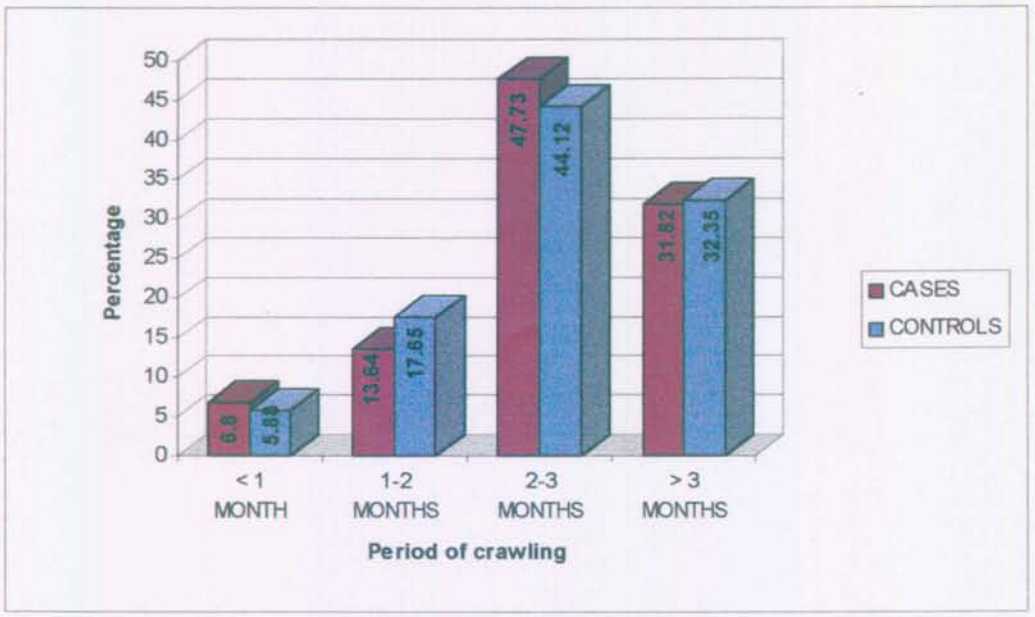

Figure 30: Comparison between case and control subjects who crawled indicating the period of crawling.

The one to two month period of crawling was reported slightly more in the control group, but this was non-significant (p=0,3). No significant difference between the two groups was found in the two-to-three month time period of crawling (p=0,38).

The percentage of case as well as control subjects, who moved forward in an alternative way to crawling, was lower than that of subjects who did not make use of another way of locomotion before walking (figure 31).

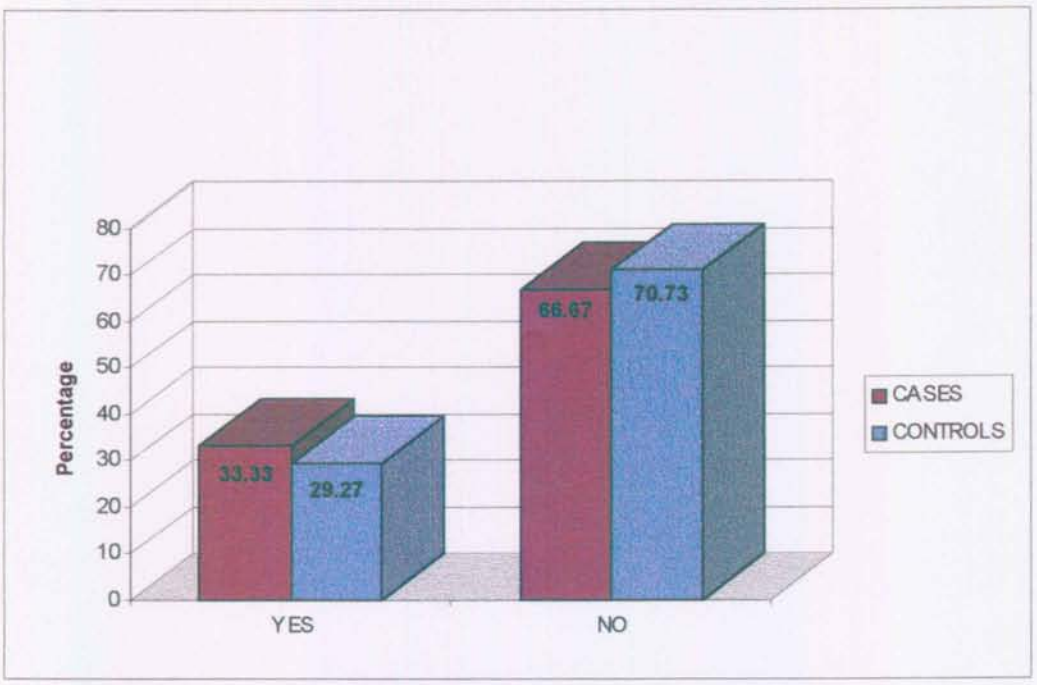

Figure 31: Percentage of case and control subjects who moved forward in an alternative method to crawling.

There was a tendency for more subjects from the case group (33,3 %) than the control group (29,27 %), to move forward in an alternative way to crawling, but this was non-significant. (p=0,33) Of those who did move forward in an alternative method to crawling, the following comparisons were made:

Table 4: Percentage case and control subjects who made use of alternative methods of locomotion.

Methods	Creeping	Shuffling	Hands and feet
Cases	50% (n=10)	45% (n=9)	15% (n=3)
Controls	50% (n=6)	42% (n=5)	8,3% (n=1)

4.3.1.3. WALKING

Most of the adolescents reportedly walked at an age between nine to twelve months. (Figure 32)

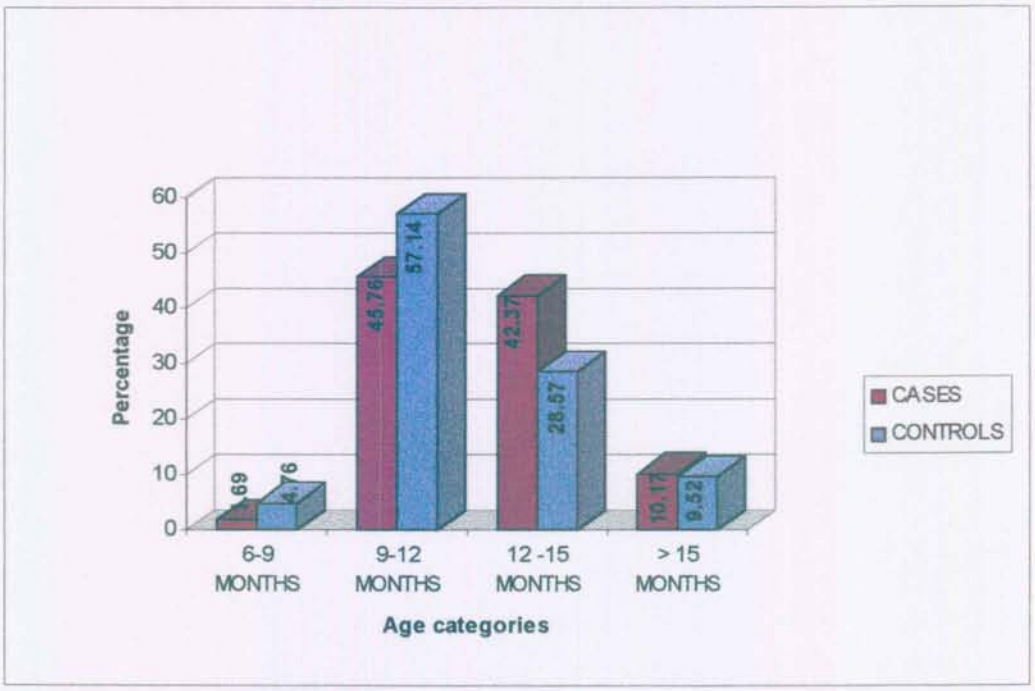

Figure 32: Comparison between case and control group subjects regarding the age at which they walked.

It was interesting to note that there was a higher tendency for the control group to walk at an age between 9 to 12 months (p=0,13), while subjects from the case group began walking later, between 12 to 15 months (p=0,078).

The Logit analysis showed that there was a trend for subjects who did not crawl and were late walkers (walking later than the age of 12 months) to have a greater likelihood of developing spinal deformities during adolescence. (Table 5).

Table 5: Maximum likelihood of crawling and walking influencing the development of spinal deformities

Age of crawling	**Age of walking**	**Likelihood to develop spinal deformity**
After 9 months	Before 12 months	0,26
After 9 months	After 12 months	0,49
Before 9 months	Before 12 months	0,51
Before 9 months	After 12 months	0,74
Did not crawl	Before 12 months	0,76
Did not crawl	After 12 months	0,90

4.3.2. DEVELOPMENTAL AIDS

4.3.2.1. SIT CHAIR

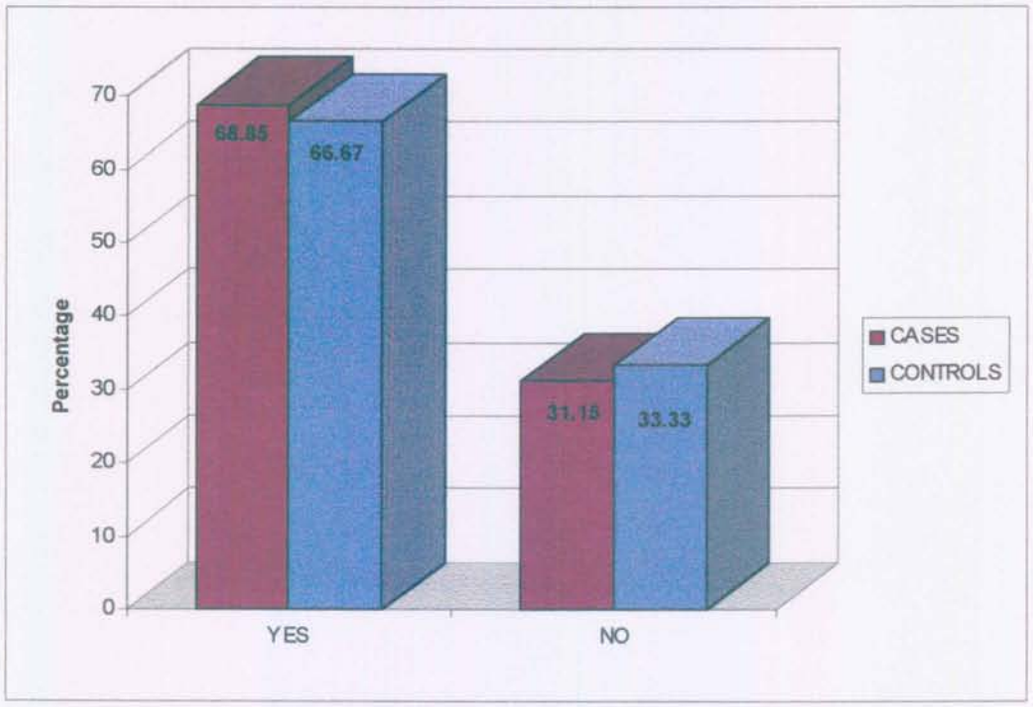

Figure 33: Comparison between case and control subjects who were placed in a sit chair as babies.

The comparison between the case (68,9 %) and control (66,7 %) group subjects who were placed in a sit chair as babies showed a non-significant higher percentage in the case group. (p=0,41). (See figure 33)

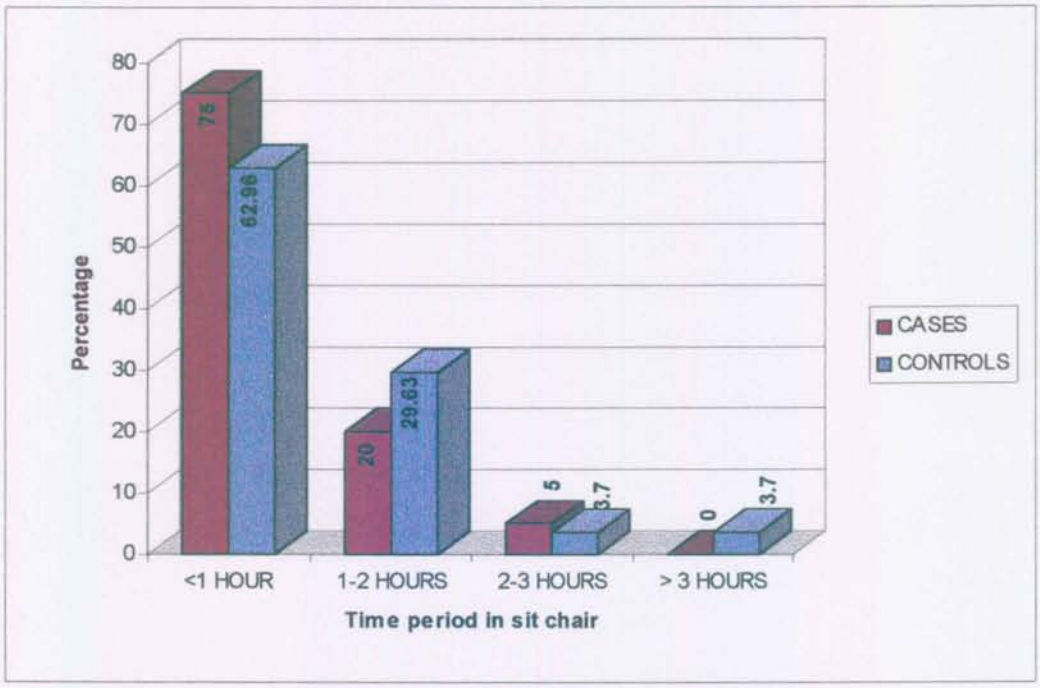

Figure 34: Percentage of case and control subjects placed in a sit chair, indicating periods spent in the chair.

There was a higher trend of having used the sit chair in the case group for the period of under one hour (p=0,15), while the control group showed a higher trend of use in the one to two hour period (p=0,18). The differences between the case and control group subjects with regard to the time which they spent in sit chairs were non-significant (figure 34).

4.3.2.2. WALKING RING

There was a higher percentage of case (70,5 %) and control (60,5 %) subjects who were placed in a walking ring, than those who were not placed in a walking ring. (Figure 35)

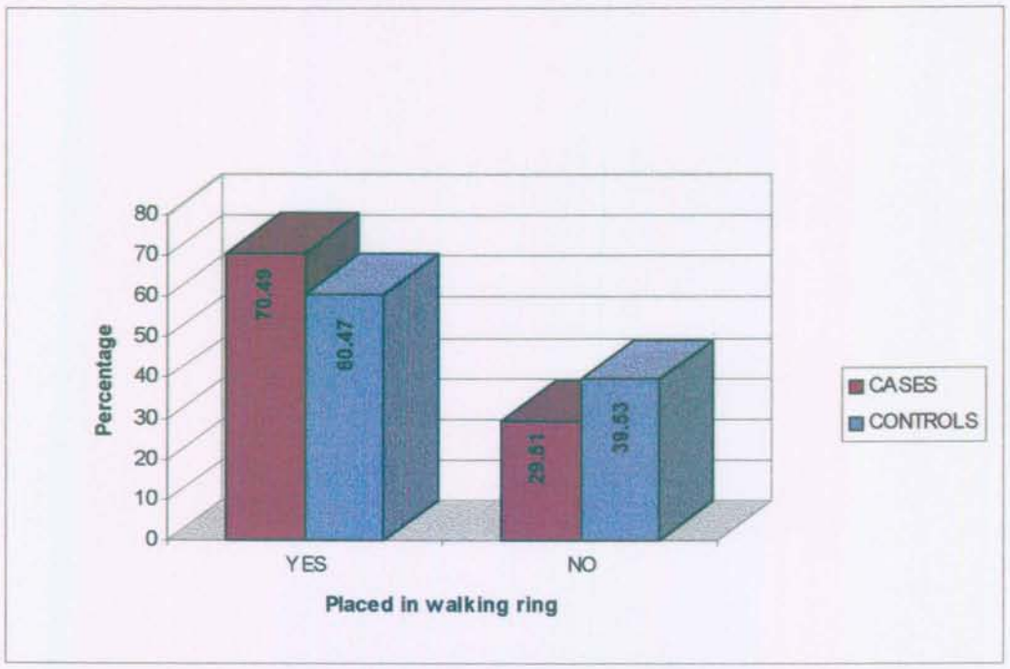

Figure 35: Comparison between percentage of case and control subjects who were placed in walking rings as babies.

Although it was statistically non-significant, there was a higher trend for the case group subjects to have used a walking ring than for the control group (p=0,14).

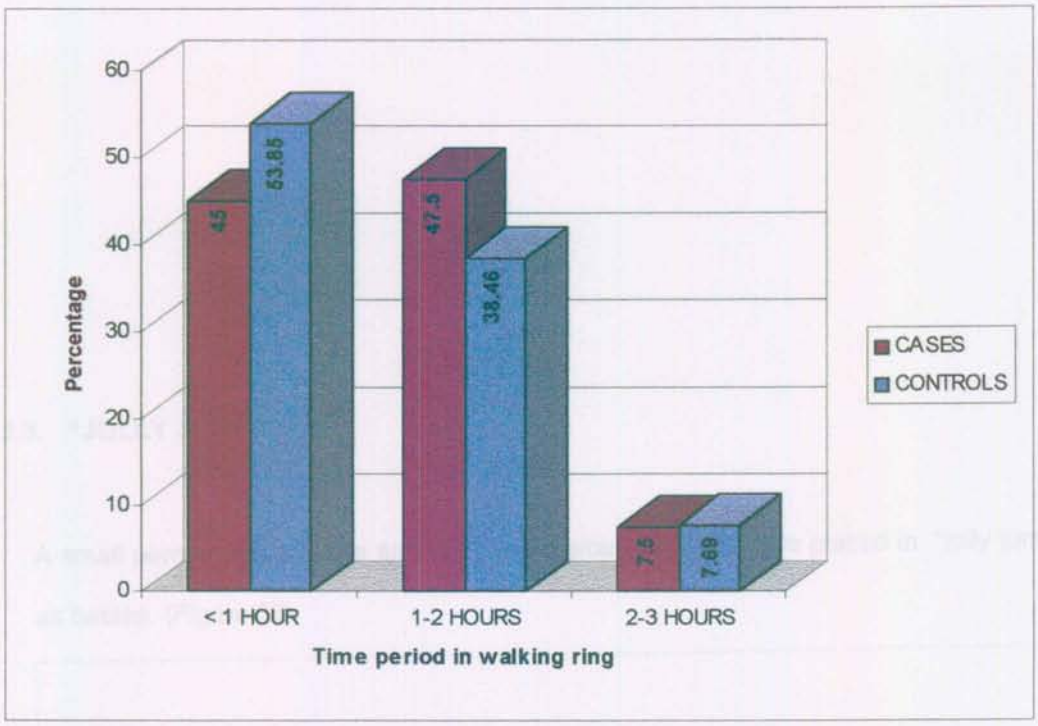

Figure 36: Comparison between percentage of case and control subjects who were placed in walking rings indicating period of time.

The period of less than one hour, that the babies were placed in walking rings, was used more in the control group than in the case group (p=0,24), while the time period of one-to-two hours was used more in the case group than in the control group (p=0,23). (See figure 36)

4.3.2.3. "JOLLY JUMPER"

A small percentage of case and the control group subjects were placed in "jolly jumpers" as babies. (Figure 37)

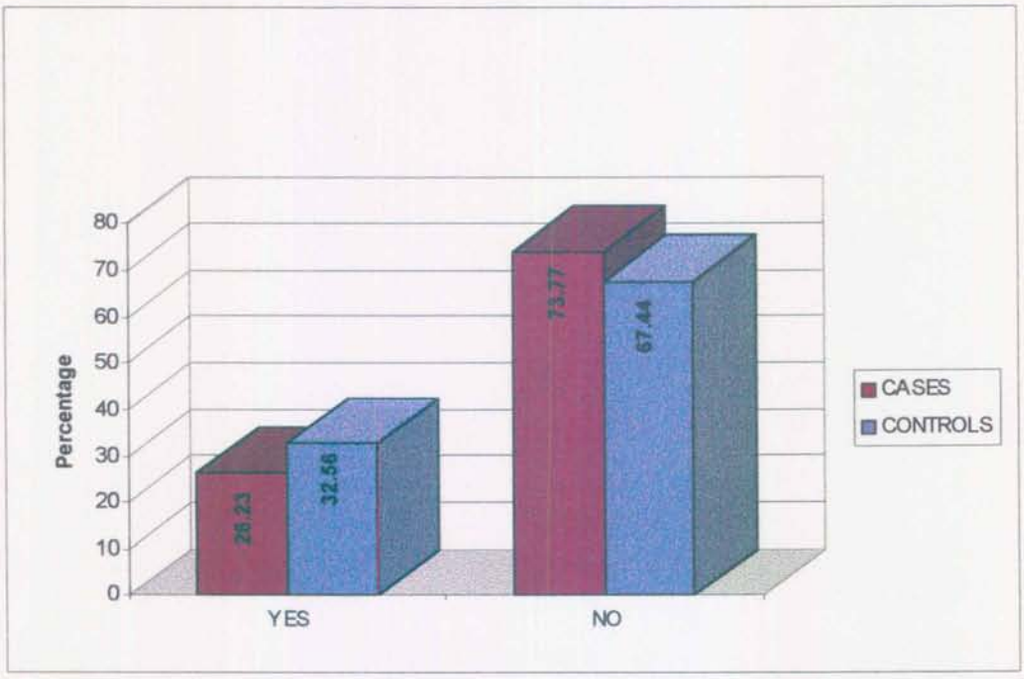

Figure 37: Percentage of case and control group subjects who were placed in "jolly jumpers" as babies.

A higher percentage of the control group (32,6 %) than of the case (26,2 %) group was placed in "jolly jumpers" as babies, but this was non-significant (p=0,24).

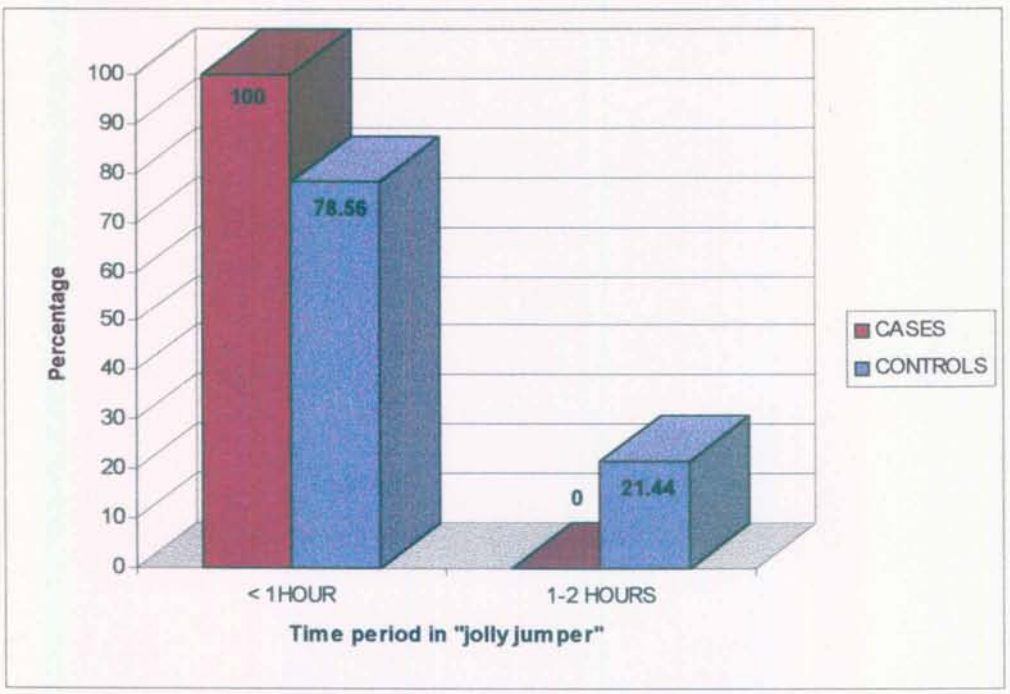

Figure 38: Comparison between case and control subjects indicating the time period spent in the "jolly jumper".

All the subjects from the case group and most of the subjects from the control group (78,56 %) who were placed in "jolly jumpers" as babies used it for under one hour. The percentage of case group subjects placed in the "jolly jumper" for less than an hour, was significantly higher . (p=0,038) See figure 38.

4.3.3.OTHER FACTORS

4.3.3.1. FAMILY HISTORY OF DEFORMITIES

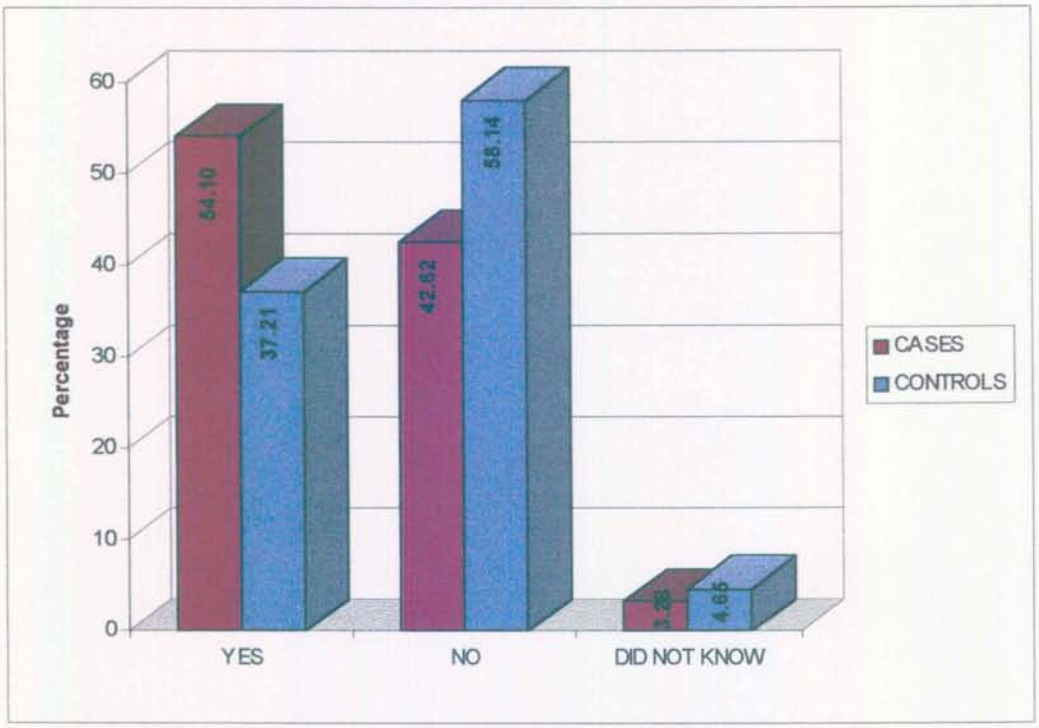

Figure 39: Percentage of the cases and controls who presented with a family history.

A significantly higher percentage of the case group than of the control group presented with a family history of deformities.(p=0,045) See figure 39.

Table 6: Comparison between the case and control groups of those subjects who presented with a direct family history of deformities.

Relationship	Percentage of cases	Percentage of controls
Mother	21,22	37,49
Father	24,23	18,76
Brother	3,03	6,26
Sister	9,08	18,76

Only the fathers of the case group showed a larger percentage in terms of a family history than the control group. It was interesting to note that there was a higher percentage of mothers in the control group with a family history of deformities than in the case group (table 7). Mothers presented with mainly scolioses in both the case and control groups (appendix G table 10), and fathers presented with mainly kyphosis in both the case and the control groups.

Table 7: Comparison between cases and controls of those subjects who presented with a family history of deformities on the maternal side.

Relationship	Percentage :cases	Relationship	Percentage :controls
Grandmother(n=12)	36,36	Grandmother(n=4)	25,0
Grandfather(n=4)	12,12	Grandfather(n=2)	12,5
Uncle(n=2)	6,06	Uncle(n=0)	0
Aunt(n=4)	12,12	Aunt(n=1)	6,25

A higher percentage of family history of deformities in grandmothers on the maternal side was reported in the case group. The deformities most frequently reported in the grandmothers were scolioses (33,3 %) and kyphoses (33,3 %) in the case group, and kyphoses (50 %) in the control group (appendix G table 10).

On the paternal side, no family history of deformities was reported in the control group. Twenty one percent of the case group with a family history of deformities reported that the paternal side was affected. More grandfathers (12,13 %) presented with a deformity and the presence of kyphosis was commonly mentioned (appendix G table 11).

4.3.3.2. GESTATION

Two mothers from the case group could not recall the gestation period of their children. Most of the subjects were born after a normal gestation period of 40 weeks.

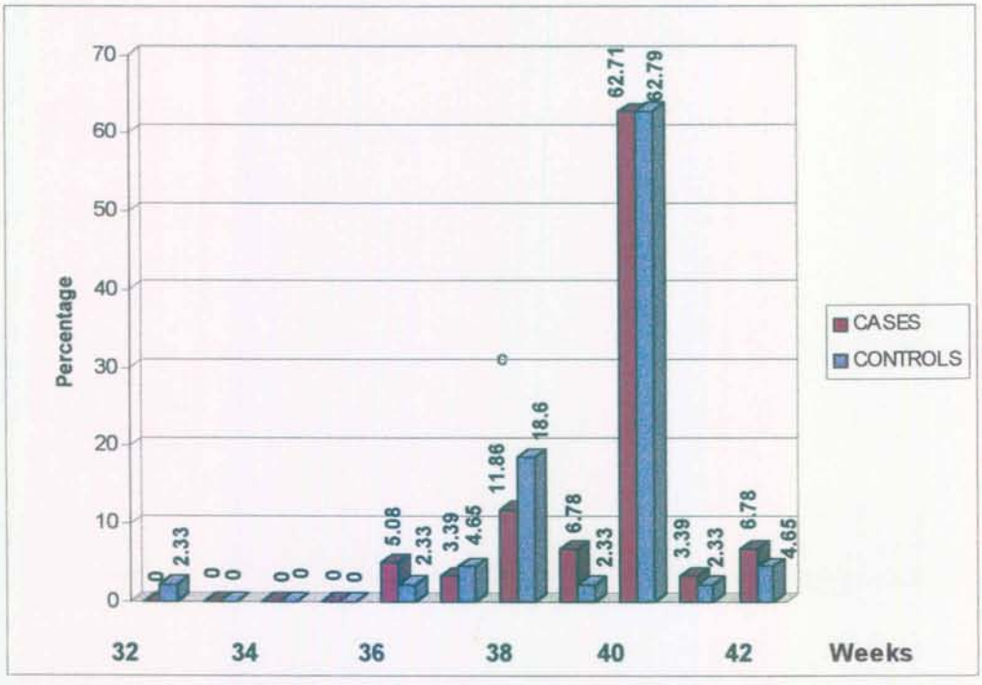

Figure 40: Percentage of cases and controls according to gestation periods.

An almost equal number of subjects from the case and control groups were carried full term (see figure 40). The thirty-eight-week-period of gestation was reported more frequently in the control group than in the case group, but this was non-significant (p=0,17). A higher percentage of control group subjects were carried up to the 38 week

gestation period, but this was due to the fact that a higher percentage of Caesarean deliveries were done in the control group. (Refer to 4.3.3.3.)

4.3.3.3. BIRTH METHOD

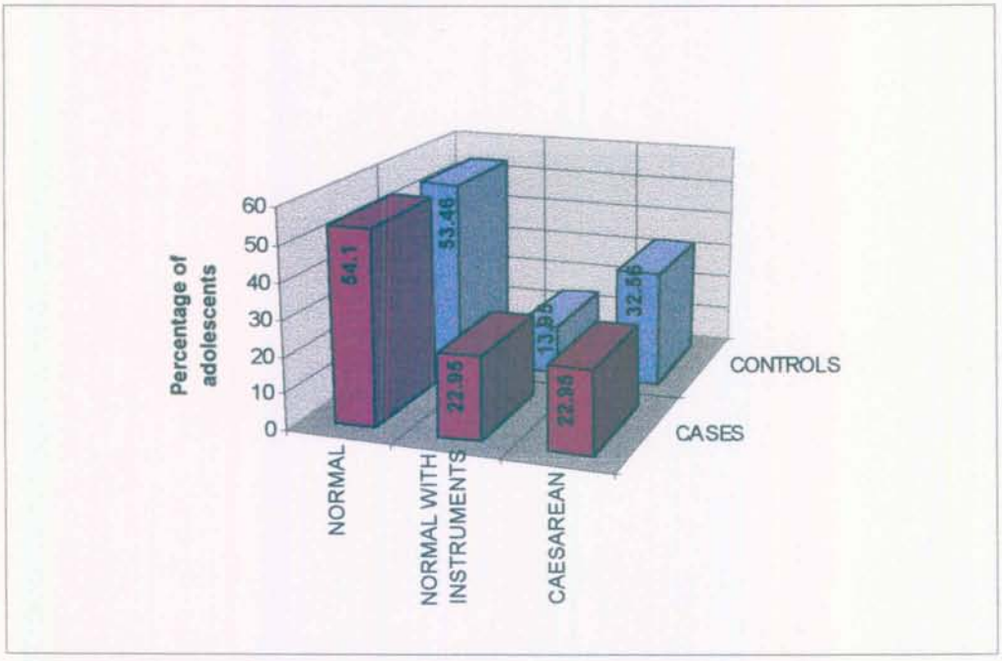

Figure 41: Method of birth indicating the percentage of cases and controls.

Normal births were reported more or less equally in the case and control groups (p=0,95). A higher percentage of cases than controls were born normally, but instruments were used during the birth process (p=0,13). Caesarean births were reported more frequently amongst the controls than the cases (p=0,14). No correlation was found between the method of birth and the development of deformities.

4.3.3.4. LYING POSITION

Most subjects preferred to lie on their sides as babies.

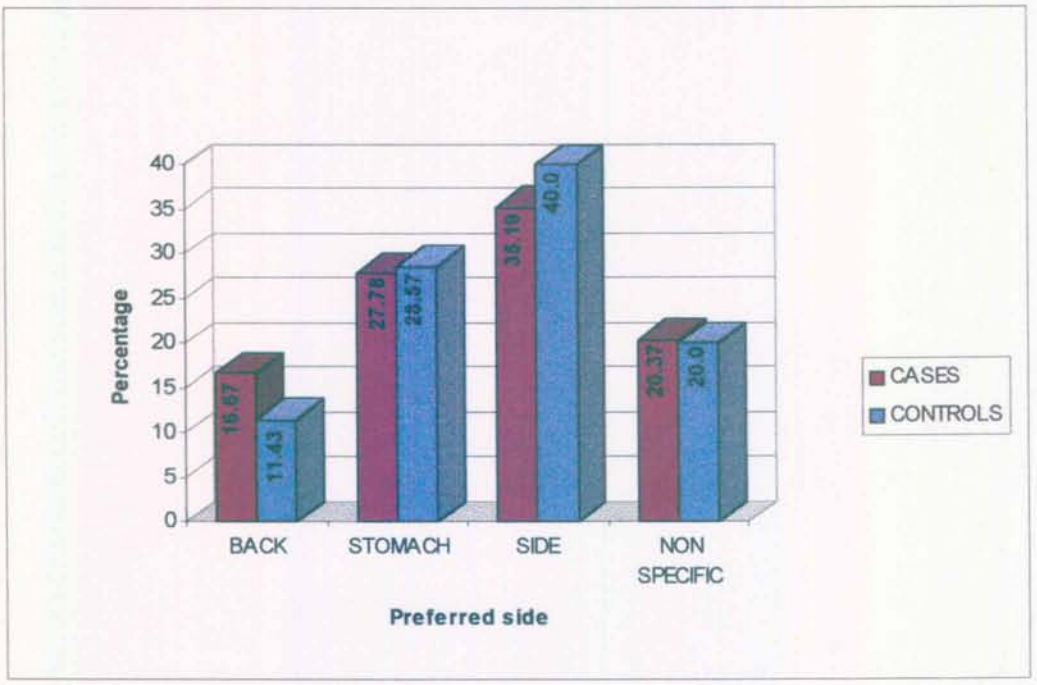

Figure 42: Comparison of percentage of cases and controls who preferred a specific lying position.

A slightly higher percentage of case group subjects preferred back lying as babies (p=0,25). The other positions showed no relevant difference in the distribution between the percentages of the case and the control groups (figure 42).

4.3.3.5. DEFECTIVE HEARING

A small percentage of the case group (9,84 %) as well the control group (11,63 %) presented with a hearing problem (appendix G figure 50). One subject from the case group who presented with defective hearing had a sagittal plane deformity, two subjects

with defective hearing had a coronal plane deformity, while defective hearing was present in three of the subjects who presented with a combined sagittal and coronal plane deformity. In the case group right sided defective hearing occurred more frequently, while left-sided defective hearing occurred more in the control group. (See appendix G table 12) Defective hearing was noticed mostly after ten years of age.(See appendix G table 13)

4.3.3.6. DEFECTIVE VISION

Defective vision was reported in 19,67 % of the case group, compared to 18,60 % of the control group (appendix G figure 51). Defective vision was mostly present in both eyes in the case as well as the control group, and mainly noticed at an age of more than ten years in both groups (appendix G table 14 and 15). The subjects from the case as well as the control group were mainly far-sighted (appendix G table 16). A forward head posture was seen in 30 percent of the subjects who presented with a visual problem. An equal distribution of subjects with sagittal, coronal and combined sagittal and coronal plane deformities who presented with defective eyesight, occurred.

4.3.3.7. KNOWLEDGE OF DEFORMITY

Approximately one third (32,79 %) of the mothers from the case group were aware that their children had a deformity. One of the mothers of the control group thought that her child had a deformity, but the subject did not comply with the inclusion criteria for the case group. Eighty percent of the mothers who knew that their children had a deformity, noticed the deformity at an age between ten to fifteen years, while the other 20 % noticed the deformity after the age of fifteen years.

4.3.3.8. GROWTH SPURT

A significantly higher percentage of cases than controls presented with a sudden growth spurt (p=0,009). (See figure 43)

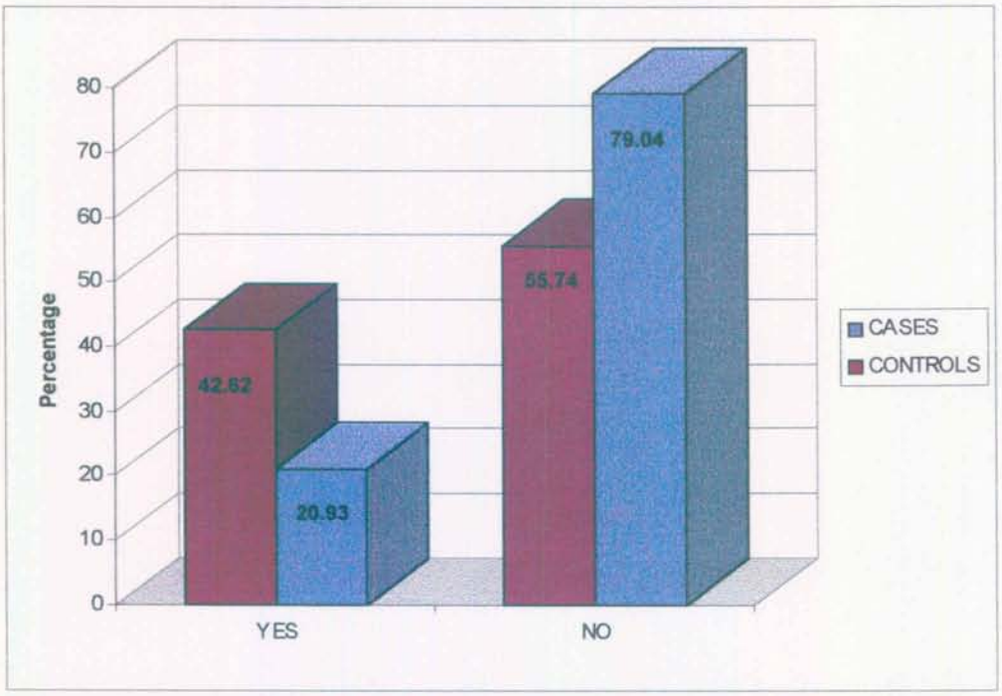

Figure 43: Percentage of case and control subjects who presented with a sudden growth spurt.

Most of the subjects presented with a sudden growth spurt between the ages of 10 and 15 years. (See figure 44)

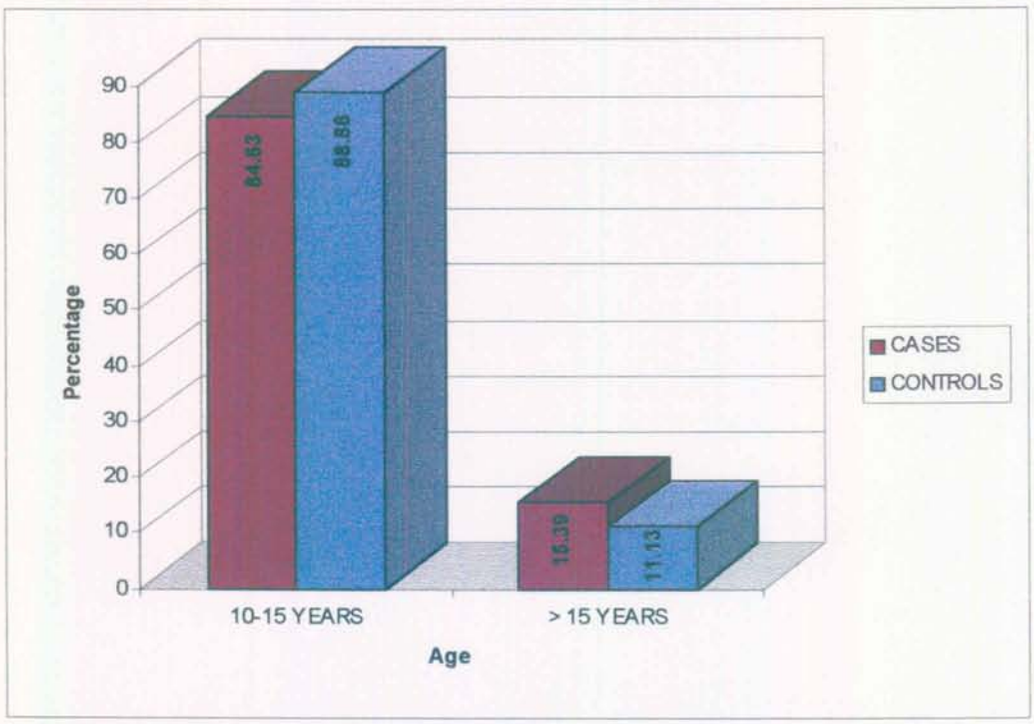

Figure 44: Comparison between cases and controls indicating the age of a sudden growth spurt.

The case as well as the control group showed a higher percentage of sudden growth spurt in the age group of ten to fifteen years. The differences between the case and control group in the age category of 10 to 15 years as well as more than fifteen years were non-significant (p=0,38). (See figure 44)

4.4. SUMMARY

The data (obtained from the 104 subjects) given in this chapter, presented significant results in the evaluation of the menarche and height. Humps of more than six millimetres were found significantly more frequently in the right thoracic area, resulting in more right-sided winging of the scapulae as well as right-sided elevated shoulders. A significant report of a family history of deformities was noted. Crawling, as well as walking, were noted as possible influential factors with regard to the development of spinal deformities in the adolescent years. The results will be discussed in the following chapter.

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