A study to determine if the prevalence of spinal joint dysfunctions are influenced by whether or not infants suffer from infantile colic.

By

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A dissertation proposal presented to the faculty of Health Services, Durban Institute of Technology, in partial fulfilment of the requirements for the Master's Degree in Technology: Chiropractic.

I, Caroline van Lingen, do hereby declare that this dissertation is representative of my own work.

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Acknowledgements

To all those who assisted with this study - without your help it would not have been possible. I greatly appreciate all the input, commitment, time and effort devoted to this study.

To Mrs Harold and the Inner West Clinics – Thank you for accommodating our study in your clinics. We are extremely grateful for your help, as you always made us feel welcome and assisted us in every way possible. The professionalism and kindness extended to us will not be forgotten.

Professor Govender – For opening the necessary doors and getting the ball rolling.

Dr Shaik – In deep gratitude for your support, dedication, guidance and enthusiasm throughout the project.

Mrs Ireland – Your contribution was unbelievable. Through you – all things became possible. Thank You.

To my family and friends – Thank you for your patience and understanding in this odyssey.

Abstract

The purpose of the study was to determine if the prevalence of spinal joint dysfunctions was influenced by whether or not infants suffered from infantile colic. Therefore, the objectives of the study were to determine if there was an association between infantile colic and the location of spinal joint dysfunctions in the spines of colicky infants and the occurrence of spinal joint dysfunctions in these infants, as compared to healthy infants.

Spinal manipulation of spinal joint dysfunctions in infants suffering from infantile colic (Mercer 1999: 37, Wiberg et al. 1999, Klougart et al. 1989) has resulted in a reduction of crying time and hence an improvement in the colic. But one study (Olafsdottir et al. 2001) determined that spinal manipulation is no more effective than placebo in the management of infantile colic. Therefore, research is yet to determine if there is a consistent association between spinal joint dysfunctions and infantile colic.

One hundred healthy infants, between the ages of 2 to 10 weeks, were recruited to a blinded quantitative association study by means of convenience and snowball sampling. The sampling continued until two groups of 50 infants, with and without colic were obtained. Two blinded examiners assessed the spines of the infants in each group. The use of the second examiner was to verify and validate the spinal examination findings of the first examiner to make the study more reliable.

The study entailed the assessment of the spines of infants and no treatment was administered to infants during the course of the study. The participating infants, who met the inclusion criteria, were assessed for signs of infantile colic. The inclusion criteria adhered to in the study were as follows: the infant had to be between 2 weeks and 10 weeks of age, have normal weight gain, be alert and healthy with no history of previous or existing illness to exclude any underlying organic problem (Wiberg et al. 1999).

The following criteria used by Wiberg et al. (1999) were employed in the study for the diagnosis of infantile colic: the infant could not show symptoms that could be a sign of any disease other than infantile colic, the infant had to have 1 or more violent spell of crying per day, the crying spells were to be at least 3 hours long per day and had to have been present on at least 5 of the 7 previous days. Apart from the attacks of infantile colic, the infant had to show normal behaviour and the typical colic behaviour during the crying spells (Wiberg et al. 1999). During the attacks the infants could not (or only temporarily) be comforted (Wiberg et al. 1999).

The methodological approach of the study was structured around the ethical considerations of the participants. Parents were required to answer questions that were aimed at contributing to the demographic data for the study.

The statistical analysis included the use of the chi squared test to determine whether there is a relationship between the infants with spinal joint dysfunctions and the infants with colic. The Cramér's V was used to measure the inter-examiner reliability. The binomial tests (using two proportions) were used to compare the occurrence of spinal joint dysfunctions between locations within a group between groups for intra and inter-group analysis, respectively.

The results concluded that a higher proportion of occurrence of spinal joint dysfunctions were associated with infantile colic. The occurrence of spinal joint dysfunctions in the control group had a very similar trend in the occurrence of the spinal joint dysfunctions as the experimental group. The difference between the groups was that the experimental (colicky) group had a far higher occurrence of spinal joint dysfunctions in following areas of the spine: C0-C2, T5-T9, L1-L3 and the sacro-iliac joints.

In conclusion, the common areas of spinal joint dysfunction, in the experimental and control group were both in keeping with the findings of Mercer (1999: 40), Wiberg (1999) and Klougart et al. (1989), with the exception of the upper lumbar spine and the sacro-iliac joints. The areas of the highest occurrence of spinal joint dysfunction were however, not always associated with infantile colic.

Definition of Terms:

SPINAL JOINT DYSFUNCTION
A spinal joint dysfunction according to Gatterman (1990: 408) is the lack of movement of a joint, caused by muscular spasm or an intra-articular blocking.

STATIC PALPATION
Static palpation is defined by Bergmann (1993: 762) as, “the palpatory diagnosis of somatic structures in a neutral static position”.

MOTION PALPATION
Motion palpation is defined by Bergmann (1993: 762) as, “the palpatory diagnosis of passive and active segmental joint range of motion”.

SOMATOVISCERAL REFLEX
The somatovisceral response occurs when nerve impulses that originate in the sensory receptors of a somatic tissue (eg. spine) stimulate the adjacent visceral (eg. organs) tissue neurons in the spinal cord (Anrig and Plaugher 1998:516).

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CHAPTER ONE

1.0 INTRODUCTION

1.1 THE PROBLEM AND IT'S SETTING

Wessel et al. (1954) described the most accepted definition of infantile colic as, "Unexplainable and uncontrolled crying in babies from 0 to 3 months old". The authors qualify their definition further by stating that the crying occurs for more than 3 hours a day, more than 3 days a week, for 3 weeks or more, usually in the afternoon and evening hours. Although this definition is old, it is the most widely recognized definition to date and is still used by authors (Canivet et al. 1996; Lindberg 1999; Wiberg et al. 1999; Lindberg 2000 and Sondergaard et al. 2000).

Infantile colic is an idiopathic condition, with much debate about its aetiology and treatment (Pineyard 1992). It presents as excessive crying in an otherwise healthy infant who has a normal weight gain (Wiberg et al. 1999; Olafsdottir et al. 2001) and is one of the most frequent problems presented to paediatricians by new parents (Barr 1998). Furthermore, it is a self-limiting and benign condition with approximately 47% of cases resolving at 3 months, a further 41% resolving between 3 and 6 months, and the remaining 12% resolving between 6 and 12 months (Hide and Guyer 1982). Approximately 10 to 20% of infants under the age of three months suffer from infantile colic (Becker et al. 1998) and less than 5% of colicky infants suffer from organic diseases (Barr 1998).

The diagnosis of infantile colic is arrived at by the method of exclusion, completing a thorough history and physical examination to rule out any possible serious illness or infection that may be present (Balon 1997). Lissauer and Clayden (1997: 126) noted that there is no firm evidence that the causative mechanism of infantile colic may be attributed to intestinal, biliary or renal causes. The authors further stipulated that cow's milk intolerance and gasto-oesphageal reflux are seldom responsible.

Effective treatment and management of infantile colic is necessary as the difficulties associated with inconsolable crying may persist and although infantile colic is not detrimental to an infant's health, it places tremendous stress on the family (Balon 1997). Moderate to severe cases of infantile colic, as stated by Lund et al. (1998), may involve uncontrollable crying for many hours during day and night, every day. The authors noted that it is destructive

to infant and family, as there is a risk that the condition may negatively affect the mother-child bond after three months (Becker et al. 1998) and result in the infant sustaining non-accidental injury (Lissauer and Clayden 1997: 126).

In view of the fact that infantile colic responded favourably to spinal manipulation, Wiberg et al. (1999) suggested that the discomfort and colicky symptoms of infantile colic might have a musculoskeletal origin rather than the assumed yet unproven gastrointestinal origin. This hypothesis is supported by the effective treatment response observed in spinal manipulative studies on infantile colic (Wiberg et al. 1999). It leads to the suggestion that either spinal manipulation may be useful in treating visceral disorders, as spinal manipulation has been postulated to cause somatovisceral spinal reflexes (Gatterman 1990: 204), or that infantile colic may be a musculoskeletal disorder, which may explain why spinal manipulation is effective in treating infantile colic.

The motion palpation of infants' spines remains controversial (Volkening 2000). Extensive literature searches have not revealed studies that have ascertained if spinal joint dysfunctions are responsible for the colicky symptoms. The observed clinical improvement (which was noted as a decrease in crying time of the infants) of the treatment groups has lead to the conclusion that removal of spinal joint dysfunctions may play a large part in the alleviation of symptoms of infantile colic (Klougart et al. 1989; Mercer 1999: 39; Wiberg et al. 1999).

In studies by Klougart et al. (1989), Mercer (1999:15), Wiberg et al. (1999), only infants suffering from infantile colic were included, therefore it is yet to be determined whether symptoms seen in infants suffering from infantile colic, possibly as a result of spinal joint dysfunction, also occur in healthy infants with no symptoms of infantile colic.

As mentioned by Gottlieb (1993), manual assessment of spinal joint dysfunctions in infants is well within the means of current practice in spinal manipulation and will be beneficial, as it may help to determine if there is a correlation between spinal joint dysfunctions and the prevalence of infantile colic. This study may result in more effective diagnosis and management of this benign, yet distressing condition.

1.2 STATEMENT OF THE PROBLEM

The purpose of the study is to determine if the prevalence of spinal joint dysfunctions is influenced by whether or not infants suffer from infantile colic.

1.3 OBJECTIVES OF THE STUDY

Objective 1: To determine if there is an association between infantile colic and the location of spinal joint dysfunctions in the spines of colicky infants by comparing healthy colicky and non-colicky infant populations in terms of clinical findings.

Objective 2: To determine the occurrence of spinal joint dysfunctions in healthy infants suffering from infantile colic as compared to the occurrence of spinal joint dysfunctions in healthy non-colicky infants, in terms of clinical findings.

Objective 3: To identify the areas of high prevalence of spinal joint dysfunctions in the spines of infants who suffer from infantile colic as compared to previous studies completed (Klougart et al. 1989, Mercer 1999: 40, Wiberg et al. 1999).

1.4 HYPOTHESES

Hypothesis 1: It is hypothesised that there would be association between infantile colic and the location of spinal joint dysfunctions in the spines of colicky infants in terms of clinical findings.

Hypothesis 2: It is hypothesised that infants with infantile colic have a higher occurrence of spinal joint dysfunctions than infants without infantile colic.

Hypothesis 3:
It is hypothesised that the areas of high prevalence of spinal joint dysfunctions in colicky infants would be similar to previously completed studies (Klougart et al. 1989, Mercer 1999, Wiberg et al. 1999).

1.5 BENEFITS OF THE STUDY

The purpose of the study was to determine if the prevalence of spinal joint dysfunctions was influenced by whether or not infants suffer from infantile colic. The study compared observation, static palpation and motion palpation findings of spinal examinations between healthy colicky and non-colicky infants. The aim was to test the hypothesis of whether infantile colic has a musculoskeletal origin by determining whether or not spinal joint dysfunctions are associated with infantile colic.

Chiropractic has been shown to be useful in the treatment of infantile colic in two randomised controlled trails by Wiberg et al. (1999), Mercer (1999: 28) where the effect of spinal manipulation was significantly better than placebo (P=0.004 and P= 0.04 respectively). Although the motion palpation of infants remains controversial, no studies to this date, after an extensive search of the

literature, have ascertained if determining spinal joint dysfunctions in infants are responsible for the colicky symptoms. The observed clinical improvement (which was noted as a decrease in crying time of the infants) of the treatment groups has lead to the conclusion that spinal joint dysfunctions may play a large part in the symptoms of infantile colic (Mercer 1999: 37, Wiberg et al. 1999, Klougart et al. 1989,).

The areas of the spine in which spinal joint dysfunctions were most commonly located in completed studies, were found to be in the upper cervical and mid-thoracic areas, as determined by Mercer (1999: 40) and Klougart et al. (1989) and the upper and mid-thoracic areas determined by Wiberg et al. (1999). The difference in the sample population numbers (30, 316 and 50 respectively) and the predominance of small sample populations included in two of the studies may play a role in explaining the variance in the predominant locations of the spinal joint dysfunctions. The small sample numbers may not have been large enough to establish trends in the locations of spinal joint dysfunctions. This study may contribute to knowledge to further determine or confirm the common locations of spinal joint dysfunctions that occur in infants who suffer from infantile colic, as compared to previous studies completed.

The information collected in this study would contribute to the demographic data of infantile colic in South Africa, especially in the Durban area as the study covered a large distribution of the communities in Durban. This research may also provide a foundation for further studies and investigations into the musculoskeletal origin of infantile colic and the effectiveness of spinal manipulative therapy in the treatment thereof.

CHAPTER TWO

2.0 REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION

The most accepted definition of infantile colic is described by Wessel et al. (1954) as "Unexplainable and uncontrolled crying in babies from 0 to 3 months old". The authors qualify their definition further by stating that the crying occurs for more than 3 hours a day, more than 3 days a week, for 3 weeks or more, usually in the afternoon and evening hours. Although this definition is dated, it is the most widely recognized definition to date and is still used by authors (Sondergaard et al. 2000 and Lindberg 2000; Wiberg et al. 1999; Barr 1998; Canivet et al. 1996).

Barr (1992) motivated that the original definition formulated by Wessel et al. (1954), was not practical since few parents or physicians would be willing to observe an infants' behaviour for 3 weeks without any intervention. The definition was modified to reduce the length of observation time. Therefore the persistent crying had to occur for to a week instead of 3 weeks, as defined before.

2.2 PREVALANCE

Infantile colic presents during the first three months of life as persistent and inconsolable crying (Kibel and Wagstaff 1991:252) in an otherwise healthy infant who has a normal weight gain (Olafsdottir et al. 2001). Infantile colic is often described as a self-limiting condition without any long-term adverse consequences (Crowcroft and Strachan 1997) that disappears spontaneously at three months of age (Gurry 1994).

In an observational study done by Hide and Guyer (1982), in England, the authors noted that only 47% of cases resolved at about 3 months, a further 41% resolved between 3 and 6 months, and the remaining 12% resolved between 6 and 12 months. The prevalence of infantile colic among infants is varied in different studies.

Authors of studies on infantile colic	Country of study	Estimated incidence of infantile colic	Years included for calculation
Wiberg et al. (1999)	Europe and USA	8-49%	1939 -1999
Canivet et al. (1996)	Sweden	9-60%	1984 -1995
Becker, et al. (1998)	Germany	10%-20%	1998
Sondergaard et al. (2000)	Denmark	10.9%	2000

The table above summarizes the estimated prevalence of infantile colic calculated in previous studies.

In a population-based study completed in Sweden, by Canivet et al. (1996), the authors noted that the occurrence of infantile colic from 10 studies completed in the last decade (1984 to 1995) ranged from 9 to 60%, but often-averaged around 20%. The studies cited by Cavinet et al. (1996) included: Rubin and Prendergast (1984), Ståhlberg (1984), Forsyth et al. (1985), Thomas et al. (1987), Moore et al. (1988), Geertsma and Hyams (1989), Lothe et al. (1990), Högdall et al. (1991), Rautava et al. (1993) and Lehtonen and Korvenranta (1995). The statistics drawn from this study showed that only 9,3% of the participating infants appeared to suffer from the classic "Wessel-type" infantile colic. When using the classic "Wessel-type" definition modified according to Barr (1992) where the duration of the crying spells were required to last at least a week, 11.7% of the infants suffered from infantile colic.

A marked difference was noted in the results of the two groups in the study. The group who formed the retrospective part of the study received telephonic interviews during participation. The occurrence of infantile colic was significantly higher in this group than in the group forming the prospective part of the study, where the mothers were given diaries to record the infants' behaviour in the first 3 months.

The authors provided possible explanations for this. The first was that the telephonic interviews for the retrospective part of the study were conducted when the infants were between five to seven months old, consequently perception might have influenced the results, since infantile colic usually stops at 3 months. The second explanation was that the mothers completing written diaries were less likely to record the crying of the infants as being a problem than the mothers reflecting on the infants' behaviour months later. Thirdly, the authors also noted that a "selection bias" may have been possible where the mothers who chose to participate in the dairy group resulted in less colicky infants in that group.

Canivet et al. (1996) concluded that when using the classic-type Wessel criteria, the prevalence of infantile colic was reduced. Factors that may have affected the results of this study were, that parents-to-be had group meetings

at the maternity health clinics during pregnancy, which may have prevented possible parent-child interaction problems, and that mothers in Sweden also received a year's paid maternity leave.

Canivet et al. (1996) also concluded that the occurrence of infantile colic was either reduced or that it was less common than previously estimated. This became evident in the results of the group using the third definition of infantile colic, copied from Clyne et al. (1991). It only required for the infants to cry for a total of 60 minutes a day for 4 days of the week, for at least a week. This definition was chosen because of the need to eliminate the "fussing behaviour" of the infants and the crying associated with hunger. Only the "vigorous" or "full force" crying was to be documented. So a time limit of 60 minutes per day was chosen. Compared to the "classic" definition of infantile colic, the use of this definition should have allowed for the occurrence of infantile colic in this group to be larger but only resulted in 16% of the infants suffering from infantile colic. When comparing this 16% to Canivet et al.'s (1996) previous observation that noted the occurrence of infantile colic to range from 9 to 60%, it would appear that infantile colic might be less common than previously estimated.

Sondergaard et al. (2000) conducted a population-based study in Denmark, using the classic "Wessel criteria" and found the occurrence of infantile colic to be 10.9%. Again, the data collected depended on the parental perception of the infant's behaviour, as the information was collected when the infants were already eight months old and this may have introduced a "recall bias" to the results at the time. However, to minimise the effects of the bias, this information was taken from two different sources, the parents as well as the participating nursing staff. Sondergaard et al. (2000) explained that the varying prevalence of infantile colic, of 8% to 40%, could be explained by differences in study designs and definitions used in the various studies. For example, factors such as the ages of the infants, the treatment periods allocated in each study and the type of definitions used for inclusion would influence the prevalence. Klougart et al. (1989), for example, included infants as old as 52 weeks and had no way of proving that the condition did not resolve spontaneously before treatment had been completed. Studies using definitions that included infants who failed to meet with the "Wessel-type" criteria possibly included infants who did not have true infantile colic, by definition, and therefore erroneously influencing the prevalence.

On an extensive search of the literature, there is currently a lack of statistics on the prevalence of infantile colic in South Africa (Mercer 1999: 33). In the study completed by Mercer (1999: 34) the ethnic distribution of the participants in the study included: 86% (26) white infants and 6.66% (2) Indian infants. The coloured and black infants each represented 3.33% (1) of the sample population. It may be noted that the sample population in Mercer's (1999: 33) study was only 30 infants and was therefore not a true reflection of the demographics of the population. Due to the small sample of Mercer's (1999: 33) study, no significant differences in ethnic distribution can be inferred from the data obtained. Therefore this study will facilitate in the collation of demographic and epidemiological data pertaining to South Africa.

2.3 AETIOLOGY

Investigators (Miller and Barr 1991, Högdall et al. 1991 and Balon 1997) agree that the exact cause of infantile colic is uncertain. Lissauer and Clayden (1997: 126) explain that colic is a term used to describe a symptom complex in young infants, while Barr (1998) observed that colic could be a behavioural problem or the clinical manifestation of normal emotional development where the infant has a diminished capacity to regulate the duration of crying. However, Lucassen et al. (1998) believes that parental misinterpretation of the infant's normal crying is the problem and modification of parent-child interaction would be beneficial in reducing infantile colic.

A complete history and physical examination is necessary to rule out any conditions such as urinary tract infections, middle ear infections (Lissauer and Clayden 1997: 126) or merely over-feeding (Kibel and Wagstaff 1991:253) that may also result in persistent crying (Balon 1997). Therefore the diagnosis of infantile colic is arrived at after a process of exclusion. Infants suffering from infantile colic are healthy and appear to have normal weight gain (Olafsdottir et al. 2001).

Some of the previously investigated causative mechanisms of infantile colic are reviewed below. For the purpose of discussion, the aetiological factors have been divided into two sections. The first includes the physiological or organic causes and would pertain to any mechanism or influences involving the infant or the mother's body. The second section includes all the psychological theories and factors that would contribute to or develop in families where infantile colic occurs.

2.3.1 PHYSIOLOGICAL OR ORGANIC THEORIES

2.3.1.1 Gastrointestinal Theories

In the opinion of Hull and Johnston (1999: 84), it is very difficult for parents to watch as an infant cries for extended periods of time at night. Kibel and Wagstaff (1991:253) noted that in an attempt to calm the infant, it could often be tempting for the parents to feed the infant during every bout. But the infant responds to the resultant overfeeding by vomiting (Hull and Johnston 1999: 84), thus adding to the parental stress. Kibel and Wagstaff (1991:253) recommend that over-feeding of infants should be eliminated as a possible cause of prolonged crying. Assessing the techniques employed in feeding and winding the infants may be helpful.

Evans et al. (1995) completed an exploratory study that compared the effect of two methods of breast-feeding and the impact thereof on the infants in the sample, breast engorgement, mastitis and infantile colic. The experimental group (n=150) used the technique of breast-feeding that employed prolonged

emptying of one breast at each feed, while the control group (n=152) ensured that both breasts were equally drained at each feed. The results revealed that the experimental group had a lower occurrence of infantile colic (12% vs. 23.4%; $p < 0.02$). The large sample size of this study supports the results achieved and suggests that the feeding technique may be a possible factor in causing infantile colic. More specifically, the slow and prolonged emptying of a single breast per feed (experimental group) produced less colicky symptoms than the half emptying of two very full breasts (control group) during each feed. Based on the results, the most likely explanation for this is that the infants may be swallowing air while attempting to drink the faster flowing milk. The ingested air may be responsible for the colicky symptoms in these infants.

Newman (2000: cited at: http://pediatrics.about. com/library/breastfeeding/ blbreastfeedingc.htm) noted another possible explanation supporting the results obtained by Evans et al. (1995). The author motivated that it is important not to switch breasts during a feed before the infant has "finished with the breast". The explanation given for this is that the content of the milk changes during feeds and changing breasts too early may deprive the infant of necessary fat in the remaining hind milk. The milk ingested is therefore low in fat and high in sugar, resulting in the stomach empting quickly after feeds. As a consequence, the enzymes in the intestine are unable to process the large quantity of milk, and the infant develops colicky symptoms. The author motivated that in such cases, infants are not lactose intolerant, the correct breastfeeding methods, as described by Evans et al. (1995) need to be employed.

In a questionnaire-based cohort study completed by Clifford et al. (2002), to determine whether breastfeeding had a protective effect on the development of infantile colic, it was noted that the prevalence of colic was higher in breastfed infants (23%) than in formula fed infants (21%). The study concluded that breastfeeding did not reduce the likelihood of an infant developing colic, however the breastfeeding techniques were not described or regulated during the study, as described by Evans et al. (1995). If the feeding technique used did not employ the prolonged emptying of each breast, the likely hood of the colic developing in the breastfeeding group was twice as likely, as noted in the results described by Evans et al. (1995). This may provide a possible explanation for the results obtained by Clifford et al. (2002).

In the study completed by Søndergaard, Olsen, Maurits, Friis-Haschè and Sørensen (2001), when analysing the confounding or risk factors influencing the occurrence of infantile colic, it was noted that postpartum maternal caffeine consumption did not significantly increase or influence the rate at which infantile colic occurred. Lust et al. (1996) completed a study to determine which cruciferous vegetables and other foods (such as chocolate, onion, beef and cow's milk), were related to colicky symptoms in strictly breast fed infants. Based on the results of the information gathered from the participating mothers, Lust et al. (1996) motivated that mothers eliminating cow's milk from their diet while breastfeeding infants, reduced the symptoms of infantile colic. The authors further stipulated that maternal consumption of more than one cruciferous vegetable or chocolate was associated with an

increase in colicky symptoms in infants that were strictly breastfed. The vegetables included in the study were cabbage, cauliflower, broccoli and onion.

The authors (Lust et al. 1996) describe that the possible mechanism by which cruciferous vegetables cause colicky symptoms in breastfed infants may be related to two particular compounds. The first is *S*-methyl-*L*-cysteine sulfoxide and the second is sinigrin. *S*-methyl-*L*-cysteine sulfoxide is a derivative of a sulphur-containing amino acid cysteine and on heating forms volatile sulphur compounds such as dimethyl disulphide and hydrogen sulphide. The authors further explain that the *S*-methyl-*L*-cysteine sulfoxide may pass into the breast milk and result in abdominal distress and cramps in the infant's immature gut. The sinigrin is (also a sulphur-containing compound) thought to give rise to the flavour in raw vegetables and it may also be responsible for abdominal distress in infants as it is also a sulphur-containing compound. According to Lust et al. (1996), the exact mechanism as to how the infant gut is affected by the maternal diet of cruciferous vegetables is not certain, but the process described above may be partly biologically probable.

Lindberg (1999) suggests that other proteins such as fish or egg can also cause colic in breast fed infants. Miller and Barr (1991) further concluded that the colicky symptoms might be as a result of painful contraction of the intestines caused by an allergy to cow's milk or lactose intolerance. In the review of literature, Lindberg (1999) noted that there were several signs (such as increased motilin levels in serum, increased breath hydrogen excretion and decreased gallbladder contractility) that indicate an abnormal intestinal function in infants with infantile colic. Lindberg (1999) further stipulated that the exact nature of the abnormality associated with infantile colic still remained unknown.

The gut hormone motilin is an amino acid peptide secreted by endocrinocytes in the mucosa of the proximal small intestine. Control of motilin secretion is largely unknown, although it is thought to occur as a result of parasympathetic or vagal stimulus (Kirjavainen et al. 2001) and some studies suggest that an alkaline pH in the duodenum stimulates its release (Motilin, 1999 cited at: http://arbl.cvmbs.colostate.edu/hbooks/pathphys/endocrine/gi/motilin.html).
Lothe et al. (1990) cited that gut hormones develop early in infancy and all peptide-containing cells of the intestinal mucosa have developed by 25 weeks of gestation. The authors completed a study noting that the serum levels of motilin in the cord blood at birth and during the first few days of life were higher in the infants who later developed colic. Lothe et al. (1990) further explained that motilin was found to accelerate gastric emptying and increase intestinal emptying time by increasing the motor activity to the gut. Higher levels of motilin in infants with colic may explain the possible gastrointestinal symptoms noted in these infants. In view of the information revealed by Lothe et al. (1990), where infants with higher motilin levels later develop colic, Lindberg (1999) concluded that the intestinal tract might be affected long before the symptoms of infantile colic develop.

Other theories that can be noted as possible factors in infantile colic include: the swallowing of air that occurs during excessive crying (Merenstein et al. 1994: 587), which results in cramping and distension of the stomach; immaturity of the gastrointestinal system (Pinyerd and Zipf 1989); abnormal sensitivity to food components such as cow's milk or soy proteins (Lucassen et al. 1998); excessive intestinal gas (Miller and Barr 1991); intestinal hypermobility and hormonal factors (Lothe et al. 1990, Miller and Barr 1991). All of the above may contribute to the underlying factors causing infantile colic in the first few months of life.

2.3.1.2 Gestational Age and Foetal Growth

Sondergaard et al. (2000) conducted a population-based study in Denmark, to describe how foetal growth and gestational age may affect infantile colic. The study used the classic "Wessel criteria" and found the occurrence of infantile colic to be 10.9%. The results revealed that low birth weight infants (<2500 g) had more than twice the risk of being reported as having colic than infants with a birth weight between 3500 g and 4499 g. This may suggest that the infants born pre-term (<37 weeks completed) also had a higher risk of developing infantile colic (16.5% CIP) as this group of infants formed the majority of low birth weight group of infants.

Sondergaard et al. (2000) further determined that there was no association between infantile colic and infants who were determined as small for their gestational age or ponderal index [calculated birth weight (kg) divided by length at birth $(m)^3$]. Details about maternal smoking were also recorded but the association of smoking during pregnancy and low birth weight was not determined.

2.3.1.3 Maternal Smoking or Infants cotinine consumption

Søndergaard, Henriksen, Obel and Wisborg (2001) completed a follow-up study on 1820 mothers with newborn infants, to evaluate the association between maternal smoking during pregnancy and infantile colic. The results of the data analysis revealed that smoking during pregnancy and postpartum increased the infant's risk of developing infantile colic. It was noted that smoking more than 15 cigarettes a day during pregnancy or postpartum doubled the infant's risk of developing infantile colic. The onset of infantile colic in the first week was as high as 30% in the group of mothers who had smoked during pregnancy, as compared to the 21% occurrence of infantile colic in the infants of non-smoking mothers. The authors commented that infantile colic did not last for a longer period as a result of postpartum smoking and it was also noted that paternal smoking increased the infant's risk of developing infantile colic.

Reijneveld et al. (2000) conducted a study to determine the association between maternal smoking, the type of feeding and the occurrence of infantile colic in a sample of 3345 infants. The authors also noted that maternal

smoking was associated with an increased occurrence of infantile colic. The sample population of infants were divided into three age groups: 1 month (1115), 3 months (1085) and 6 months (1120) and the prevalence of infantile colic was 9%, 3.7% and 1.3 % respectively. The occurrence of infantile colic was 4.7% in the study and was most frequent in the younger (1 month) group of infants (9%). This may have been as a result of the age grouping of the infants in the study, as infantile colic ceases at about 3 months of age. The authors modified the results to compensate for the infants ages and showed that maternal smoking and strictly formula fed infants, rather than breastfed infants, were associated with a higher occurrence of infantile colic. Although the study concluded that maternal smoking was associated with an increased risk of infantile colic, it was noted that breastfeeding weakened the association.

The studies described above (Søndergaard, Henriksen, Obel and Wisborg 2001, Reijneveld et al. 2000) utilized a strict definition of infantile colic according to Wessel et al. (1954), thereby strengthening the statistical results obtained.

2.3.1.4 Infant Migraine

Mohammed and Al-Buhairi (2001) completed a study, which examined the possible association between infantile colic and childhood migraine. The study was comprised of an experimental group (n=29) that included children (aged 7.5 to 12 years) who suffered from migraines and a control group (n=29), which included children (aged 7 to 13 years) who did not suffer from headaches or migraines.

Using the strict diagnosis of infantile colic according to Wessel (1954), it was noted that fifteen (52%) of the experimental group, compared to six (20%) of the control group of children had a history of colic during infancy. Based on these calculations, it was noted that children suffering from migraines were four times more likely to have a history of infantile colic.

It was therefore suggested that children suffering from migraines could have a positive history of infantile colic. When examining the results of the two groups, the authors noted that the children suffering from migraines were more likely to have a history of infantile colic, family history of infantile colic, and family history of migraine in any of the first-degree relatives. The authors therefore deduced that children with a history of infantile colic were also more likely to have family history of migraine. In conclusion, although the study was limited by a recall bias and a small sample size, the focus on the detailed history of behaviour during infancy brought to light the higher prevalence of sleep disturbances and infantile colic in children who suffer from migraines. This leads to reason that further investigation into migraine, as a causative mechanism needs to be pursued.

None of these studies (Balon 1997, Barr 1998, Canivet et al. 1996, Lucassen et al. 1998, Lust et al. 1996, Reijneveld et al. 2000, Sondergaard et al. 2001)

have identified consistent abnormalities in infants with colic and furthermore, none of these studies investigated the spine as a possible origin of infantile colic.

2.3.1.5 Spinal Joint Dysfunction

In review of the available literature, the conclusion drawn by the author is that the association between the spinal joint dysfunction and infantile colic is a debatable one. The motivation for the statement is that no accepted or reliable scientific conclusions can be proved regarding the somato-visceral theory (Leboeuf-Yde et al. 1999, Jamison et al. 1992, Nansel and Szlazak 1995), yet, evidence such as the improvement of infantile colic to spinal manipulation (Mercer 1999: 37, Wiberg et al. 1999, Klougart et al. 1989), does advocate the relationship.

The author additionally remarks that the effect of spinal manipulation on infantile colic is a further contested matter for the following reasons. Spinal manipulation of spinal joint dysfunctions in infants suffering from infantile colic (Mercer 1999: 37, Wiberg et al. 1999, Klougart et al. 1989) has resulted in a reduction of crying time and hence an improvement in the colic. But one study (Olafsdottir et al. 2001) determined that spinal manipulation is no more effective than placebo in the management of infantile colic. Therefore, research is yet to determine if there is a consistent association between spinal joint dysfunctions and infantile colic.

Jamison et al. (1992) conducted a survey to establish whether chiropractors in Australia consider spinal manipulation as an intervention option for patients presenting with visceral conditions. One thousand three hundred and eleven registered practitioners were invited to participate and only 285 (22%) completed the questionnaire. The respondents were required to indicate whether they noted that spinal manipulative therapy was effective in the management of various visceral conditions, including: migraine, asthma, hypertension and dysmenorrhoea. One of the recommendations put forward by 10 % of the participating chiropractors was that in their clinical experience, spinal manipulation was recommended as effective in the management of infantile colic. Although the study concluded that there was no scientific evidence to support the theoretical basis for the effect of spinal manipulation on visceral disorders, research (Mercer 1999: 37, Wiberg et al. 1999) has determined that spinal manipulation is more effective than placebo in the management of infantile colic.

Leboeuf-Yde et al. (1999) completed a retrospective study to investigate how often non-musculoskeletal symptoms improved after spinal manipulation. Although the information collected was subjective, a large sample was included. It can be noted that of the 462 reported non-musculoskeletal reactions, the improved digestive system reactions accounted for 20% of the total. Furthermore 25% of the participants (1504) in the study experienced at least 1 improved non-musculoskeletal symptom.

Leboeuf-Yde et al. (1999) commented that although chiropractors treat musculoskeletal conditions, the numbers of chiropractors that apply the somatovisceral theory in their clinical practice are on the decline. It was further stated that some chiropractors still accept the possibility of an unexpected, positive, non-musculoskeletal effect on bodily functions. In view of the conclusions of this study, although subjectively documented, somatovisceral reactions related to the gastrointestinal system were noted.

In view of the fact that infantile colic responded favourably to spinal manipulation, Wiberg et al. (1999) suggested that the discomfort and colicky symptoms of infantile colic might have a musculoskeletal origin rather than the assumed yet unproven gastrointestinal origin. This supports the hypothesis that spinal manipulation may cause somatovisceral spinal reflexes (Gatterman 1990: 381). Although spinal manipulation is used in the treatment of musculoskeletal disorders, the effective treatment response observed in the spinal manipulation studies on infantile colic (Wiberg et al.1999, Mercer 1999: 28), leads to the suggestion that either spinal manipulation is effective in treating certain visceral disorders like infantile colic or that infantile colic may be a musculoskeletal disorder (Wiberg et al. 1999).

Nansel and Szlazak (1995) completed a study that reviewed 350 articles pertaining to the subject of somatic dysfunction and visceral disease simulation and concluded that there was not enough scientific evidence to support the somatovisceral theory. The authors stated that no controlled study has determined that spinal manipulation has established a valid curative strategy for true visceral disease and the existence of the visceral disease before treatment, has never been proved. It was noted that the autonomic nervous system did not seem able to induce tissue disease in the organs it innervated, to substantiate the somatovisceral disease mechanism.

The authors did acknowledge that somatic pain did have the ability to elicit local or general somatovisceral reflex responses but that it could not cause disease. It was explained that the symptoms of visceral disorders may be produced by somatic dysfunctions of the spine and that removal of the spinal joint dysfunctions may remove the symptoms previously produced. This phenomenon was referred to as “pseudo” or “simulated” visceral disease syndromes.

The process is thought to occur when afferent nociceptive signals generated from dysfunctional deep somatic structures in the spine could result in referred pain patterns, along with several equally misleading autonomic reflex responses, that have been shown to simulate (rather than cause) true visceral disease. The explanation for this is because of the convergence of these signals on the same pools of central nervous system neutrons that also receive afferent input from regional internal organs (Nansel and Szlazak 1995).

In view of this conclusion, spinal joint dysfunctions may cause symptoms that mimic those of infantile colic. This further implies that infantile colic may be a musculoskeletal condition that produces symptoms that mimic or manifest as

gastrointestinal symptoms and or infantile colic. Therefore spinal manipulative therapy of the spinal joint dysfunctions found in infants may remove the symptoms that are similar to those noted in gastro-intestinal conditions such as infantile colic.

The studies completed by Olafsdottir et al. (2001), Mercer (1999: 15), Wiberg et al. (1999) and Klougart et al. (1989), only included infants suffering from infantile colic. It is yet to be determined, whether the clinical observations of spinal joint dysfunctions that mimic the symptoms of infantile colic (Wiberg et al.1999) also occur in infants that do not manifest the symptoms of infantile colic.

The motion palpation of infants remains controversial since no studies to this date, after an extensive search of the literature, have ascertained if determining spinal joint dysfunctions in infants is accurate or reliable and if they are responsible for the colicky symptoms. The observed clinical improvement (which was noted as a decrease in crying time of the infants) of the treatment groups has lead to the conclusion that spinal joint dysfunctions may play a large part in the symptoms of infantile colic (Mercer 1999: 37, Wiberg et al. 1999 and Klougart et al. 1989).

In a letter to JMPT editor, Volkening (2000) queried Wiberg et al. (1999) on spinal manipulation being effective in treating infantile colic because motion palpation was used as the diagnostic tool and its reliability was doubtful in infants of 2 to 10 weeks of age. In response, Wiberg (2000) mentioned that the spinal manipulation was effective in reducing crying time irrespective of the use of motion palpation. On reviewing the available literature it is apparent that although motion palpation is not determined as reliable in infants, it is still widely used (Olafsdottir et al. 2001, Mercer 1999: 18, Wiberg et al. 1999 and Klougart et al. 1989), and is a tool that is necessary to determine the correct vertebral levels that have spinal joint dysfunctions, that require manipulation.

According to Russell (1983) the use of the manual assessment procedure carries the possibility of a treatment effect. This non-specific “placebo” effect of the manual assessment procedure has not been determined (Hawk et al. 1999). Therefore the question arises as to whether the effect of the spinal and pelvic examinations conducted on the infants to be treated by spinal manipulative therapy had benefited by this procedure, independently to spinal manipulation and mobilization. An investigative study needs to further determine the “placebo treatment effect” of motion palpation as a diagnostic tool by comparing its effect when used only as a tool for detecting the levels of spinal joint dysfunction, to the effect of spinal manipulation in the treatment of spinal joint dysfunctions.

In 1985, a retrospective study was undertaken in England, by Nilsson, on the spinal manipulation of infantile colic (Nilsson 1985) and was followed by a prospective multi-centre study, in 1989 (Klougart et al.1989). Both studies showed that spinal manipulation had a positive effect in the treatment of infantile colic, with 90% and 94% success rates, respectively, but neither of

these studies had a control group. As a result it was impossible to assess whether the effect observed was significantly better than placebo (Wiberg et al. 1999). Two randomised controlled trials on infantile colic (Wiberg et al.1999, Mercer 1999: 28) showed that spinal manipulation was significantly better than placebo in the treatment of infantile colic (P= 0.004 and P= 0.04 respectively).

Olafsdottir et al. (2001) completed a randomised double-blinded placebo controlled trial on a sample of 100 infants suffering from strict "Wessel-criteria" type colic. All infants with lactose intolerance and possible allergies to cow's milk were excluded from the study. Only healthy infants were included in the study and were aged 3 to 9 weeks. The average duration of the colic in the sample of this study was 3,9 weeks. The infants were divided into 2 groups of 50 (46 in the treatment group and 40 in the control, after drop-outs). The treatment group received three spinal manipulative treatment sessions for a period of eight days, where intervals between treatments ranged from two to five days. The treatment plan was predetermined by a group of 14 chiropractors. The parents as well as the chiropractor were blinded and the parents of both groups received counselling to manage the infant's behaviour. The study determined that spinal manipulative therapy was no more effective than placebo in the treatment of infantile colic.

In a letter to JMPT editor, Grunnet-Nilsson and Wiberg (2001) commented on the results of the study by Olafsdottir et al. (2001). The possible explanation for the results as suggested by Olafsdottir et al. (2001), was that the mothers were blinded from the infants grouping and therefore the treatment received. Grunnet-Nilsson and Wiberg (2001) suggested that the results could be due to a "dose response phenomenon". This was explained as follows. The infants in the study by Olafsdottir et al. (2001) only received 3 treatment sessions of spinal manipulation. It was mentioned that two previously completed randomised controlled clinical trials (RCTs), which determined that spinal manipulation was significantly better than placebo (P=0.004 and P= 0.04 respectively) (Wiberg et al.1999, Mercer 1999: 28), used a treatment dose at a frequency of 1 treatment every 2 to 3 days over a 2 week period, with a maximum or six and seven treatments respectively (Mercer 1999: 19; Wiberg et al.1999).

Therefore, in conclusion, the minimum number of treatments received by the infants in the studies that determined that spinal manipulation was significantly better than placebo (P=0.004 and P= 0.04 respectively) (Wiberg et al.1999, Mercer 1999: 28), were 4 in comparison to 3 sessions given in the study by Olafsdottir et al. (2001). The frequency of treatment given by Olafsdottir et al. (2001) had allowed treatment intervals of up to five days, which may explain the diminished effect of the spinal manipulation in the treatment groups, when compared to a consistent treatment frequency of every 2 to 3 days over a 2-week period, by Mercer (1999: 19) and Wiberg et al. (1999).

Other factors that may contribute to the results of the study include the fact that parents in both groups started receiving counselling at the beginning of the study. As the parents received counselling from the trained nursing staff,

the crying of the infants in both groups was perceived as being diminished by the parents, as their coping skills improved. This may be contributed to that fact that parents were given the necessary education and support regarding the infants' behaviour. The effect of placebo on the parent's perception of the infants' behaviour may be explained, as Olafsdottir et al. (2001) reported that all infants were returned to the parents undressed as if they had been treated. If parents therefore assumed that the infants had been treated, the placebo effect on the parents had reduced the crying of the infants.

Hughes and Bolton (2002) completed a report for Archives of Disease in Childhood, reviewing previously completed studies on chiropractic, to determine if chiropractic is effective in the treatment of infantile colic. A case approach was taken and information about the previously completed studies was taken from Medline on the Internet. Although this approach is not determined as reliable in the opinion of the author, it would be the first line of information available to interested individuals.

The report concluded that there was not sufficient evidence that chiropractic was better that placebo in the treatment of infantile colic, however, that chiropractic treatment would result in a reduction of reported crying duration. In view of the critical analysis of the studies included (Klougart et al. 1989, Mercer and Nook 1999, Wiberg et al. 1999, and Olafsdottir et al. 2001), the conclusion was drawn on the basis that Olafsdottir et al. (2001) reduced parental bias and had an intention to treat analysis, which means that the treatment plan was predetermined. The most likely conclusion drawn from this exercise is that further chiropractic research is necessary to reduce the number of inaccurate assumptions on chiropractic and it's role in the treatment of infantile colic, based on four available abstracts.

The areas of the spine in which spinal joint dysfunctions were most commonly located in completed studies, were found to be in the upper cervical and mid-thoracic areas, as determined by Mercer (1999: 40) and Klougart et al. (1989) and the upper and mid-thoracic areas determined by Wiberg et al. (1999). The difference in the sample population numbers (30, 316 and 50 respectively) and the predominance of small sample populations included in two of the studies may play a role in explaining the variance in the predominant locations of the spinal joint dysfunctions. The small sample numbers may not have been large enough to establish trends in the locations of spinal joint dysfunctions.

Manual assessment of spinal joint dysfunctions in infants is well within the means of current practice in spinal manipulation as mentioned by Gottlieb (1993) and may be beneficial, as it may help to determine if there is a correlation between spinal joint dysfunctions and the prevalence of infantile colic. This may result in more effective diagnosis and management of this benign, yet distressing condition.

2.3.1.6 Birth Trauma or Injuries

Wiberg and Nilsson (2000) noted in a preliminary report, that the birth duration of infants with infantile colic was shorter (a mean of 9.7 hours) than non-colicky infants (a mean of 14.3 hours). The duration of the birth process was measured from the start of labour to delivery of the infant. It was concluded that the shorter birth process resulted in the infant experiencing a more concentrated or condensed birth process. The authors suggest that the more forceful birth as a result of the condensed birth period might be a physical variable in the cause of infantile colic and recommend that further research be conducted into the birth process.

Anrig and Plaugher (1998: 431) define birth trauma as tissue deformation, distortion or destruction sustained to the foetus during birth. In review of the available literature, the authors noted that the origin of birth trauma might occur as the result of gestation, incident to labour or trauma during delivery. Hughes et al. (1999) who conducted a study to determine the incidence of head and neck trauma during birth (n=312) further supported the hypothesis of birth trauma. The authors commented that malposition of the infant during birth increased the likelihood of trauma. However, the authors of this study excluded injuries that did not occur to the head and neck, minor abrasions and soft tissue injuries. However, Anrig and Plaugher (1998: 159) note that soft tissue injuries such as erythema, petechiae and abrasions occur as a result of forceps deliveries, cephalo-pelvic disproportion and prolonged and traumatic deliveries, often as a result of abnormal presentations. Although soft tissue injuries do not compare in severity to the infant sustaining a fracture of the skull or clavicle or neurological injuries such a facial paresis of brachial plexus injuries (Hughes et al. 1999), the traumatic petechiae that occur during difficult deliveries, indicate the amount of stress and pressure the infant was subject to during delivery (Anrig and Plaugher 1998: 159). It is in the opinion of Anrig and Plaugher (1998: 617) that the trauma of the normal birth process (rotation, lateral flexion and traction of the cervical spine) is a possible cause of spinal joint dysfunctions in the upper cervical segments.

A prospective trial completed by Hogdall et al. (1991) in Denmark, tested the hypothesis that medication during labour increased the risk of infantile colic. During the study, the management protocol of labour was examined. Factors taken into account included the infant presentations, types of birth, labour complications, instruments utilized and medication administered to the mothers. It was concluded that no significant association between labour or labour complications were found to be associated with infantile colic. On further analysis of the data obtained during the study, the authors determined that the “psychological complications” of pregnancy and a bad pregnancy experience for the mother were highly associated with infantile colic. In view of this finding, the authors recommended that psychologically supporting the mothers and providing the necessary obstetrical management and pain relief would be helpful in the prevention of infantile colic. The most likely explanation for the conclusions drawn from this study indicated that infantile colic is a manifestation of the mother’s perception of the infant’s behaviour.

2.3.1.7 Central nervous system

In a study conducted by Barr et al. (1999) it was noted that sucrose had a less effective calming response on the crying of infants with colic (n=19) than the crying of infants without colic (n=19). The study investigated the effect of sucrose taste as compared to water taste, administered to infants in before and after-feed crying. The effect of sucrose produced a greater calming effect on the infant (as compared to water) in both the colicky and noncolicky infants, before feeds ($P<0.01$) as compared to after feeds ($P=0.78$). The authors explained that the calming response of sucrose was noted to continue after the mouthing that occurred as a result of the sucrose taste, had ceased. The sucrose solution decreased the crying of infants in both groups to less than ten percent in the first minute, with effectiveness of calming response lasting for more than five minutes. It can be noted that the sucrose taste in the mouth is known to disappear after the second minute of administration, as demonstrated in previous research completed by Hase et al. and Macpherson and Dawes in 1994, as cited by the authors.

From the results of this study, the authors noted that infants with colic were less able to regulate crying once it has started and proposed that the infants with colic may have a functional difference in the central opioid-dependent calming system. This conclusion was reached in view of the fact that sucrose-induced calming may be mediated by the central opioid-dependent system. The authors further concluded that this finding could further be supported by research where colicky infants calm in response to the orotactile stimulation induced by a pacifier.

2.3.1.8 Autonomic Nervous System

Kirjavainen et al. (2001) completed a study (n=26) on infants measuring the heart rate variability (HRV) during slow wave sleep (stages 3 and 4) to estimate function, balance and maturation of the autonomic nervous system (ANS). The rationale for the study, as explained by the author, on review of the available literature, was that a predominance of the peripheral as well as the sympathetic nervous systems have been implicated as possible explanations for colicky behaviour in infants. Kirjavainen et al. (2001) cited the study by Lothe et al. (1990) and explained that the increased levels of motilin noted in the colicky infants was suggestive of parasympathetic or vagal dominance in early infancy, since motilin is secreted in higher amounts under parasympathetic stimulus. Kirjavainen et al. (2001) also cited the study completed by Lehtonen et al. (1994) on the hypocontractility of the gall bladder in colicky infants. The results suggested that since gallbladder contractility was vagally stimulated and hypocontractility of the gallbladder therefore suggested low parasympathetic tone.

Kirjavainen et al. (2001) studied the HRV in colicky (n=12) and noncolicky (n=14) infants to determine whether the imbalance in the ANS was associated with infantile colic. The conclusion of the study, although based on a small sample size (n=26), concluded that an imbalance between the

parasympathetic and sympathetic systems was not associated with infantile colic. If this study were to be completed with a larger sample size, it may assist in further determining the gastro-intestinal hypothesis as a cause for infantile colic.

2.3.2 PSYCHOLOGICAL THEORIES

The psychological theories to account for the behaviour of infants suffering from infantile colic and the mother/infant interaction have been hypothesized and tested (Sondergaard et al. 2001). There are two main schools of thought. The first is that infantile colic is merely a manifestation of extreme normal behaviour in infants who have a low tolerance to environmental stimulus (Barr 1998, Kibel and Wagstaff 1991:252) and the other is inadequate parental interaction with the infant (Lucassen et al. 1998, Kibel and Wagstaff 1991:253).

Rautava et al. (1993) completed a study to determine associations between characteristics of families during the first pregnancy, after birth and after the development of infantile colic. The sample that completed questionnaires included 1333 nulliparous women and 1279 partners during pregnancy and 1208 women and 1115 men when the infant was three months old. The questionnaires included questions about parental relationships, personal and social behaviour of parents during pregnancy, coping with pregnancy, physical health, the experiences of parents in relation to pregnancy and childbirth, sociodemographic variables and the measure of colic when the infant was three months old. In assessment of possible psychological predisposing factors for infantile colic, it was noted that stress and physical symptoms during pregnancy, dissatisfaction with a sexual relationship and difficult or negative experiences during childbirth were associated with the development of colic in the infants. The authors explained that parental stress and dissatisfaction in marital relationships during colic did not explain the cause of colic, however, that families with low coping capabilities or dysfunctional family dynamics were more likely to have an infant who developed colic. The encouragement of parents through family difficulties by teaching coping mechanisms and nurturing skills enabled parents to manage screaming infants at home. The likely conclusion from the results of the study is that infants are sensitive to the emotional environment created by the parents at home.

Lissauer and Clayden (1997: 123) also supported this observation as they noted that the emotional climate within a home was readily transmitted to the infant. The authors explain that parents who are tense and anxious are likely to cause similar behaviour in the infants. It is of the opinion of Kibel and Wagstaff (1991:253) that the difficulties in the mother-infant relationship might be largely maternal. The authors further explain that the infants are very sensitive to the mother's emotional state and a lack of confidence or anxiety in the mother may lead to an "excessively irritable" infant. The effect of inconsolable crying on the mental health of mothers with infants who had infantile colic was noted in a study completed by Pinyerd (1992). The sample

consisted of 12 mothers who had infants with colic and 12 mothers of infants without colic. Profile of Mood States and the Symptom Checklist-90R tests assessed the mental health of the mothers in both groups. Pinyerd (1992) observed that the mothers of colicky infants had "multidimensional psychological distress". The signs that were observed included: "bodily dysfunction, fears, disordered thinking, depression, anxiety, fatigue, hostility and impulsive thoughts and actions". It was noted that the mothers of the colicky infants also had more feelings of "personal inadequacy or inferiority". The impact of infantile colic on the emotional states of mothers was also noted in the results of a questionnaire-based cohort study completed by Clifford et al. (2002), which aimed to determine whether breastfeeding had a protective effect on the development of infantile colic. It was noted that infants born to mothers who were married or had a common-law partner were 70% less likely to exhibit colicky behaviour, further substantiating the importance of support for parents with colicky infants.

Sondergaard et al. (2000) found that the older women had a higher risk of having infants with infantile colic. However, the author noted that the level of education, type of residence and cohabitation were not associated with infantile colic as previously believed (Crowcroft and Strachan 1997). Kibel and Wagstaff (1991:253) noted that in South Africa, on questioning mothers and experienced health care providers in the health clinics, colic occurred in sophisticated educated communities just as often as in unsophisticated uneducated communities. The authors concluded that the parents of the unsophisticated communities seldom sought advice for the typical colic behaviour and accepted it as normal.

Although infantile colic is said to be a benign condition (Lissauer and Clayden 1997: 126), in moderate to severe cases of infantile colic, which may involve uncontrollable crying for many hours by day and night, every day, colic is destructive to infant and family (Lund et al. 1998) resulting in inadequate interaction between mother and infant (Lindberg 2000). A peaceful home can be transformed into a state of chaos with family tempers being severely strained (Beers and Berkow 1999) and it may result in non-accidental injury in infants already at risk (Lissauer and Clayden 1997: 126).

Authors (Dihigo, 1998 Lucassen et al. 1998, Balon 1997, Räihä et al. 1996, Rautava et al. 1993, Hogdall et al. 1991) recommend that support and counselling of the parents to modify the parental response, are the most accepted treatment interventions.

2.4 CLINICAL PRESENTATION AND FEATURES

According to Barr (1998) infantile colic or excessive crying is one of the most common problems presented to paediatricians by new parents and organic disease only accounts for 5% of these infants.

The trademarks of infantile colic are described in the definition according to Wessel et al. (1954). These include the prolonged and unexplained crying

which may occur for as least 3 hours a day, for more than 3 days a week in the first 3 months in a healthy infant's life. Apart from the excessive crying, the infant has normal weight gain (Olafsdottir et al.2001).

Balon (1997) noted that infants suffering from infantile colic have a typical crying pattern that develops, where the concentration of the day's crying occurs in the late afternoon and evening. The author further explained that during such an "attack" the parents describe the crying of the infant as high pitched and piercing, as though the infant were in pain.

The inclusion criteria used by Wiberg et al. (1999) for the study on the short-term effect of spinal manipulation in the treatment of infantile colic, effectively describe the signs and symptoms of infantile colic for the purpose of this study. They are as follows:

- The infant may not show symptoms that could be a sign of any disease other than infantile colic.
- The infant must have 1 or more violent spells of crying per day.
- These crying spells must be at least 3 hours long per day and must have been present at least 5 of the 7 previous days.
- Apart from the attacks of infantile colic, the infant must show normal behaviour.
- The infant must show typical colic behaviour during the spells of crying:
    - Often flexing knees and hips against the abdomen
    - Extending the trunk, neck and extremities.
- During the attacks the infants cannot (or only temporarily) be comforted by:
    - Being picked up
    - Walked
    - Cradled
    - Change of diaper
    - Being offered a dummy.

Other features may include: reddening of the face, irregular sleeping patterns and feeding difficulties (Balon 1997) but these are not limited to infantile colic.

2.5 IMPACT OF INFANTILE COLIC ON FAMILY LIFE

The long-term implications of the impact of infantile colic on family life have been studied (Canivet et al. 2000; Räihä et al. 1997;Räihä et al. 1996; Rautava et al. 1995; Lehtonen et al. 1994). Canivet et al. (2000) completed a follow-up study where a group of infants who had previously suffered from infantile colic, and a control group, had reached 4 years of age. The study looked into various behavioural aspects of the children's lives. The study noted in support of the conclusions drawn by a similar study (Rautava et al. 1995), that ex-colicky children were reported to throw temper tantrums more often than infants who were non-colicky. The mothers stated that their children were "more emotional". Furthermore the study concluded that there were no serious long-term side effects of infantile colic but that the ex-colicky infants were more likely to display negative behaviour.

Effective treatment and management of infantile colic is necessary even though it is a benign and self-limiting condition as it is very distressing to the family. There is risk that colic may negatively influence the mother-child interaction beyond three months (Becker et al. 1998) resulting in sleep deprivation of the mother and physical abuse of the infant (Gurry 1994).

2.6 DIFFERENTIAL DIAGNOSIS

According to Lissauer and Clayden (1997: 126), the organic causes of persistent crying should not be overlooked as crying of sudden onset may have many underlying causes that need to be excluded before a diagnosis of infantile colic can be reached.

The most common conditions associated with persistent crying in infants that need to be ruled out as causative factors are (Lissauer and Clayden 1997: 123-126):

- Urinary tract infections
- Meningeal infections
- Middle ear infections
- Pain from an unrecognised fractures
- Oesophagitis
- Torsion of the testis
- Pyloric stenosis
- Intestinal obstruction
- Severe nappy rash
- Constipation
- Coeliac disease
- Gastro-oesophageal reflux.

Although regurgitation seems harmless and forms part of the infant's feeding process in the first few weeks of life, it often occurs as the result of benign episodes of feeding disorders, mild gastro-oesophageal reflux or more serious conditions, such as gastroenteritis (Lissauer and Clayden 1997: 123). The authors explain that although severe reflux is uncommon, the complications associated with reflux can present serious difficulties. The common complications include: failure to thrive, feeding problems, bronchitis and pneumonia due to pulmonary aspiration and oesophagitis.

According to Balon (1997) a thorough history and physical examination would help to exclude acute causes of infant crying. These include conditions such as infection, trauma or gastrointestinal dysfunction. The author recommends that the infant's diet, stooling and sleeping patterns be studied for abnormalities that could provide assistance in reaching a diagnosis, although, it can be noted that despite difficulties with crying and feeding, infants with colic continue to thrive.

2.7 MANAGEMENT OF INFANTILE COLIC

Once the infant's health is established, it is best to give a full explanation of the nature of infantile colic to the parents, as the necessary coping mechanism and nurturing skills can be taught to the parents (Rautava et al. 1993) and would result in the appropriate management of the colic. The explanation should include information about the behavioural aspects of the colic in combination with advice on handling a crying infant (Kibel and Wagstaff 1991:253) to improve or establish parental confidence (Olafsdottir et al. 2001).

Kibel and Wagstaff (1991:253) recommend that basic advice should include that infants should not be offered the breast every time they cry and parents should be encouraged to make use of a pacifier. Placing the infant in a harness close to the mother's body or swaddling them to give the infants a sense of security may also be helpful in soothing the infant. It was also noted that increased carrying of the infant did not result in a reduction of crying (St. James-Roberts and Hurry 1995, Barr et al. 1991), however, reduction in stimulation proved better than control (McKenzie 1991).

One modification that can be implemented to reduce the effect of infantile colic is to restrict the mother's diet, with strict elimination of cow's milk in breast-fed infants (Lindberg 1999) and to give casein hydrolysate formula to bottle-fed infants (Lindberg 1999, Lucassen et al. 1998). Protein hydrolysate is the preferred treatment for colicky infants with allergic features. The advantage of this formula over casein hydrolysate is that it tastes better and is more cost effective. However the availability of this product in South Africa, especially in the rural communities is not known.

In a systematic review of the effective treatments of infantile colic, which included 27 trials, Lucassen et al. (1998) remark that there is no evidence that low lactose formulas or fibre enriched formulas are effective in reducing infantile colic. It was recommend that soy protein formula be avoided as certain infants (especially those allergic to cow's milk) could risk developing allergies to soy proteins. This conclusion was supported by the American Academy of Pediatrics' Committee on Nutrition, by their recommendations for use of soy products in the feeding of infants (Soy protein-based formulas: recommendations for use in infant feeding. 1998: 148-153).

Lucassen et al. (1998) furthermore stated that herbal teas, motion and sound trials are not yet determined as effective treatments since controlled trials have not yet been completed. The anticholinergic drugs dicyclomine and dicycloverine showed some benefit in the treatment of excessive crying, however, adverse reactions such as sleep apnoea were noted. Metcalf et al. (1994) completed a double-blinded randomised controlled trial on 83 infants with colic, utilizing the criteria according to Wessel et al. (1954). The efficacy of simethicone as a treatment for infantile colic was determined. According to the authors, simethicone is a well absorbed, non-toxic, defoaming agent that is thought to decrease the surface tension of intestinal gas bubbles. The authors explained that the resultant effect of simethicone was that the gas bubbles combined and their passage through the intestine was accelerated

although the volume of the gas remained unaltered. The results of the study revealed that simethicone showed no benefit as a treatment for infantile colic.

2.8 CONCLUSION

The effective treatment and management of infantile colic is necessary even though it is a benign and self-limiting condition because it is very distressing to the parents. There is risk that colic may negatively influence the mother-child interaction beyond three months (Becker et al. 1998) resulting in sleep deprivation of the mother and non-accidental injury of the infant (Gurry 1994). Therefore, the effective management of infantile colic should encompass parental counselling and support.

Although chiropractic management of infants with colic has been demonstrated as significantly better than placebo (P= 0.004 and P= 0.04 respectively) in two randomised controlled trials (Wiberg et al.1999, Mercer 1999: 28), it is not included as a treatment option for infantile colic in literature reviews (Søndergaard 2001 and Lindberg 2000) discussing the management options available to infants.

Rautava et al. (1995) concluded that since the parent-child interaction could still be affected up to 3 years after the occurrence of infantile colic, early intervention to the parent-child interaction was important. The author determined that colic resulted in no serious long-term side effects on the infants other than that they were more likely to display negative behaviour, such as frequent temper tantrums and be described as “emotional” by their mothers.

It is evident that infantile colic is a complex and multi dimensional condition. Although many aspects of the condition are under investigation, no definitive causative mechanism or effective treatment has yet been determined.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 INTRODUCTION

This chapter outlines the basic method of operation used during this study. It includes an overview of the study design, sample selection, inclusion and exclusion criteria, the examination process used, the ethical guidelines employed and the method of statistical analysis chosen.

3.2 STUDY DESIGN

This research project was a blinded quantitative association study with a population size of one hundred infants between the ages of 2 and 10 weeks. Two participating researchers each, in turn, assessed the sample of infants and did not communicate or reveal the outcome of their findings to each other, so as to eliminate the element of bias from the study. The use of the second examiner was to verify and validate the spinal examination findings of the first examiner to make the study more reliable.

Due to the nature of the condition and the sample group, only clinical data was available for collection based purely on clinical findings, as used by Olafsdottir et al. (2001), Mercer (1999: 21), Wiberg et al. (1999) and Klougart et al. (1989) in previous studies. The study entailed assessment of infants and no treatment was administered to infants during the course of the study. The two participating researchers were under the supervision of a qualified chiropractor at all times during each assessment of each infant.

3.3 THE STUDY SAMPLE

The population size comprised of one hundred healthy infants, fifty colicky and fifty non-colicky infants from the greater Durban area (Thomas, 2002). The infants were selected by means of a combination of convenience and snowball sampling and the assessment of the infants stopped when the sample requirements were met (Robert, 2003).

This study was limited to infants from the Province of KwaZulu-Natal. The researcher travelled to government and private primary health care clinics in the greater Durban area, to assess groups of infants while accompanied by a

qualified chiropractor at all times. No restrictions were placed on the participants' sex, ethnic group, socio-economic situation and HIV status. At least one parent (over 18 years of age) was required to accompany the infants if they were to be considered for participation in the study, as informed consent was required.

The researchers obtained permission to conduct the research study at the government primary health clinics in the inner west region from the heads of the department governing the Durban inner west region (Mrs Harold, 2002). Meetings were arranged with the nursing sisters to inform them about the study and presentations were completed for both the nursing sisters and groups of parents. An advert was placed in a local community newspaper to inform interested parents about the study. Posters were put up and flyers were made available at the participating clinics.

At each clinic, the nursing sister performed a physical examination (Wiberg et al. 1999) as part of the normal clinic routine. The participating infants, who met the inclusion criteria, were assessed for signs of infantile colic. The parents were consulted for the necessary information. The minimum criteria required for the diagnosis of infantile colic (See 3.3.1.1) were used as a guideline in the diagnostic process. The researchers were blinded from the grouping process in the study.

The inclusion and exclusion criteria adhered to in the study were as follows:

3.3.1 THE INCLUSION CRITERIA

- The infant had to be between 2 weeks and 10 weeks of age (Wiberg et al. 1999).
- The infant had to have normal weight gain (Wiberg et al. 1999).
- The infant had to be alert and healthy with no history of previous or existing illness to exclude any underlying organic problem (Wiberg et al. 1999).
- Infants who presented with mild conditions [e.g. rhinitis, constipation or mild diarrhoea] were permitted to participate in the study (Merenstein et al. 1994: 163, 584, 575).
- Infants suspected of having colic had to conform to the clinical diagnosis of infantile colic (Wiberg et al. 1999).

The participating infants were assessed for infantile colic. The minimum criteria that were required for the diagnosis of infantile colic were as follows:

3.3.1.1 The criteria that governed the diagnosis of infantile colic:

- The infant could not show symptoms that could be a sign of any disease other than infantile colic (Wiberg et al. 1999).

- The infant had to have 1 or more violent spell of crying per day (Wiberg et al. 1999).
- These crying spells were to be at least 3 hours long per day and had to have been present on at least 5 of the 7 previous days (Wiberg et al. 1999).
- Apart from the attacks of infantile colic, the infant had to show normal behaviour (Wiberg et al. 1999).
- The infant had to show typical colic behaviour during the crying spells:
    - Often flexing knees and hips against the abdomen
    - Extending the trunk, neck and extremities (Wiberg et al. 1999).
- During the attacks the infants could not (or only temporarily) be comforted by:
    - Being picked up
    - Walked
    - Cradled
    - Change of diaper
    - Being offered a dummy (Wiberg et al. 1999).

3.3.2 THE EXCLUSION CRITERIA

- Infants with a history of previous or existing episodes of the following were excluded from the study (Roos 2001):
    - Pyrexia
    - Projectile vomiting
    - Passing of melena stools or
    - Passing of occult stools.
- Infants who were brought to the clinics by under aged parents (below 18 years of age) were not included in the study.
- Infants who were brought to the clinics by guardians were not included in the study.
- The infant with the following conditions were excluded from the study:
    - Chromosomal abnormalities (Beers and Berkow 1999: 2232-2233), including:
        - Down's syndrome
    - Birth defects (Beers and Berkow 1999:2198, 221, 2371, 2222, 2219), including:
        - heart defects
        - gastro-intestinal defects
        - spinal abnormalities
        - hip, leg and foot abnormalities
        - brain and spinal cord defects.
    - Cerebral palsy (Beers and Berkow 1999:2416)
    - Musculoskeletal disorders (Beers and Berkow 1999: 2397 –2413), including:
        - severe torticolis and
        - scoliosis (Beers and Berkow 1999: 2219).
    - Inflammatory diseases (Beers and Berkow 1999: 2397 – 2402) and
    - Mental retardation (Beers and Berkow 1999: 2259 – 2264).
    - Infections, including:

        - Pneumonia (Beers and Berkow 1999: 601-616)
        - Tuberculosis (Beers and Berkow 1999: 1193-1204)
        - Meningitis (Beers and Berkow 1999: 1352)
        - Encephalitis (Beers and Berkow 1999:1437-1439)
        - Congenital rhubella (Beers and Berkow 1999: 2327)
        - Hepatitis (Beers and Berkow 1999: 2187 – 2188)
        - Congenital syphilis (Beers and Berkow 1999: 2191 -2193)
        - Acute infectious diarrhoea (Beers and Berkow 1999: 2308)
        - Polio (Beers and Berkow 1999: 2341 – 2343)
        - Mumps (Beers and Berkow 1999: 2325)
        - Measles (Beers and Berkow 1999: 2320).
    - Signs of systemic infection (Crain and Gershel 1997: 343-349) including:
        - Chronic fevers (Crain and Gershel 1997: 343, 346)
        - Soft tissue infections (Crain and Gershel 1997: 343, 346)
        - Pneumonia (Crain and Gershel 1997: 347, 349)
        - Diarrhoea and gastroenteritis (Crain and Gershel 1997: 345, 348)
        - Measles (Crain and Gershel 1997: 345, 348, 349)
        - Varicella (Crain and Gershel 1997: 345, 349)
        - Wheezing secondary to HIV Cardiomyopathy (Crain and Gershel 1997: 345, 347) and
        - Persistent respiratory distress (Crain and Gershel 1997: 349).

3.3.3 SUBJECT ALLOCATION

All the healthy infants aged between 2 to 10 weeks, whose parents were interested in participating in the study were included, on condition that the inclusion criteria were fulfilled. Due to the fact that the researchers were blinded from the grouping process, more than one hundred infants were examined in an attempt to reach the target of fifty colicky and fifty non-colicky infants. Once these targets were met, the assessment of the infants was stopped.

At each clinic, the participating infants, who met the inclusion criteria, were assessed for signs of infantile colic. If all of the criteria governing the diagnosis of infantile colic (3.3.1.1) were met, the infants were placed in Group A (the experimental group). If the participating infants did not meet the criteria governing the diagnosis of infantile colic, the infants were placed in Group B (the control group). The grouping of each infant was recorded in Appendix C.

3.3.4 BLINDING PROCEDURE

The researchers were blinded from the grouping procedure by not being notified as to which group the infants were placed in. Appendix C on which the group of the infants was recorded, was not returned to the researchers

until all the infants at the clinic were examined and all the findings of the researchers were recorded.

During the study, a researcher handed out the questionnaires to the parents while explaining the study procedure. On occasion the researcher had to assist parents in completing the questionnaires. The information regarding the diagnosis of infantile colic was not collected until after the assessment of the infant was completed and the findings of the researchers were recorded. This however introduced a researcher bias into the study, as it would have been ideal for an independent observer to distribute the questionnaires and to assist the parents.

Apart from being blinded from the group allocation of the infants, the researchers were blinded from each other's findings. The two participating researchers each, in turn, assessed the sample of infants and did not communicate or reveal the outcome of their findings to each other, so as to eliminate the element of bias from the study.

3.4 EHTICAL CONSIDERATIONS

The methodological approach of the study was structured around the ethical considerations of the participants. The Durban Institute of Technology's ethical guidelines were used to ensure that the correct ethical conduct was employed.

The following guidelines were implemented throughout the study to ensure that the highest ethical standard was maintained to protect the participants' interests at all times:

- Parents were notified that participation in the study was voluntary.
- The parents were not subject to coercion for participation in the study.
- Parents were informed that refusing to participate would not result in any adverse or negative consequences.
- To avoid causing the parents difficulty in refusing participation or feeling obliged to participate in this study, the nursing sisters first made mention of the study to the parents whose infants met the inclusion criteria. Only when the parents were interested in participation were the researchers signalled to further explain the purpose of the study to the parents.
- Parents were also informed that they were free to withdraw the infant's participation at any stage without fear of negative consequences.
- It was mentioned that participation was free.
- The parents were notified that all information collected was strictly confidential.
- The participant's rights to privacy were protected, as all the information collected was kept confidential. It was made clear that no personal identifiable information would be published.

- The demographic data collected during the study was displayed in table form and was evaluated for trends and no personal details were revealed at any time.
- The researchers did not divulge any personal identifiable information collected to anyone, for any purpose.
- The information collected during the study was placed in storage in a manner that prohibited anyone from gaining access to it.
- The infants suffering from infantile colic were offered four free treatments at the Chiropractic Day Clinic. The supervised treatments were offered over a two-week period.
- The data will be kept at a safe location, at the Chiropractic Day Clinic after completion of the study, for a period of 5 years and thereafter will be shredded.

3.5 THE DATA

The data collected in this study consisted only of primary data, comprised of demographic and objective data.

3.5.1 PRIMARY DATA

Due to the nature of infantile colic, and the fact that the study was conducted on infants, the data collected in the study, was based purely on clinical findings, as used by Olafsdottir et al. (2001), Mercer (1999: 21), Wiberg et al. (1999) and Klougart et al. (1989). The clinical findings were recorded as objective data, based only on the researchers' examination.

3.5.1.1 Demographic Data

Parents were required to answer questions (Appendix C) that were aimed at contributing to the demographic data for the study. The questions were structured in such a way as to extract simple, unambiguous information from the parents. The data collected is displayed in table form and was evaluated for trends in infantile colic to compare with the results of previous studies (Olafsdottir et al. 2001, Mercer 1999: 26, Wiberg et al. 1999 and Klougart et al. 1989). The data retrieved will also contribute epidemiological information towards the statistics on infantile colic in South Africa.

3.5.1.2 Objective Data

The aim of the study was to analyse the data collected to determine if spinal joint dysfunctions are associated with infantile colic and to determine the locations with high prevalence of spinal joint dysfunction in colicky infants as compared to non-colicky infants. The findings were also used to further determine common locations of spinal joint dysfunctions in infants suffering from infantile colic, as compared to previously completed studies (Olafsdottir et al. 2001, Mercer 1999: 26, Wiberg et al. 1999 and Klougart et al. 1989).

This information was statistically analysed and the results were displayed in table and graph form.

3.5.2 SECONDARY DATA

The secondary data was obtained from journal articles, textbooks, the Internet and any literature relating to infantile colic. The data included the prevalence aetiology, clinical features, impact of the infantile colic, differential diagnoses and the management of the condition.

3.6 THE METHODOLOGY

According to Hass (1991), a diagnosis is normally based on the weight of evidence gathered from the outcomes of multiple diagnostic test regimens that closely resemble the clinical setting. It was for this reason that observation, static and motion palpation were included in the assessment, to increase the likelihood of making an accurate diagnosis of a spinal joint dysfunction.

3.6.1 SPINAL JOINT DYSFUNCTION ASSESSMENT

The participating infants, in both Group A and B, received a single assessment by each of the blinded researchers who were unaware of the infants' grouping, thereby eliminating bias from the assessment. The assessments included a physical examination of the spine and pelvis to detect the presence of spinal joint dysfunctions. The spinal joint dysfunctions were either noted a being present or absent, with the resultant data being recorded in "1's" and "0's", respectively.

A spinal joint dysfunction according to Gatterman (1990: 408) is the lack of movement of a joint, caused by muscular spasm or an intra-articular blocking. The author further explained that the gastrointestinal system is influenced by the autonomic nervous system and spinal joint dysfunctions have shown to have a strong segmental relationship in cases of visceral pathophysiology. Correction of these spinal joint dysfunctions is said to normalize neurogenic function and promote the healing process (Gatterman 1990:381). From this clinical observation, Wiberg et al. (1999) cited spinal joint dysfunctions to cause symptoms similar to those in infantile colic. Appendix D was drawn from the assessment described below and its purpose was for recording the clinical findings during the assessment of the infants.

3.6.1.1 Observation:

The infant was placed supine on the examination table or on parent's lap and inspected for any of the following signs of spinal joint dysfunction:

- **Cervical spine:**
  - Deviation of the head towards the left or right (Stierwait pp*: 5) or tilting of the head may indicate spinal joint dysfunction on the ipsilateral side (Anrig and Plaugher 1998: 344).

- **Lumbar spine and pelvis**:
  - Asymmetry of posterior superior iliac spine level (Stierwalt pp: 5)*.

Included in the observation section of Appendix D, the researchers were also required to take note of muscle spasms in specific muscle groups of the cervical (posterior cervical, sterno-cleid mastoid), thoracic (erector spinae) and lumbar spine (quadratus lumborum). The researchers were required to take note of the involvement of the muscle groups both visually and by palpation. Visual observation of the muscles in the cervical area, namely the posterior cervical and sterno-cleido mastoid muscles was not possible, so palpation of the muscles was sufficient.

3.6.1.2 Static Palpation:

Static palpation is defined by Bergmann (1993: 762) as, "palpatory diagnosis of somatic structures in a neutral static position". The examiners used the distal aspect of the first digit or fifth digit to palpate the entire length of the infants' spine and pelvis. Static palpation was used to establish anatomical landmarks as a baseline for the spinal assessment (Anrig and Plaugher 1998: 140) and to locate any signs of spinal joint dysfunction.

Throughout the static palpation examination, the researchers noted unusual alignment or rigidity (noted as A) of the vertebral levels palpated, spasm (noted as S) of the muscles over the involved vertebral levels palpated and tenderness (noted as T) elicited by the infants when light pressure was applied during the examination process.

In the examination of the cervical spine, the researchers noted the side and level of the spinal joint dysfunctions, as well as the muscles that were involved. The researchers noted the side at which the spinal joint dysfunctions occurred in order to compare the findings to the head position involvement.

* Stierwalt DD. Adjusting the child. Distributed by: The Copy Shop, 628 Harrison Street, Davenport, Iowa 52803, pp1, 2, 5-9, 36-55 pp. No further information is known about this reference.

In the thoracic and lumbar spine, the researchers noted the levels of the spinal joint dysfunctions, as well as the muscles that were involved. The reason for this was that the researchers required only to determine the levels at which the spinal joint dysfunctions commonly occurred.

The infant was placed in the prone position on the examiner's, or parent's lap for palpation of the spine and pelvis (Anrig and Plaugher 1998: 140).

The following signs of spinal joint dysfunction were noted:

- **Cervical, Thoracic and Lumbar spine:**
    - Unusual alignment (Anrig and Plaugher 1998: 140).
    - Muscular spasm or asymmetric muscle bulging (Anrig and Plaugher 1998: 140, 332, 344, 362).
    - Tenderness of spinous processes or musculature (Anrig and Plaugher 1998: 373, 362) noted by infant's reaction to palpation with a light amount of pressure (Anrig and Plaugher 1998: 387).

- **Sacro-iliac joints**:
    - Asymmetry of posterior superior iliac spine level (Anrig and Plaugher 1998: 140).
    - Tenderness along the length of the sacro-iliac joint or around the posterior superior iliac spine (noted by infant's reaction to palpation with a light amount of pressure) (Anrig and Plaugher 1998: 387).

3.6.1.3 Motion Palpation:

Motion palpation is defined by Bergmann (1993: 762) as, "palpatory diagnosis of passive and active segmental joint range of motion". The examiners used passive motion palpation to evaluate segmental range of motion and accessory joint motion bilaterally (right then left) in the infant's spine and sacro-iliac joints (Anrig and Plaugher 1998: 148). Any degree of restricted or aberrant movement of the joint was recorded as a sign of spinal joint dysfunction (Anrig and Plaugher 1998: 148).

In the examination of the cervical spine, the researchers noted the side and level of the spinal joint dysfunctions, as well as the muscles that were involved. The researchers noted the side at which the spinal joint dysfunctions occurred in order to compare the findings to the head position involvement.

In the thoracic and lumbar spine, the researchers only noted the levels of the spinal joint dysfunctions, as well as the muscles that were involved. The reason for this was that the researchers required only to determine the levels at which the spinal joint dysfunctions commonly occurred.

Cervical spine:

- The infant was placed supine or in a supported seated position on the parent's lap with the parent helping to stabilize the infant by gently supporting the chest (Anrig and Plaugher 1998: 140).

- The examiner's indifferent hand stabilized the infant's head and introduced motion in:
    - right and left lateral flexion, noting whether there was relaxation of the soft tissue on the ipsilateral side (Anrig and Plaugher 1998: 353),
    - right and left rotation (Anrig and Plaugher 1998: 344) and in
    - flexion and extension (Anrig and Plaugher 1998: 352).
- The first digit of the contact hand contacted:
    - the transverse process to access rotation and lateral flexion and
    - the spinous process to assess flexion and extension.

Thoracic spine: (Anrig and Plaugher 1998: 362-363)

- The infant was placed prone on the parent's lap.
- The first digit of the contact hand contacted the spinous process to assess:
    - the anterior glide of the spinous process on extension and
    - the posterior glide on flexion.
- The examiner's indifferent hand:
    - stabilized the infant and introduce motion in flexion and extension.
- Anrig and Plaugher (1998: 363) do not recommend motion palpation in rotation and lateral flexion for infants in the thoracic and lumbar regions.

Lumbar spine: (Anrig and Plaugher 1998: 373)

- The infant was placed prone across the parent's lap.
- The first digit of the contact hand contacted the spinous process to assess:
    - the anterior glide of the spinous process on extension and
    - the posterior glide on flexion.
- The examiner's indifferent hand raised and lowered the legs to introduce flexion and extension motion.

Sacro-iliac joints: (Anrig and Plaugher 1998: 387)

- The infant was placed prone across the parent's lap.
- The first digit of the contact hand contacted:
    - the superior medial aspect of the posterior superior iliac spine.
    - the examiner's indifferent hand raised and lowered the leg on the ipsilateral side to assess flexion and extension of the sacroiliac joint bilaterally.
- The examiner then placed the first digit on (Anrig and Plaugher 1998: 148):
    - the sacral tubercle to use as a reference point and
    - the thumb on the ipsilateral superior medial aspect of the posterior superior iliac spine.
    - The examiner's indifferent hand raised and lowered the leg on the ipsilateral side to assess flexion and extension of the sacroiliac joint bilaterally.

The common levels of spinal joint dysfunctions noted were compared with the findings of Mercer (1999: 40) and Klougart et al. (1989), which were the upper cervical and the mid-thoracic regions or Wiberg et al. s' (1999) findings, which were the upper and mid-thoracic regions, to either confirm or dispute them. Stierwalt* (pp: 2, 5) cited that these areas were of prime interest due to their location in the high stress areas of the spine and their influence on the sympathetic (motor) nerve supply to the gut.

3.7 STATISTICAL ANALYSIS

The Durban Institute of Technology's statistician was consulted on the statistical analysis of the data (Robert, 2003). All the data was captured onto a spreadsheet and the SPSS © software package, version 9.0 was used for statistical analysis (SPSS Inc., 444N Michigan Ave, Chicago, Illinois, 60611, USA). The data was statistically analysed and the results are displayed in table and graph form. The null hypothesis was rejected at the $\alpha = 0.05$ level of significance if $p < \alpha$ where p was the probability of H_0 being true.

3.7.1 OBJECTIVE ONE

3.7.1.1 CHI SQUARE TEST

The statistical analysis included the use of the χ^2 test to determine whether there is a relationship between the infants with spinal joint dysfunctions and the infants with colic (Fisher and van Belle: 219). The Critical Value given was 3.84 for the $\alpha = 0.05$ level of significance, calculated at 1 degree of freedom. The p-value was used for decision-making. When the p-value is less than α, the level of significance, we reject the null hypothesis (Thomas, 2002).

Hypothesis Testing

- **H_0:** There is no association between spinal joint dysfunctions and infantile colic.
- **H_1:** There is an association between spinal joint dysfunctions and infantile colic.
- $\alpha = 0.05$ = level of significance.

* Stierwalt DD. Adjusting the child. Distributed by: The Copy Shop, 628 Harrison Street, Davenport, Iowa 52803, pp1, 2, 5-9, 36-55 pp. No further information is known about this reference.

- If χ^2 is ≤ 3.84 (1 df, α = 0.05), we fail to reject H_0.

- If χ^2 is > 3.84 (1 df, α = 0.05), we reject H_0.

Decision rule:

If p ≥ α, at α level of significance, we fail to reject H_0.

If p < α, at α level of significance, we reject H_0.

3.7.1.2 CRAMÉR'S V MEASURE OF ASSOCIATION

The Cramér's V was used to measure the association between the findings of examiner 1 and examiner 2, hence constituted an inter-examiner reliability test. They are used on dichotomous categorical data and are a measure of association based on chi-square (Robert, 2003). In contingency tables of 2 x 2, Cramer's V and Phillip's Phi generate the same result of association.

The achieved value of Cramer's V ranges from zero to 1, with zero indicating no association between the examiners findings and a value close to 1 indicating a high degree of association between the examiners findings (Fisher and van Belle: 278). The p-value was used for decision-making. When the p-value is less than α, the level of significance, we reject the null hypothesis.

Hypothesis Testing

- **H_0:** There is an association between examiner 1 and examiner 2.

- **H_1:** There is no association between examiner 1 and examiner 2.

- α = 0.05 = level of significance.

Decision rule:

If p ≥α, at α level of significance, we fail to reject H_0.

If p < α, at α level of significance, we reject H_0.

3.7.2 OBJECTIVE TWO

3.7.2.1 BINOMIAL TEST USING TWO PROPORTIONS

A) INTRA GROUP ANALYSIS

The binomial test (using two proportions) was used to compare the occurrence of spinal joint dysfunctions between locations within a group. The results of the two examiners were pooled to even out the results by creating a larger sample size. All tests were carried out at a 5% level of significance and p-values were used for decision-making.

Hypothesis Testing

- **H_0**: The population proportion at location 2 is equal to the population proportion at location 1. $\pi_1 = \pi_2$

- **H_1**: The population proportion is higher at location 2 as opposed to location 1. $\pi_1 < \pi_2$

Where π_1, π_2 equal the population proportion of successes from population 1 and population 2 respectively, where success is indicated by a spinal joint dysfunction.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject H_0.

If $p < \alpha$, at the α level of significance, we reject H_0.

B) INTER GROUP ANALYSIS

The binomial test (using two proportions) was used to compare the occurrence of spinal joint dysfunctions between locations between groups. The locations included: C0-C2, C2-C4, C4-C6, C6-T1, T1-T5, T5-T9, T9-L1, L1-L3, L3-L5 and the sacro-iliac joints. The results of the two examiners were pooled to even out the results by creating a larger sample size. All tests were carried out at a 5% level of significance and p-values were used for decision-making. The tests are two tailed.

- **H_0**: The population proportion at location 2 in group 1 is equal to the population proportion at location 2 in group 2. $\pi_1 = \pi_2$

- **H_1**: The population proportion is higher at location 2 in group 1 as opposed to location 2 in group 2. $\pi_1 < \pi_2$

Where π_1, π_2 equal the population proportion of successes from population 1 and population 2 respectively, where success is indicated by a spinal joint dysfunction.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject H_0.

If $p < \alpha$, at the α level of significance, we reject H_0.

3.8 SUMMARY

The population size comprised of one hundred healthy infants, fifty colicky and fifty non-colicky infants that were selected by means of a combination of convenience sampling and snowball sampling. The infants with infantile colic were placed in the experimental Group A, and the non-colicky infants were placed in the control Group B. Each infant was assessed, in terms of the researchers' objective clinical findings and the necessary data was obtained for statistical analysis.

CHAPTER FOUR

4.0 THE RESULTS

4.1 INTRODUCTION

This chapter presents the statistical analysis of the data collected in the study. The data included is comprised of demographic data and the researchers' objective data.

Due to the nature of infantile colic, and the fact that the study was conducted on infants, the data collected in the study was based purely on clinical findings, as used by Olafsdottir et al. (2001), Mercer (1999: 21), Wiberg et al. (1999) and Klougart et al. (1989) in previous studies. The clinical findings were recorded as objective data, based only on the researchers' findings. The experimental group (Group A) refers to the group of infants with infantile colic and the control group (Group B) refers to the group of infants without infantile colic.

4.2 HYPOTHESES

4.2.1 OBJECTIVE ONE

4.2.1.1 Chi Squared Test

The statistical analysis included the use of the χ^2 test to determine whether there is a relationship between the infants with spinal joint dysfunctions and the infants with colic (Fisher and van Belle: 219). Using a population size of 100 infants (50 colicky and 50 non-colicky) and a contingency table constructed for the variables being tested: spinal joint dysfunction, no spinal joint dysfunction, colic, no colic. The Critical Value given was 3.84 for the α = 0.05 level of significance for the calculated 1 degree of freedom. After classification into the two categories, it was then determined if there was a significant association between the existence of spinal joint dysfunctions and the occurrence of infantile colic. If the Test Statistical Value calculated for chi-squared is greater than 3.84 (1 degree of freedom) at the α = 0.05 level of significance, we will have sufficient evidence to reject the hypothesis of

independence hence determining that infantile colic and spinal joint dysfunction are dependent (Robert, 2003). The p-value will be used for decision-making.

If $p \geq \alpha = 0.05$, at the α level of significance, we fail to reject H_0 and therefore we have insufficient evidence to reject the hypothesis of independence, hence determining that infantile colic and spinal joint dysfunction are not associated. If $p < \alpha = 0.05$, at the α level of significance, we reject H_0 and therefore we have sufficient evidence to reject the hypothesis of independence, hence determining that infantile colic and spinal joint dysfunction are associated.

$$\chi^2 = \sum_{i-1}^{r} \sum_{j-1}^{c} \left(\frac{Oij - \mathrm{E}ij}{\mathrm{E}ij} \right)^2$$

Where:
Oij = Observed frequency in the i-th row, j-th column
Eij = Expected frequency in the i-th row, j-th column
r = number or rows
c = number of columns
Degrees of freedom (df), where df = (r - 1)(c - 1)

The Null Hypothesis (H_0) states that, in the general population of infants, there is no association between spinal joint dysfunctions and infantile colic.

Alternate Hypothesis (H_1) states that, in the general population of infants, there is an association between spinal joint dysfunctions and infantile colic.

- **H_0**: There is no association between spinal joint dysfunctions and infantile colic.
- **H_1**: There is an association between spinal joint dysfunctions and infantile colic.
- α = 0.05 = level of significance.
- If χ^2 is ≤ 3.84 (1 df, α = 0.05), we fail to reject H_0.
- If χ^2 is > 3.84 (1 df, α = 0.05), we reject H_0.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject H_0.

If $p < \alpha$, at the α level of significance, we reject H_0.

4.2.1.2 Cramer's V Measure Of Association

The Cramér's V was used to measure the association between the findings of examiner 1 and examiner 2, hence constituting an inter-examiner reliability test. They are used on dichotomous categorical data and are a measure of association based on chi-square (Robert, 2003).

In contingency tables of 2 x 2, Cramer's V and Phillip's Phi generate the same value because in the Cramer's V equation, the value of [minimum (r-1)(c-1)] will always be 1. Therefore in this analysis Cramer's V and Phillip's Phi generate the same result of association.

The achieved value of Cramer's V ranges from zero to 1, with zero indicating no association between the examiners' findings and a value close to 1 indicating a high degree of association between the examiners findings. Cramer's V can attain a value of 1 and 0 for tables of any dimension (Fisher and van Belle: 278). The p-value will be used for decision-making.

$$V = \sqrt{\frac{\frac{\chi^2}{n}}{\min(r-1)(c-1)}} \qquad \Phi = \sqrt{\frac{\chi^2}{n}}$$

where:
r = number or rows
c = number of columns
χ^2 *= chi squared statistic*

- **H_0:** There is no association in the data recorded by examiner 1 and examiner 2.
- **H_1:** There is an association in the data recorded by examiner 1 and examiner 2.
- α = 0.05 = level of significance.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject H_0.

If $p < \alpha$, at the α level of significance, we reject H_0.

4.2.2 OBJECTIVE TWO

4.2.2.1 Binomial Test Using Two Proportions

A) Intra Group Comparison

Statistical analysis of the occurrence data involved the use of the binomial test (using two proportions) to perform a comparison of the occurrence of spinal joint dysfunction between locations within the same group. Thus the data in Group A and Group B was tested separately. The comparison between the locations in the intra group analysis was conducted within each group to determine which location had a significant occurrence of spinal joint dysfunctions as compared to other locations. The binomial tests for intra group comparison were only conducted at locations within the defined areas of the spine. The results of the two examiners were pooled to even out the results by creating a larger sample size. All tests were carried out at a 5% level of significance and p-values were used for decision-making.

4.2.2.1.1 BINOMIAL TEST USING TWO PROPORTIONS FOR INTRA GROUP ANALYSIS.

The binomial test (using two proportions) was used to compare the occurrence of spinal joint dysfunctions between locations within a group for intra group analysis. The occurrence data collected by examiner 1 and 2 was put in spread sheet form by the location. The locations included: C0-C2, C2-C4, C4-C6, C6-T1, T1-T5, T5-T9, T9-L1, L1-L3, L3-L5 and the sacro-iliac joints. The test is one tailed.

The Null Hypothesis (H_0) states that the population proportion at location 2 is equal to the population proportion at location 1.

Alternate Hypothesis (H_1) states that the population proportion is higher at location 2 as opposed to location 1.

The test statistic is:

$$Z = \frac{(p_1 - p_2) - (\pi_1 - \pi_2)}{\sqrt{\hat{\pi}(1-\hat{\pi})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

where $\hat{\pi} = \frac{(x_1 + x_2)}{(n_1 + n_2)}$

where:
p_1 and p_2 = proportions 1 and 2, respectively.
n_1 and n_2 = sample totals 1 and 2, respectively.
x_1 and x_2 = location totals 1 and 2, respectively.

- **H_0**: The population proportion at location 2 is equal to the population proportion at location 1. $\pi_1 = \pi_2$
- **H_1**: The population proportion is higher at location 2 as opposed to location 1. $\pi_1 < \pi_2$
- $\alpha = 0.05$ = level of significance.

Where π_1, π_2 equal the population proportion of successes from population 1 and population 2 respectively, where success is indicated by a spinal joint dysfunction.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject H_0.

If $p < \alpha$, at the α level of significance, we reject H_0.

B) Inter Group Comparison

Statistical analysis of the occurrence data involved the use of the binomial test (using two proportions) to perform a comparison of the occurrence of spinal joint dysfunction between parallel locations between groups. Therefore, parallel locations in Group A (colic) and Group B (non-colic) were compared. An example of the comparison of parallel locations between groups would be as follows: C0-C2 of Group A would be compared to C0-C2 of Group B. The comparison between parallel locations in the inter group analysis was conducted between groups to determine which group had a location with the significant occurrence of spinal joint dysfunctions. Thus determining if the occurrence of infantile colic in infants influenced the occurrence of spinal joint dysfunctions. The binomial tests for inter group comparison were only conducted at locations within the defined areas of the spine. The results of the two examiners were pooled to even out the results by creating a larger sample size. All tests were carried out at a 5% level of significance and p-values were used for decision-making.

4.2.2.1.2 BINOMIAL TEST USING TWO PROPORTIONS FOR INTER GROUP ANALYSIS.

The binomial test (using two proportions) was used to compare the occurrence of spinal joint dysfunctions between locations between groups for inter group analysis. The occurrence data collected by examiner 1 and 2 was put in spread sheet form by the location. The locations included: C0-C2, C2-C4, C4-C6, C6-T1, T1-T5, T5-T9, T9-L1, L1-L3, L3-L5 and the sacro-iliac joints. The test is one tailed.

The Null Hypothesis (H_0) states that the population proportion at location 2 in group 1 is equal to the population proportion at location 2 in group 2.

Alternate Hypothesis (H_1) states that the population proportion is higher at location 2 in group 1 as opposed to location 2 in group 2.

The test statistic is:

$$Z = \frac{(p_1 - p_2) - (\pi_1 - \pi_2)}{\sqrt{\hat{\pi}(1-\hat{\pi})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

where $\hat{\pi} = \frac{(x_1 + x_2)}{(n_1 + n_2)}$

where:
p_1 and p_2 = proportions 1 and 2, respectively.
n_1 and n_2 = sample totals 1 and 2, respectively.
x_1 and x_2 = location totals 1 and 2, respectively.

- **H_0**: The population proportion at location 2 in group 1 is equal to the population proportion at location 2 in group 2. $\pi_1 = \pi_2$
- **H_1**: The population proportion is higher at location 2 in group 1 as opposed to location 2 in group 2. $\pi_1 < \pi_2$
- $\alpha = 0.05$ = level of significance.

Where π_1, π_2 equal the population proportion of successes from population 1 and population 2 respectively, where success is indicated by a spinal joint dysfunction.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject $H_{0.}$

If $p < \alpha$, at the α level of significance, we reject $H_{0.}$

4.3 DEMOGRAPHIC DATA

The demographic data collected from the mothers was extracted in questionnaire form. The data was captured on spreadsheets and then further evaluated for trends. The demographic data has been displayed in tabular form.

4.3.1 ETHNIC DISTRIBUTION

Table 4. 1 *The Ethnic Distribution of Group A and B.*

ETHNIC DISTRIBUTION	NUMBER OF INFANTS IN GROUP A	NUMBER OF INFANTS IN GROUP B	OVERALL / PERCENTAGE
BLACK	32	32	64 (64%)
COLOURED	0	1	1 (1%)
INDIAN	2	5	7 (7%)
WHITE	16	12	28 (28%)

In the ethnic distribution of the study population, the largest group of participating infants were black infants (64%) and the smallest group of infants were from the coloured population (1%). The table above also illustrates that infantile colic is equally common in all the participating ethnic groups, when comparing the ratios between groups.

4.3.2 AGE DISTRIBUTION OF THE INFANTS

The average age of the participating infants in the study was 46 days for the experimental group (Group A) and 49 days for the control group (Group B). The minimum age of participating infants in the experimental and control group was 14 days while the maximum age included was 70 days.

The youngest age group of infants ranged between 14 and 21 days and included 13% of the study population. The oldest age group of infants ranged

between 64 and 70 days and included 30% of the study population. All the data is illustrated in table 4.2, below.

Table 4. 2 The *Age Distribution of the Infants in Group A and B.*

AGE INTERVALS (DAYS)	NUMBER OF INFANTS IN GROUP A	NUMBER OF INFANTS IN GROUP B	OVERALL / PERCENTAGE
14-21	5	8	13 (13%)
22-28	5	8	13 (13%)
29-35	5	1	6 (6%)
36-42	9	3	12 (12%)
43-49	3	1	4 (4%)
50-56	8	4	12 (12%)
57-63	5	5	10 (10%)
64-70	10	20	30 (30%)
AVERAGE AGE	46.38 days	49.46 days	N/A
MINIMUM AGE	14 days	14 days	N/A
MAXIMUM AGE	70 days	70 days	N/A

4.3.3 GENDER DISTRIBUTION OF THE INFANTS

Table 4. 3 *The Gender Distribution of the Infants in Group A and B.*

GENDER	NUMBER OF INFANTS IN GROUP A	NUMBER OF INFANTS IN GROUP B	OVERALL / PERCENTAGE
FEMALE	22	29	51 (51%)
MALE	28	21	49 (49%)

The gender distribution of the infants in the study was 51% female and 49% male. The gender ratios in the experimental group are 22 females and 28 males while the control group included 29 females and 21 males.

4.3.4 TYPE OF BIRTH

Table 4. 4 *The Distribution of the Type of Birth in Group A and B.*

TYPE OF BIRTH	NUMBER OF INFANTS IN GROUP A	NUMBER OF INFANTS IN GROUP B	OVERALL / PERCENTAGE
CAESAR	17	20	37 (37%)
NATURAL	33	30	63 (63%)

The majority of the participating infants in the study were born by natural birth (63%) while the remaining infants (37%) were born by caesarean section. The comparison of natural birth and caesarean section in the experimental (17 and 33) and control group (20 and 30) revealed that nearly a third of the infants were born by caesarean section in both groups.

4.3.4.1 Incidence of Caesarean Birth vs. Ethnic Distribution

Table 4. 5 *The Incidence of Caesarean Section vs. Ethnic Distribution in Group A and B.*

ETHNIC DISTRIBUTION	CAESARS IN GROUP A	CAESARS IN GROUP B	OVERALL / PERCENTAGE
BLACK	11	11	22 (22%)
COLOURED	0	0	0 (0%)
INDIAN	0	1	1 (1%)
WHITE	6	8	14 (14%)
TOTALS	17	20	37 (37%)

In the comparison of the ethnic distribution and the number of caesarean sections, it was noted that there was no notable difference in the number of caesarean births in the groups.

The black participating infants, in both the experimental (11) and control group (11) accounted for the largest group of infants (22%) born by caesarean section. The white infants were the second largest group accounting for the 37% of the infants born by means of caesarean section where the experimental (6) and control group (8) revealed no notable differences. There were not sufficient infants from the coloured and Indian populations participating to contribute to the data.

4.3.4.2 Incidence of Natural Birth vs. Ethnic Distribution

In the comparison of the ethnic distribution and the number of natural births, it was noted that there was no notable difference in the number of natural births in the groups.

Table 4. 6 *The Incidence of Natural Birth vs. Ethnic Distribution in Group A and B.*

ETHNIC DISTRIBUTION	NATURAL IN GROUP A	NATURAL IN GROUP B	OVERALL / PERCENTAGE
BLACK	21	21	42 (42%)
COLOURED	0	1	1 (1%)
INDIAN	2	4	6 (6%)
WHITE	10	4	14 (14%)
TOTALS	33	30	63 (63%)

The black participating infants, in both the experimental (21) and control group (21) accounted for the largest group of infants (42%) born by natural birth. Of the total number (63%) of the infants born by means of natural birth, the white infants were the second largest group and the experimental (10) and control group (4) revealed the only notable difference (6).

The group of participating Indian infants accounted for 6% of the natural births and also revealed no notable difference between the experimental group (2) and the control group (4). There were not sufficient infants from the coloured populations participating to contribute to the data.

4.3.5 METHOD OF FEEDING

Table 4. 7 *The Method of Feeding in Group A and B.*

METHOD OF FEEDING	NUMBER OF INFANTS IN GROUP A	NUMBER OF INFANTS IN GROUP B	OVERALL / PERCENTAGE
BREAST	28	27	55 (55%)
FORMULA	11	10	21 (21%)
BOTH	11	13	24 (24%)

In comparison of the experimental and control group for the method of feeding, no notable differences were revealed. The breast fed infants accounted for the largest group of infants (55%), while the formula fed infants (21%) and the infants being both, breast and formula fed (24%) accounted for the remaining groups of infants.

4.3.5.1 Incidence of Breast Feeding vs. Ethnic Distribution

Table 4. 8 *The Incidence of Breast Feeding vs. Ethnic Distribution in Group A and B.*

ETHNIC DISTRIBUTION	BREAST FEEDING IN GROUP A	BREAST FEEDING IN GROUP B	OVERALL / PERCENTAGE
BLACK	18	20	38 (38%)
COLOURED	0	1	1 (1%)
INDIAN	1	2	3 (3%)
WHITE	9	4	13 (13%)
TOTALS	28	27	55 (55%)

In the comparison of the number of breast fed infants and the ethnic distribution, there were no notable differences between groups. The group of black infants accounted for the largest group of infants (38%) and the white infants formed the second largest group (13%). The Indian (3%) and coloured (1%) infants formed the remaining groups of infants.

4.3.5.2 Incidence of Formula Feeding vs. Ethnic Distribution

Table 4. 9 *The Incidence of Formula Feeding vs. Ethnic Distribution in Group A and B.*

ETHNIC DISTRIBUTION	FORMULA FEEDING IN GROUP A	FORMULA FEEDING IN GROUP B	OVERALL / PERCENTAGE
BLACK	6	6	12 (12%)
COLOURED	0	0	0 (0%)
INDIAN	0	2	2 (2%)
WHITE	5	2	7 (7%)
TOTALS	11	10	21 (21%)

In the comparison of the number of formula fed infants and the ethnic distribution, there were no notable differences between groups. The group of black infants accounted for the largest group of infants (12%) and the white infants formed the second largest group (7%). The Indian (2%) infants formed the remaining group of infants.

4.3.5.3 Incidence of Both Breast and Formula Feeding vs. Ethnic Distribution

Table 4. 10 *The Incidence of Breast and Formula Feeding vs. Ethnic Distribution in Group A and B.*

ETHNIC DISTRIBUTION	BREAST AND FORMULA FEEDING IN GROUP A	BREAST AND FORMULA FEEDING IN GROUP B	OVERALL / PERCENTAGE
BLACK	8	6	14 (14%)
COLOURED	0	0	0 (0%)
INDIAN	1	1	2 (2%)
WHITE	2	6	8 (8%)
TOTALS	11	13	24 (24%)

In the comparison of the number of breast and formula fed infants and the ethnic distribution, there were no notable differences between groups. The group of black infants accounted for the largest group of infants (14%) and the white infants formed the second largest group (7%). The Indian (2%) infants formed the remaining group of infants.

4.3.6 MATERNAL AGE

The average age of the mothers (table 4.11) of the participating infants was 25.9 years in the experimental group and 27.4 years in the control group. The youngest group of mothers was aged 18 to 20 years (17%), while the oldest group of mothers was over 35 years and accounted for 4%. The group aged 26-30 years was the largest with 32%, the second largest group was aged 21-25 years with 26% and thirdly followed by 23% from the group aged 31-35 years.

Table 4. 11 *The Distribution of Maternal Age in Group A and B.*

MATERNAL AGE	GROUP A	GROUP B	OVERALL / PERCENTAGE
18-20 YEARS	7	10	17 (17%)
21-25 YEARS	11	15	26 (26%)
26-30 YEARS	19	13	32 (32%)
31-35 YEARS	11	12	23 (23%)
≥35 YEARS	2	2	4 (4%)
AVERAGE AGE	27.4	25.9	N/A
MINIMUM AGE	18	18	N/A
MAXIMUM AGE	40	39	NA/

4.3.6.1 Group A: Maternal Age vs. Ethnic distribution

Table 4. 12 *The Distribution of Maternal Age in Group A vs. Ethnic Distribution.*

MATERNAL AGE	BLACK	COLOURED	INDIAN	WHITE	TOTALS
18-20 YEARS	6	0	1	0	7
21-25 YEARS	9	1	0	1	11
26-30 YEARS	12	0	3	4	19
31-35 YEARS	4	0	1	6	11
≥35 YEARS	1	0	0	1	2
AVERAGE AGE	24	25	27	32	25.9
MINIMUM AGE	18	25	19	24	18
MAXIMUM AGE	39	25	32	40	39

The average age of the mothers in the experimental group was 25.9 years. The youngest mother in the experimental group, to participate in the study was 18 years of age and the oldest mother in this group was 39 years old. The age group of mothers that formed the largest group was 26-30 years, and totalled 19 mothers and the smallest age group of mothers was the group of over 35 years and constituted 2 mothers.

4.3.6.2 Group B: Maternal Age vs. Ethnic distribution

The average age of the mothers in the control group was 27.4 years. The youngest mother in the control group to participate in the study was 18 years of age and the oldest mother in this group was 40 years old. The age group of mothers that formed the largest group was 21–25 years, and totalled 15 mothers and the smallest age group of mothers was the group of over 35 years and constituted 2 mothers. This information is illustrated in table 4.13 below.

Table 4. 13 *The Distribution of Maternal Age in Group B vs. Ethnic Distribution.*

MATERNAL AGE	BLACK	COLOURED	INDIAN	WHITE	TOTALS
18-20 YEARS	10	0	0	0	10
21-25 YEARS	11	0	2	2	15
26-30 YEARS	7	0	0	6	13
31-35 YEARS	6	0	0	6	12
≥35 YEARS	0	0	0	2	2
AVERAGE AGE	24	0	23	30	27.4
MINIMUM AGE	18	0	21	21	18
MAXIMUM AGE	35	0	24	39	40

4.3.7 MATERNAL PARITY

Table 4. 14 *The Distribution of Maternal Parity.*

MATERNAL PARITY	GROUP A	GROUP B	OVERALL / PERCENTAGE
AVERAGE MATERNAL PARITY	1.54	1.72	N/A
1ST CHILD	29	27	56 (56%)
2ND CHILD	17	15	32 (32%)
3RD OR MORE	4	8	12 (12%)
1ST CHILD	58.00%	54.00%	N/A
2ND CHILD	34.00%	30.00%	N/A
3RD OR MORE	8.00%	16.00%	N/A
NUMBER OLDER SIBLINGS	21	23	44 (44%)
PERCENTAGE OLDER SIBLINGS	42.00%	46.00%	N/A
PERCENTAGE FIRST CHILD	58.00%	54.00%	N/A

The average maternal parity in the experimental group was 1.54 compared to 1.72 in the control group. The comparison between the groups for first child revealed no notable differences and was the largest group participating in the study, which totalled at 56%. The number of second and third siblings revealed no notable differences in the comparison between the groups and totalled at 32% and 12%, respectively.

The experimental as well as the control group had a higher percentage of first siblings participating (58% and 54% respectively) as compared to the percentage of participating infants with older siblings (42% and 46% respectively).

4.3.7.1 Group A: Maternal Parity vs. Ethnic distribution

The average maternal parity in the experimental group was lowest in the Indian and white ethnic groups with 1.5 infants and the highest in the black ethnic group with 1.6 infants per mother. The minimum parity noted in all the participating ethnic groups was 1 while the highest parity noted was 5, noted in the black ethnic group. The results are demonstrated below.

Table 4. 15 *Maternal parity vs. Ethnic Distribution for Group A.*

MATERNAL PARITY	BLACK	COLOURED	INDIAN	WHITE	TOTALS
1	19	0	1	9	29
2	10	0	1	6	17
≥3	3	0	0	1	4
AVERAGE MATERNAL PARITY	1.6	0	1.5	1.5	1.54
MINIMUM PARITY	1	0	1	1	1
MAXIMUM PARITY	5	0	2	3	5

4.3.7.2 Group B: Maternal Parity vs. Ethnic distribution

Table 4. 16 *Maternal parity vs. Ethnic Distribution for Group B.*

MATERNAL PARITY	BLACK	COLOURED	INDIAN	WHITE	TOTALS
1	16	1	4	6	27
2	9	0	1	5	15
≥3	7	0	0	1	8
AVERAGE MATERNAL PARITY	1.8	1	1.2	1.7	1.72
MINIMUM PARITY	1	1	1	1	1
MAXIMUM PARITY	5	1	2	4	5

The average maternal parity in the control group was lowest in the coloured ethnic group with 1 infant, followed by the Indian ethnic group with 1.2 infants per mother. The minimum parity noted in all the participating ethnic groups was 1 while the highest parity noted was 5, noted in the black ethnic group.

4.3.8 ONSET AND DURATION OF COLIC

Table 4. 17 *The Distribution of the Age of Onset and Duration of Colic for Group A and B.*

ONSET OF COLIC (DAYS)	INFANTS IN GROUP A
AVERAGE AGE OF ONSET	11.5
MINIMUM AGE	1
MAXIMUM AGE	63
AVE DURATION OF COLIC BEFORE ENTERING THE STUDY	35.48
MINIMUM DURATION	4
MAXIMUM DURATION	69

The average onset of infantile colic in the experimental group was 11.5 days. The minimum observed age at which the infants developed infantile colic was

the first day of life and the oldest infant participating in the study to develop colic was 63 days old. The average duration of infantile colic before the infants entered the study was 35.48 days. The minimum duration of an infant with infantile colic, before being included into the study was 4 days while the oldest infant with colic accepted into the study was 69 days old.

4.3.9 DURATION OF CRYING SPELLS

The average duration of crying spells of infants in the experimental group was 5.75 hours per day, compared to the control group where the average duration of crying per day was noted to be 16 minutes per infant. The average duration per crying spell in the experimental group was 2.06 hours per spell compared to the 7.5 minutes per spell of the infants in the control group.

The minimum duration of crying in the experimental group was 30 minutes as compared to 0 minutes noted in the control group. The maximum duration of crying in the experimental group was 6 hours as compared to 30 minutes noted in the control group. It can be noted that 100% of the infants in the control group cried for less that 30 minutes per crying spell, whereas 99% of the experimental group cried for longer that 30 minutes per spell. The data is illustrated in table 4.18, below.

Table 4. 18 *The Distribution of the Duration of Crying Spells in Group A and B.*

DURATION OF CRYING SPELLS	INFANTS IN GROUP A	INFANTS IN GROUP B	OVERALL / PERCENTAGE
AVERAGE OF THE TOTAL AMOUNT OF CRYING PER DAY	5.75 hours	16 minutes	N/A
AVERAGE DURATION PER SPELL	2.06 hours	7.5 minutes	N/A
< 30 MIN	1	45	46 (46%)
30 MIN	3	5	8 (8%)
1 HOURS	13	0	13 (13%)
2 HOURS	34	0	34 (34%)
3 HOURS	27	0	27 (27%)
4 HOURS	24	0	24 (24%)
≥ 5 HOURS	5	0	5 (5%)
MINIMUM TIME	30 minutes	0	N/A
MAXIMUM TIME	6 hours	30 minutes	N/A

4.3.10 FREQUENCY OF CRYING SPELLS

The average frequency of crying spells in the experimental group was 3.14 times per day as compared to 2.38 times per day in the control group. The minimum frequency of crying noted in the experimental group was once per day as compared to zero time per day in the control group. The maximum frequency of crying per day noted in the experimental group was 10 times per day as compared to 8 times per day in the control group. The experimental group reveal that the majority of infants experienced crying spells between 2 (15%) to 3 (15%) times per day as compared to the control group where the most common frequency of crying spells was twice (20%) per day. The information is illustrated in table 4.19 below.

Table 4. 19 *The Distribution of Crying Spells in Group A and B.*

FREQUENCY OF SPELLS	INFANTS IN GROUP A	INFANTS IN GROUP B	OVERALL / PERCENTAGE
AVERAGE FREQUENCY	3.14	2.38	N/A
0X	0	4	4 (4%)
1X	8	9	17 (17%)
2X	15	20	35 (35%)
3X	15	10	25 (25%)
4X	3	2	5 (5%)
≥4X	9	5	14 (14%)
MINIMUM FREQUENCY	1	0	N/A
MAXIMUM FREQUENCY	10	8	N/A

4.3.11 OCCURRENCE OF DAILY CRYING SPELLS

Table 4. 20 *The Distribution of the Daily Crying Spells.*

PERIOD OF THE DAY	INFANTS IN GROUP A	INFANTS IN GROUP B	OVERALL / PERCENTAGE
MORNING	2	8	10 (10%)
MORNING AND AFTERNOON	1	4	5 (5%)
MORNING AND EVENING	4	3	7 (7%)
AFTERNOON	0	7	7 (7%)
AFTERNOON AND EVENING	6	0	6 (6%)
EVENING	35	25	60 (60%)
ALL DAY	2	2	4 (4%)

The majority of the crying noted in the participating infants occurred in the evening period of the day and totalled at 60%. There was a notable difference noted in the comparison between the groups for the experimental (35) and control (25) group.

4.3.11.1 Percentage Occurrence Of Daily Crying Spells

Table 4. 21 *The Percentage of Daily Crying Spells.*

PERCENTAGE OCCURRENCE OF DAILY CRYING	PERCENTAGE OCCURRENCE IN INFANTS IN GROUP A	PERCENTAGE OCCURRENCE IN INFANTS IN GROUP B	TOTAL / PERCENTAGE
MORNING	4.00%	16.33%	10 (10%)
MORNING AND AFTERNOON	2.00%	8.16%	5 (5%)
MORNING AND EVENING	8.00%	6.12%	7 (7%)
AFTERNOON	0.00%	14.29%	7 (7%)
AFTERNOON AND EVENING	12.00%	0.00%	6 (6%)
EVENING	70.00%	51.02%	60 (60%)
ALL DAY	4.00%	4.08%	4 (4%)

There was a notable difference noted in the comparison between the groups for the experimental (70%) and control (51%) group of infants who cried in the evening period. The second largest group of infants in the control group cried in the morning (16%) as compared to the experimental group, which demonstrated the second largest group with crying in the afternoon and evening (12%).

4.4 ANALYSED DATA

A) OBJECTIVE ONE

The clinical findings of the researchers were recorded as objective data, which was then transferred onto a spreadsheet and statistically analysed. The chi-squared test was used to test for association between occurrence of spinal joint dysfunction in infants and infantile colic. When testing the occurrence of spinal joint dysfunctions and the association with infantile colic, the contingency tables were constructed for the presence or absence of spinal joint dysfunctions in the areas of the spine being tested. As a result, the

contingency tables constructed had 1 degree of freedom, which generated the Critical Value (3.84). The Test Statistic Value was used for the hypothesis testing. The chi-squared tests were completed on the findings of both researchers.

The Cramér's V measure of association was also used on the data to measure the association between the findings of examiner 1 and examiner 2, hence constituting an inter-examiner reliability test. The statistical analysis of the researchers findings therefore determined whether the data recorded was associated. If the results revealed that a significant association occurred, a level of inter-examiner reliability was achieved. The p-value will be used for decision-making.

B) OBJECTIVE TWO

The binomial test (using two proportions) was used to compare the occurrence of spinal joint dysfunctions between locations within a group and between groups. The occurrence data collected by examiner 1 and 2 was put in spread-sheet form by location and pooled to level out the findings of the examiners. The locations included: C0-C2, C2-C4, C4-C6, C6-T1, T1-T5, T5-T9, T9-L1, L1-L3, L3-L5 and the sacro-iliac joints. Comparisons between locations were restricted to their respective areas in the spine for intra group analysis. For inter group analysis, a single parallel location was compared between groups, thus C0-C2 from Group A was compared to C0-C2 from Group B.

4.4.1 OBJECTIVE ONE

4.4.1.1 Chi-squared tests for the cervical spine, thoracic spine, lumbar spine and sacro-iliac joints

The spines of the infants were initially divided into the cervical spine, thoracic spine, lumbar spine and sacro-iliac joints. The chi-squared tests were run on cervical, thoracic, lumbar and sacro-iliac joints of the spine, for each of the researchers' findings to determine if there was a significant association between the occurrence of spinal joint dysfunctions and infantile colic.

If $p \geq \alpha = 0.05$, at the α level of significance, we fail to reject H_0 and therefore we have insufficient evidence to reject the hypothesis of independence, hence determining that infantile colic and spinal joint dysfunction are not associated. If $p < \alpha = 0.05$, at the α level of significance, we reject H_0 and therefore we have sufficient evidence to reject the hypothesis of independence, hence determining that infantile colic and spinal joint dysfunction are associated.

Hypotheses

- **H_0**: There is no association between spinal joint dysfunctions and infantile colic.
- **H_1**: There is an association between spinal joint dysfunctions and infantile colic.
- $\alpha = 0.05$ = level of significance.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject H_0.

If $p < \alpha$, at the α level of significance, we reject H_0.

Table 4. 22 *The contingency table below illustrates the number of spinal joint dysfunctions in the cervical spine (C0-T1), noted by examiner 1.*

EX 1 Cervical Spine (C0-T1)

Observed Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	46	4	50
Group B	26	24	50
	72	28	100

Expected Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	36	14	50
Group B	36	14	50
	72	28	100

Table 4.22 illustrates that examiner 1 found that 92% of the infants in Group A (colic) had the spinal joint dysfunctions, while 52% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 23 *The contingency table below illustrates the number of spinal joint dysfunctions in the cervical spine (C0-T1), noted by examiner 2.*

EX 2 Cervical Spine (C0-T1)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	44	6	50
Group B	23	27	50
	67	33	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	33.5	16.5	50
Group B	33.5	16.5	50
	67	33	100

Table 4.23 illustrates that examiner 2 found that 88% of the infants in Group A (colic) had the spinal joint dysfunctions, while 46% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 24 *The contingency table below illustrates the number of spinal joint dysfunctions in the thoracic spine (T1-L1), noted by examiner 1.*

EX 1 Thoracic Spine (T1-L1)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	38	12	50
Group B	22	28	50
	60	40	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	30	20	50
Group B	30	20	50
	60	40	100

Table 4.24 illustrates that examiner 1 found that 76% of the infants in Group A (colic) had the spinal joint dysfunctions, while 44% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 25 *The contingency table below illustrates the number of spinal joint dysfunctions in the thoracic spine (T1-L1), noted by examiner 2.*

EX 2 Thoracic Spine (T1-L1)

Observed Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	41	9	50
Group B	22	28	50
	63	37	100

Expected Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	31.5	18.5	50
Group B	31.5	18.5	50
	63	37	100

Table 4.25 illustrates that examiner 2 found that 82% of the infants in Group A (colic) had the spinal joint dysfunctions, while 44% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 26 *The table below illustrates chi squared calculated for the occurrence of spinal joint dysfunctions in the cervical (C0-T1) and thoracic (T1-L1) spine (1 degree of freedom, α= 0.05).*

Chi Square calculated for Cervical Spine (C0-T1)

	Chi Square	P-value
EX 1	19.84	0.000008
EX 2	19.95	0.000008

Chi Square calculated for Thoracic Spine (T1-L1)

	Chi Square	P-value
EX 1	10.67	0.001
EX 2	15.49	0.00008

By considering table 4.26 we conclude that there is a significant association between spinal joint dysfunctions in the cervical (C0-T1) and thoracic (T1-L1) spines and infantile colic for both examiners at a 5% level of significance. (C0-T1 = Examiner 1, P-value = 0.000008; Examiner 2, P-value = 0.000008.) (T1-L1 = Examiner 1, P-value = 0.001; Examiner 2, P-value = 0.00008.)

In the cervical spine (C0-T1), we therefore reject the null hypothesis (p-value is < 0.05 at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and

whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.000008) and examiner 2 (p-value= 0.000008), at a 5% level of significance.

In the thoracic spine (T1-L1), we therefore reject the null hypothesis (p-value is < 0.05 at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.001) and examiner 2 (p-value= 0.00008), at a 5% level of significance.

Table 4. 27 *The contingency table below illustrates the number of spinal joint dysfunctions in the lumbar spine (L1-L5), noted by examiner 1.*

EX 1 Lumbar Spine (L1-L5)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	24	26	50
Group B	8	42	50
	32	68	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	16	34	50
Group B	16	34	50
	32	68	100

Table 4.27 illustrates that examiner 1 found that 48% of the infants in Group A (colic) had the spinal joint dysfunctions, while 16% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 28 *The contingency table below illustrates the number of spinal joint dysfunctions in the lumbar spine (L1-L5), noted by examiner 2.*

EX 2 Lumbar Spine (L1-L5)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	23	27	50
Group B	7	43	50
	30	70	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	15	35	50
Group B	15	35	50
	30	70	100

Table 4.28 illustrates that examiner 2 found that 46% of the infants in Group A (colic) had the spinal joint dysfunctions, while 14% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 29 *The contingency table below illustrates the number of spinal joint dysfunctions in the sacro-iliac joints, noted by examiner 1.*

EX 1 Sacro-iliac Joints			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	27	23	50
Group B	12	38	50
	39	61	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	19.5	30.5	50
Group B	19.5	30.5	50
	39	61	100

Table 4.29 illustrates that examiner 1 found that 54% of the infants in Group A (colic) had the spinal joint dysfunctions, while 24% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 30 *The contingency table below illustrates the number of spinal joint dysfunctions in the sacro-iliac joints, noted by examiner 2.*

EX 2 Sacro-iliac Joints			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	27	23	50
Group B	14	36	50
	41	59	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	20.5	29.5	50
Group B	20.5	29.5	50
	41	59	100

Table 4.30 illustrates that examiner 2 found that 54% of the infants in Group A (colic) had the spinal joint dysfunctions, while 28% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 31 *The table below illustrates chi squared calculated for the occurrence of spinal joint dysfunctions in the lumbar spine (L1-L5) and the sacro-iliac joints (1 degree of freedom, α= 0.05).*

Chi Square calculated for Lumbar Spine (L1-L5)

	Chi Square	P-value
EX 1	11.76	0.0006
EX 2	12.19	0.0005

Chi Square calculated for Sacro-iliac Joints

	Chi Square	P-value
EX 1	9.46	0.002
EX 2	6.99	0.008

By considering table 4.31 we conclude that there is a significant association between spinal joint dysfunction in the lumbar (L1-L5) spine and sacro-iliac joints and infantile colic for both examiners at a 5% level of significance. (L1-L5 = Examiner 1, P-value = 0.0006; Examiner 2, P-value = 0.0005.) (S.I. joints= Examiner 1, P-value = 0.002; Examiner 2, P-value = 0.008.)

In the lumbar spine (L1-L5), we therefore reject the null hypothesis (P-value = $0.0006 < 0.05$ at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.0006) and examiner 2 (p-value= 0.0005), at a 5% level of significance.

In the sacro-iliac joints, we therefore reject the null hypothesis (P-value = $0.0005 < 0.05$ at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.002) and examiner 2 (p-value= 0.008), at a 5% level of significance.

4.4.1.2 Cramer's V measure of association

The Cramér's V was used to measure the association between the findings of examiner 1 and examiner 2, hence constituting an inter-examiner reliability test. The Cramér's V was run on the data, for each of the researchers' findings to determine if there was a significant association between the findings recorded by each researcher.

The achieved value of Cramer's V ranges from zero to 1, with zero indicating no association between the examiners' findings and a value close to 1 indicating a high degree of association between the examiners findings. Cramer's V can attain a value of 1 and 0 for tables of any dimension (Fisher and van Belle: 278). The p-value will be used for decision-making.

Hypotheses

- **H_0:** There is no association in the data recorded by examiner 1 and examiner 2.
- **H_1:** There is an association in the data recorded by examiner 1 and examiner 2.
- $\alpha = 0.05$ = level of significance.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject H_0.

If $p < \alpha$, at the α level of significance, we reject H_0.

Table 4. 32 *The table below illustrates the results of the Cramer's V measure of association (1 degree of freedom, α= 0.05) and P-values, calculated for the findings of the researchers (Examiner 1 and Examiner 2).*

Spinal Area	Cramer's V		P-value	
	GROUP A	GROUP B	GROUP A	GROUP B
Cervical Spine (C0-T1)	0.57	0.57	0.00005	0.00006
Thoracic Spine (T1-L1)	0.35	0.43	0.014	0.002
Lumbar Spine (L1-L5)	0.72	0.14	0.0000004	0.328
Si Joints (S.I.)	0.72	0.59	0.0000004	0.00003

By considering table 4.32, we can conclude that the data recorded by examiner 1 and 2, for spinal joint dysfunctions in the cervical (C0-T1) and thoracic (T1-L1) spines of infants with colic (Group A) and without colic (Group B), have a significant measure of association at a 5% level of significance. (C0-T1 = Group A, P-value = 0.00005; Group B, P-value = 0.00006) (T1-L1 = Group A, P-value = 0.014; Group B, P-value = 0.002).

In the cervical spine (C0-T1), we therefore reject the null hypothesis (p-value is < 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, for Group A (p-value = 0.00005) and Group B (p-value = 0.00006), at a 5% level of significance.

In the thoracic spine (T1-L1), we therefore reject the null hypothesis (p-value is < 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, for

Group A (p-value = 0.014) and Group B (p-value = 0.002), at a 5% level of significance.

By considering table 4.32, we can conclude that the data recorded by examiner 1 and 2, for spinal joint dysfunctions in the lumbar (L1-L5) spine and sacro-iliac joints of infants with colic (Group A) and without colic (Group B), have a significant measure of association at a 5% level of significance, however, there was insufficient evidence to suggest as association for the findings of the examiners in Group B of the lumbar spine. (L1-L5 = Group A, P-value = 0.0000004; Group B, P-value = 0.328) (S.I. joints = Group A, P-value = 0.0000004; Group B, P-value = 0.00003).

In the lumbar spine (L1-L5), we therefore reject the null hypothesis (p-value is $<$ 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, for Group A (p-value = 0.0000004), at a 5% level of significance. In the data recorded by examiner 1 and examiner 2, for Group B (p-value = 0.328), in the lumbar (L1-L5) spines of infants, we fail to reject the null hypothesis as there is insufficient evidence to suggest that there is a significant association in the data recorded by the examiners, at a 5% level of significance.

In the sacro-iliac joints, we therefore reject the null hypothesis (p-value is $<$ 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, for Group A (p-value = 0.0000004) and Group B (p-value = 0.00003), at a 5% level of significance.

4.4.1.3 Chi-squared tests calculated for the different areas of the cervical spine

The cervical spines of the infants were initially divided into the upper (C0-C4) and lower (C4-T1) levels and again into four sections (C0-C2, C2-C4, C4-C6, C6-T1). The chi-squared tests were run on each of these sections of the cervical spine, for each of the researchers' findings, to determine if there was a significant association between the occurrence of spinal joint dysfunctions and infantile colic.

If $p \geq \alpha = 0.05$, at the α level of significance, we fail to reject H_0 and therefore we have insufficient evidence to reject the hypothesis of independence, hence determining that infantile colic and spinal joint dysfunction are not associated. If $p < \alpha = 0.05$, at the α level of significance, we reject H_0 and therefore we have sufficient evidence to reject the hypothesis of independence, hence determining that infantile colic and spinal joint dysfunction are associated.

Hypotheses

- **H_0**: There is no association between spinal joint dysfunctions and infantile colic.
- **H_1**: There is an association between spinal joint dysfunctions and infantile colic.

- $\alpha = 0.05$ = level of significance.

Decision rule:
If $p \geq \alpha$, at the α level of significance, we fail to reject H_0.

If $p < \alpha$, at the α level of significance, we reject H_0.

A) Upper (C0-C4) and Lower (C4-T1) Cervical Spine

Table 4. 33 *The contingency table below illustrates the number of spinal joint dysfunctions in the upper half (C0-C4) of the cervical spine, noted by examiner 1.*

EX 1 Cervical Spine (C0-C4)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	37	13	50
Group B	16	34	50
	53	47	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	26.5	23.5	50
Group B	26.5	23.5	50
	53	47	100

Table 4.33 illustrates that examiner 1 found that 74% of the infants in Group A (colic) had the spinal joint dysfunctions, while 32% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 34 *The contingency table below illustrates the number of spinal joint dysfunctions in the upper half (C0-C4) of the cervical spine, noted by examiner 2.*

EX 2 Cervical Spine (C0-C4)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	41	9	50
Group B	15	35	50
	56	44	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	28	22	50
Group B	28	22	50
	56	44	100

Table 4.34 illustrates that examiner 2 found that 82% of the infants in Group A (colic) had the spinal joint dysfunctions, while 30% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 35 *The contingency table below illustrates the number of spinal joint dysfunctions in the lower half (C4-T1) of the cervical spine, noted by examiner 1.*

EX 1 Cervical Spine (C4-T1)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	24	26	50
Group B	13	37	50
	37	63	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	18.5	31.5	50
Group B	18.5	31.5	50
	37	63	100

Table 4.35 illustrates that examiner 1 found that 48% of the infants in Group A (colic) had the spinal joint dysfunctions, while 26% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 36 *The contingency table below illustrates the number of spinal joint dysfunctions in the lower half (C4-T1) of the cervical spine, noted by examiner 2.*

EX 2 Cervical Spine (C4-T1)

Observed Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	13	37	50
Group B	11	39	50
	24	76	100

Expected Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	12	38	50
Group B	12	38	50
	24	76	100

Table 4.36 illustrates that examiner 2 found that 26% of the infants in Group A (colic) had the spinal joint dysfunctions, while 22% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 37 *The table below illustrates chi squared calculated for the occurrence of spinal joint dysfunctions in the upper (C0-C4) and lower (C4-T1) cervical spine, (1 degree of freedom, α= 0.05).*

Chi Square calculated for Cervical Spine Upper (C0-C4)

	Chi Square	P-value
EX 1	17.70	0.00003
EX 2	27.44	0.0000002

Chi Square calculated for Cervical Spine Lower (C4-T1)

	Chi Square	P-value
EX 1	5.19	0.023
EX 2	0.22	0.640

By considering table 4.37 we conclude that there is a significant association between spinal joint dysfunction and infantile colic for both examiners at a 5% level of significance in the upper half (C0-C4) of the cervical spine. An association between spinal joint dysfunction and infantile colic was also noted for examiner 1 in the lower half (C4-T1) of the cervical spine. There was insufficient evidence to suggest a significant association between spinal joint dysfunction and infantile colic for the findings of examiner 2 in the lower half (C4-T1) of the cervical spine. (C0-C4 = Examiner 1, P-value = 0.00003; Examiner 2, P-value = 0.0000002.) (C4-T1 = Examiner 1, P-value = 0.023; Examiner 2, P-value = 0.640.)

In the upper half (C0-C4) of the cervical spine, we therefore reject the null hypothesis (p-value is < 0.05 at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.00003) and examiner 2 (p-value= 0.0000002), at a 5% level of significance.

In the lower half (C4-T1) of the cervical spine, we therefore reject the null hypothesis (p-value is < 0.05 at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.023) at a 5% level of significance. For the findings of examiner 2 (p-value= 0.640), we fail to reject the null hypothesis (p-value is ≥ 0.05 at the α level of significance), as there is insufficient evidence to suggest that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, at a 5% level of significance.

B) Upper (C0-C2), Mid-Upper (C2-C4), Mid-Lower (C4-C6) and Lower (C6-T1) Cervical Spine

Table 4. 38 *The contingency table below illustrates the number of spinal joint dysfunctions in the upper (C0-C2) cervical spine, noted by examiner 1.*

EX 1 Cervical Spine (C0-C2)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	13	37	50
Group B	6	44	50
	19	81	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	9.5	40.5	50
Group B	9.5	40.5	50
	19	81	100

Table 4.38 illustrates that examiner 1 found that 26% of the infants in Group A (colic) had the spinal joint dysfunctions, while 12% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 39 *The contingency table below illustrates the number of spinal joint dysfunctions in the upper (C0-C2) cervical spine, noted by examiner 2.*

EX 2 Cervical Spine (C0-C2)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	8	42	50
Group B	5	45	50
	13	87	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	6.5	43.5	50
Group B	6.5	43.5	50
	13	87	100

Table 4.39 illustrates that examiner 2 found that 16% of the infants in Group A (colic) had the spinal joint dysfunctions, while 10% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 40 *The contingency table below illustrates the number of spinal joint dysfunctions in the upper-mid (C2-C4) cervical spine, noted by examiner 1.*

EX 1 Cervical Spine (C2-C4)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	28	22	50
Group B	11	39	50
	39	61	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	19.5	30.5	50
Group B	19.5	30.5	50
	39	61	100

Table 4.40 illustrates that examiner 1 found that 56% of the infants in Group A (colic) had the spinal joint dysfunctions, while 22% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 41 *The contingency table below illustrates the number of spinal joint dysfunctions in upper-mid (C2-C4) cervical spine, noted by examiner 2.*

EX 2 Cervical Spine (C2-C4)

Observed Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	38	12	50
Group B	12	38	50
	50	50	100

Expected Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	25	25	50
Group B	25	25	50
	50	50	100

Table 4.41 illustrates that examiner 2 found that 76% of the infants in Group A (colic) had the spinal joint dysfunctions, while 24% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 42 *The table below illustrates chi squared calculated for the occurrence of spinal joint dysfunctions in the upper (C0-C2) and mid-upper (C2-C4) cervical spine, (1 degree of freedom, α= 0.05).*

Chi Square calculated for Upper Cervical Spine (C0-C2)

	Chi Square	P-value
EX 1	3.18	0.074
EX 2	0.80	0.372

Chi Square calculated for Mid-upper Cervical Spine (C2-C4)

	Chi Square	P-value
EX 1	12.15	0.0005
EX 2	27.04	0.0000002

By considering table 4.42 we conclude that there is a significant association between spinal joint dysfunction and infantile colic for both examiners at a 5% level of significance in the mid-upper (C2-C4) cervical spine. There was insufficient evidence to suggest that a significant association between spinal joint dysfunction and infantile colic for the examiners in the upper (C0-C2) cervical spine. (C0-C2 = Examiner 1, P-value = 0.074; Examiner 2, P-value = 0.372.) (C2-C4 = Examiner 1, P-value = 0.0005; Examiner 2, P-value = 0.0000002.)

In the upper (C0-C2) cervical spine, we fail to reject the null hypothesis (p-value is ≥ 0.05 at the α level of significance), and thus conclude that there is insufficient evidence to suggest that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.074) and examiner 2 (p-value= 0.372) at a 5% level of significance.

In the mid-upper (C2-C4) cervical spine, we reject the null hypothesis (p-value is < 0.05 at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.0005) and examiner 2 (p-value= 0.0000002), at a 5% level of significance.

Table 4. 43 *The contingency table below illustrates the number of spinal joint dysfunctions in the mid-lower (C4-C6) cervical spine, noted by examiner 1.*

EX 1 Cervical Spine (C4-C6)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	21	29	50
Group B	11	39	50
	32	68	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	16	34	50
Group B	16	34	50
	32	68	100

Table 4.43 illustrates that examiner 1 found that 42% of the infants in Group A (colic) had the spinal joint dysfunctions, while 22% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 44 *The contingency table below illustrates the number of spinal joint dysfunctions in the mid-lower (C4-C6) cervical spine, noted by examiner 2.*

EX 2 Cervical Spine (C4-C6)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	10	40	50
Group B	6	44	50
	16	84	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	8	42	50
Group B	8	42	50
	16	84	100

Table 4.44 illustrates that examiner 2 found that 20% of the infants in Group A (colic) had the spinal joint dysfunctions, while 12% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 45 *The contingency table below illustrates the number of spinal joint dysfunctions in the lower (C6-T1) cervical spine, noted by examiner 1.*

EX 1 Cervical Spine (C6-T1)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	3	47	50
Group B	2	48	50
	5	95	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	2.5	47.5	50
Group B	2.5	47.5	50
	5	95	100

Table 4.45 illustrates that examiner 1 found that 6% of the infants in Group A (colic) had the spinal joint dysfunctions, while 4% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 46 *The contingency table below illustrates the number of spinal joint dysfunctions in the lower (C6-T1) cervical spine, noted by examiner 2.*

EX 2 Cervical Spine (C6-T1)

Observed Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	4	46	50
Group B	6	44	50
	10	90	100

Expected Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	5	45	50
Group B	5	45	50
	10	90	100

Table 4.46 illustrates that examiner 2 found that 8% of the infants in Group A (colic) had the spinal joint dysfunctions, while 12% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 47 *The table below illustrates chi squared calculated for the occurrence of spinal joint dysfunctions in the mid-lower (C4-C6) and lower (C6-T1) cervical spine, (1 degree of freedom, α= 0.05)*.

Chi Square calculated for Mid-lower Cervical Spine (C4-C6)

	Chi Square	P-value
EX 1	4.60	0.032
EX 2	1.19	0.275

Chi Square calculated for Lower Cervical Spine (C6-T1)

	Chi Square	P-value
EX 1	0.21	0.646
EX 2	0.44	0.505

By considering table 4.47 we conclude that there is a significant association between spinal joint dysfunction and infantile colic in the mid-lower (C4-C6) cervical spine for the findings of examiner 1. There is insufficient evidence to suggest that there is a significant association between infantile colic and spinal joint dysfunction for the findings examiner 2 in the mid-lower (C4-C6) cervical spine and for the examiners in the lower (C6-T1) cervical spine. (C4-C6 = Examiner 1, P-value = 0.032; Examiner 2, P-value = 0.275.) (C6-T1 = Examiner 1, P-value = 0.646; Examiner 2, P-value = 0.505.)

In the mid-lower (C4-C6) cervical spine, we reject the null hypothesis (p-value is $<$ 0.05 at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.032), at a 5% level of significance. For the findings of examiner 2 (p-value= 0.275), we fail to reject the null hypothesis (p-value is $\geq$ 0.05 at the α level of significance), and thus conclude that there is insufficient evidence to suggest that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, at a 5% level of significance.

In the lower (C6-T1) cervical spine, we fail to reject the null hypothesis (p-value is $\geq$ 0.05 at the α level of significance), and thus conclude that there is insufficient evidence to suggest that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.646) and examiner 2 (p-value= 0.505), at a 5% level of significance.

4.4.1.4 Cramer's V measure of association

The Cramér's V was used to measure the association between the findings of examiner 1 and examiner 2, hence constituting an inter-examiner reliability test. The Cramér's V measure of association was run on the data, for each of the researchers' findings to determine if there was a significant association between the findings recorded by each researcher. The areas of the cervical spine tested for association were: the upper (C0-C4) and lower (C4-T1) cervical levels and the cervical sections divided as follows: C0-C2, C2-C4, C4-C6, C6-T1.

The achieved value of Cramer's V ranges from zero to 1, with zero indicating no association between the examiners' findings and a value close to 1 indicating a high degree of association between the examiners findings. Cramer's V can attain a value of 1 and 0 for tables of any dimension (Fisher and van Belle: 278). The p-value will be used for decision-making.

Hypotheses

- **H_0:** There is no association in the data recorded by examiner 1 and examiner 2.
- **H_1:** There is an association in the data recorded by examiner 1 and examiner 2.
- α = 0.05 = level of significance.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject $H_{0.}$

If $p < \alpha$, at the α level of significance, we reject $H_{0.}$

A) Upper (C0-C4) and Lower (C4-T1) Cervical Spine

Table 4. 48 *The table below illustrates the results of the Cramer's V measure of association (1 degree of freedom, α= 0.05) and P-values, calculated for the findings of the researchers (Examiner 1 and Examiner 2).*

Spinal Area	Cramer's V		P-value	
	GROUP A	GROUP B	GROUP A	GROUP B
Cervical Spine (C0-C4)	0.43	0.49	0.002	0.001
Cervical Spine (C4-T1)	0.34	0.57	0.015	0.00006

By considering table 4.48, we can conclude that the data recorded by examiner 1 and 2, for spinal joint dysfunctions in the upper (C0-C4) and lower (C4-T1) halves of the cervical spines of infants with colic (Group A) and without colic (Group B), have a significant measure of association at a 5% level of significance. (C0-C4 = Group A, P-value = 0.002; Group B, P-value = 0.001) (C4-T1 = Group A, P-value = 0.015; Group B, P-value = 0.00006).

In the upper (C0-C4) half of the cervical spine, we therefore reject the null hypothesis (p-value is < 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, for Group A (p-value = 0.002) and Group B (p-value = 0.001), at a 5% level of significance.

In the lower (C4-T1) half of the cervical spine, we therefore reject the null hypothesis (p-value is < 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, for Group A (p-value = 0.015) and Group B (p-value = 0.00006), at a 5% level of significance.

B) Upper (C0-C2), Mid-Upper (C2-C4), Mid-Lower (C4-C6) and Lower (C6-T1) Cervical Spine

Table 4. 49 *The table below illustrates the results of the Cramer's V measure of association (1 degree of freedom, α= 0.05) and P-values, calculated for the findings of the researchers (Examiner 1 and Examiner 2).*

Spinal Area	Cramer's V		P-value	
	GROUP A	GROUP B	GROUP A	GROUP B
Cervical Spine (C0-C2)	0.49	0.49	0.001	0.0005
Cervical Spine (C2-C4)	0.16	0.49	0.251	0.0005
Cervical Spine (C4-C6)	0.28	0.40	0.045	0.005
Cervical Spine (C6-T1)	0.24	0.55	0.095	0.00009

By considering table 4.49, we can conclude that the data recorded by examiner 1 and 2, for spinal joint dysfunctions in the upper (C0-C2) and mid-lower (C4-C6) cervical spines of infants with colic (Group A) and without colic (Group B), have a significant association at a 5% level of significance. Furthermore, a significant association was noted for the examiners in Group B for the remaining sections of the cervical spine (C2-C4, C6-T1). There was insufficient evidence to suggest that there was a significant association between examiners in Group A for the following locations of the cervical spine: C2-C4 and C6-T1. (C0-C2 = Group A, P-value = 0.001; Group B, P-value = 0.0005) (C2-C4 = Group A, P-value = 0.251; Group B, P-value = 0.0005) (C4-C6 = Group A, P-value = 0.045; Group B, P-value = 0.005) (C6-T1 = Group A, P-value = 0.095; Group B, P-value = 0.00009).

In the upper (C0-C2) cervical spine, we therefore reject the null hypothesis (p-value is < 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, for Group A (p-value = 0.001) and Group B (p-value = 0.0005), at a 5% level of significance.

In the mid-upper (C2-C4) cervical spine, for Group A (p-value = 0.251), we fail to reject the null hypothesis (p-value is ≥ 0.05, at the α level of significance) as there is insufficient evidence to suggest that there is a significant association between the findings of the examiners, at a 5% level of significance. For the Group B (p-value = 0.0005), however, we reject the null hypothesis (p-value is < 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, at a 5% level of significance.

In the mid-lower (C4-C6) cervical spine, we therefore reject the null hypothesis (p-value is < 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and

examiner 2, for Group A (p-value = 0.045) and Group B (p-value = 0.005), at a 5% level of significance.

In the lower (C6-T1) cervical spine, for Group A (p-value = 0.095), we fail to reject the null hypothesis (p-value is $\geq$ 0.05, at the α level of significance) as there is insufficient evidence to suggest that there is a significant association between the findings of the examiners, at a 5% level of significance. For the Group B (p-value = 0.00009), however, we reject the null hypothesis (p-value is $<$ 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, at a 5% level of significance.

4.4.1.5 Chi-squared tests for the different areas of the thoracic spine

The thoracic spines of the infants were initially divided into the upper (T1-T7) and lower (T7-T12) levels and again into three sections (T1-T5, T5-T9, T9-L1). The chi-squared tests were run on each of these sections of the thoracic spine, for each of the researchers' findings, to determine if there was a significant association between the occurrence of spinal joint dysfunctions and infantile colic.

If $p \geq \alpha = 0.05$, at the α level of significance, we fail to reject H_0 and therefore we have insufficient evidence to reject the hypothesis of independence, hence determining that infantile colic and spinal joint dysfunction are not associated. If $p < \alpha = 0.05$, at the α level of significance, we reject H_0 and therefore we have sufficient evidence to reject the hypothesis of independence, hence determining that infantile colic and spinal joint dysfunction are associated.

Hypotheses

- **H_0**: There is no association between spinal joint dysfunctions and infantile colic.
- **H_1**: There is an association between spinal joint dysfunctions and infantile colic.
- α = 0.05 = level of significance.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject H_0.

If $p < \alpha$, at the α level of significance, we reject H_0.

A) Upper (T1-T7) and Lower (T7-L1) Thoracic

Table 4. 50 *The contingency table below illustrates the number of spinal joint dysfunctions in the upper half (T1-T7) of the thoracic spine, noted by examiner 1.*

EX 1 Thoracic Spine (T1-T7)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	26	24	50
Group B	16	34	50
	42	58	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	21	29	50
Group B	21	29	50
	42	58	100

Table 4.50 illustrates that examiner 1 found that 52% of the infants in Group A (colic) had the spinal joint dysfunctions, while 42% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 51 *The contingency table below illustrates the number of spinal joint dysfunctions in the upper half (T1-T7) of the thoracic spine, noted by examiner 2.*

EX 2 Thoracic Spine (T1-T7)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	30	20	50
Group B	18	32	50
	48	52	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	24	26	50
Group B	24	26	50
	48	52	100

Table 4.51 illustrates that examiner 2 found that 60% of the infants in Group A (colic) had the spinal joint dysfunctions, while 36% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 52 *The contingency table below illustrates the number of spinal joint dysfunctions in the lower half (T7-L1) of the thoracic spine, noted by examiner 1.*

EX 1 Thoracic Spine (T7-L1)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	15	35	50
Group B	7	43	50
	22	78	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	11	39	50
Group B	11	39	50
	22	78	100

Table 4.52 illustrates that examiner 1 found that 30% of the infants in Group A (colic) had the spinal joint dysfunctions, while 14% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 53 *The contingency table below illustrates the number of spinal joint dysfunctions in the lower half (T7-L1) of the thoracic spine, noted by examiner 2.*

EX 2 Thoracic Spine (T7-L1)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	22	28	50
Group B	6	44	50
	28	72	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	14	36	50
Group B	14	36	50
	28	72	100

Table 4.53 illustrates that examiner 2 found that 44% of the infants in Group A (colic) had the spinal joint dysfunctions, while 12% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 54 *The table below illustrates chi squared calculated for the occurrence of spinal joint dysfunctions in the upper (T1-T7) and lower (T7-L1) thoracic spine, (1 degree of freedom, α= 0.05).*

Chi Square calculated for Upper Thoracic Spine (T1-T7)

	Chi Square	P-value
EX1	4.11	0.043
EX2	5.77	0.016

Chi Square calculated for Lower Thoracic Spine (T7-T12)

	Chi Square	P-value
EX1	3.73	0.053
EX2	12.70	0.0004

By considering table 4.54 we conclude that there is a significant association between spinal joint dysfunction and infantile colic, in the upper half (T1-T7) of the thoracic spine, for both examiners at a 5% level of significance. An association was also noted in the lower half (T7-L1) of the thoracic spine for the findings of examiner 2. However, there was insufficient evidence to suggest that there was a significant association between spinal joint dysfunction and infantile colic, in the lower half (T7-L1) of the thoracic spine for the findings of examiner 1. (T1-T7 = Examiner 1, P-value = 0.043; Examiner 2, P-value = 0.016.) (T7-L1 = Examiner 1, P-value = 0.053; Examiner 2, P-value = 0.0004.)

In the upper half (T1-T7) of the thoracic spine, we reject the null hypothesis (p-value is $<$ 0.05 at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.043) and examiner 2 (p-value= 0.016), at a 5% level of significance.

In the lower half (T7-L1) of the thoracic spine, we reject the null hypothesis (p-value is $<$ 0.05 at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 2 (p-value= 0.0004), at a 5% level of significance. However, for the findings of examiner 1 (p-value= 0.275), we fail to reject the null hypothesis (p-value is $\geq$ 0.05 at the α level of significance), and thus conclude that there is insufficient evidence to suggest that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, at a 5% level of significance.

B) Upper (T1-T5), Mid (T5-T9) and Lower (T9-L1) Thoracic Spine

Table 4. 55 *The contingency table below illustrates the number of spinal joint dysfunctions in the upper (T1-T5) thoracic spine, noted by examiner 1.*

EX 1 Thoracic Spine (T1-T5)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	10	40	50
Group B	9	41	50
	19	81	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	9.5	40.5	50
Group B	9.5	40.5	50
	19	81	100

Table 4.55 illustrates that examiner 1 found that 20% of the infants in Group A (colic) had the spinal joint dysfunctions, while 18% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 56 *The contingency table below illustrates the number of spinal joint dysfunctions in the upper (T1-T5) thoracic spine, noted by examiner 2.*

EX 2 Thoracic Spine (T1-T5)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	17	33	50
Group B	8	42	50
	25	75	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	12.5	37.5	50
Group B	12.5	37.5	50
	25	75	100

Table 4.56 illustrates that examiner 2 found that 34% of the infants in Group A (colic) had the spinal joint dysfunctions, while 16% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 57 *The contingency table below illustrates the number of spinal joint dysfunctions in the mid (T5-T9) thoracic spine, noted by examiner 1.*

EX 1 Thoracic Spine (T5-T9)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	26	24	50
Group B	10	40	50
	36	64	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	18	32	50
Group B	18	32	50
	36	64	100

Table 4.57 illustrates that examiner 1 found that 52% of the infants in Group A (colic) had the spinal joint dysfunctions, while 20% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 58 *The contingency table below illustrates the number of spinal joint dysfunctions in the mid (T5-T9) thoracic spine, noted by examiner 2.*

EX 2 Thoracic Spine (T5-T9)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	23	27	50
Group B	14	36	50
	37	63	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	18.5	31.5	50
Group B	18.5	31.5	50
	37	63	100

Table 4.58 illustrates that examiner 2 found that 46% of the infants in Group A (colic) had the spinal joint dysfunctions, while 28% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 59 *The contingency table below illustrates the number of spinal joint dysfunctions in the lower (T9-L1) thoracic spine, noted by examiner 1.*

EX 1 Thoracic Spine (T9-L1)

Observed Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	8	42	50
Group B	4	46	50
	12	88	100

Expected Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	6	44	50
Group B	6	44	50
	12	88	100

Table 4.59 illustrates that examiner 1 found that 16% of the infants in Group A (colic) had the spinal joint dysfunctions, while 8% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 60 *The contingency table below illustrates the number of spinal joint dysfunctions in the lower (T9-L1) thoracic spine, noted by examiner 2.*

EX 2 Thoracic Spine (T9-L1)

Observed Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	14	36	50
Group B	3	47	50
	17	83	100

Expected Frequency

	SPINAL JOINT DYSFUNCTION	NO SPINAL JOINT DYSFUNCTION	
Group A	8.5	41.5	50
Group B	8.5	41.5	50
	17	83	100

Table 4.60 illustrates that examiner 2 found that 28% of the infants in Group A (colic) had the spinal joint dysfunctions, while 6% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 61 *The table below illustrates chi squared calculated for the occurrence of spinal joint dysfunctions in the upper (T1-T5), mid (T5-T9) and lower (T9-L1) thoracic spine, (1 degree of freedom, α= 0.05).*

Chi Square calculated for Upper Thoracic Spine (T1-T5)

	Chi Square	P-value
EX1	0.06	0.799
EX2	4.32	0.038

Chi Square calculated for Mid Thoracic Spine (T5-T9)

	Chi Square	P-value
EX1	11.11	0.001
EX2	3.47	0.062

Chi Square calculated for Lower Thoracic Spine (T9-L1)

	Chi Square	P-value
EX1	1.52	0.218
EX2	8.58	0.003

By considering table 4.61 we conclude that there is a significant association between spinal joint dysfunction and infantile colic in the upper (T1-T5) thoracic spine, for examiner 2, at a 5% level of significance. However, there was insufficient evidence to suggest that there was a significant association between spinal joint dysfunction and infantile colic, in the upper (T1-T5) thoracic spine for the findings of examiner 1. An association was also noted in the mid (T5-T9) thoracic for examiner 1 and in the lower (T9-L1) thoracic spine for examiner 2, at a 5% level of significance. Therefore there was not sufficient evidence to suggest that there was a significant association between spinal joint dysfunction and infantile colic, mid (T5-T9) thoracic for examiner 2 and in the lower (T9-L1) thoracic spine for examiner 1. (T1-T5 = Examiner 1, P-value = 0.799; Examiner 2, P-value = 0.038.) (T5-T9 = Examiner 1, P-value = 0.001; Examiner 2, P-value = 0.062.) (T9-L1 = Examiner 1, P-value = 0.218; Examiner 2, P-value = 0.003.)

In the upper (T1-T5) thoracic spine, we reject the null hypothesis (p-value is $<$ 0.05 at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 2 (p-value= 0.038), at a 5% level of significance. However, for the findings of examiner 1 (p-value= 0.799), we fail to reject the null hypothesis (p-value is $\geq$ 0.05 at the α level of significance), and thus conclude that there is not sufficient evidence to suggest that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, at a 5% level of significance.

In the mid (T5-T9) thoracic spine, we reject the null hypothesis (p-value is $<$ 0.05 at the α level of significance), and thus conclude that there is a significant

association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.001), at a 5% level of significance. However, for the findings of examiner 2 (p-value= 0.062), we fail to reject the null hypothesis (p-value is ≥ 0.05 at the α level of significance), and thus conclude that there is not sufficient evidence to suggest that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, at a 5% level of significance.

In the lower (T9-L1) mid (T5-T9) thoracic spine, we reject the null hypothesis (p-value is < 0.05 at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 2 (p-value= 0.003), at a 5% level of significance. However, for the findings of examiner 1 (p-value= 0.218), we fail to reject the null hypothesis (p-value is $\geq$ 0.05 at the α level of significance), and thus conclude that there is insufficient evidence to suggest that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, at a 5% level of significance.

4.4.1.6 Cramer's V measure of association

The Cramér's V was used to measure the association between the findings of examiner 1 and examiner 2 in the thoracic spines of the infants, hence constituting an inter-examiner reliability test. The Cramer's V measure of association was run on the data, for each of the researchers' findings to determine if there was a significant association between the findings recorded by each researcher. The areas of the thoracic spine tested for association were: the upper (T1-T7) and lower (T7-L1) thoracic levels and the thoracic sections divided as follows: T1-T5, T5-T9, T9-L1.

The achieved value of Cramer's V ranges from zero to 1, with zero indicating no association between the examiners' findings and a value close to 1 indicating a high degree of association between the examiners findings. Cramer's V can attain a value of 1 and 0 for tables of any dimension (Fisher and van Belle: 278). The p-value will be used for decision-making.

Hypotheses

- **H_0:** There is no association in the data recorded by examiner 1 and examiner 2.
- **H_1:** There is an association in the data recorded by examiner 1 and examiner 2.
- α = 0.05 = level of significance.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject H_0.

If $p < \alpha$, at the α level of significance, we reject H_0.

A) Upper (T1-T7) and Lower (T7-L1) Thoracic Spine

Table 4. 62 *The table below illustrates the results of the Cramer's V measure of association (1 degree of freedom, α= 0.05) and P-values, calculated for the findings of the researchers (Examiner 1 and Examiner 2).*

Spinal Area	Cramer's V		P-value	
	GROUP A	GROUP B	GROUP A	GROUP B
Thoracic Spine (T1-T7)	0.20	0.38	0.166	0.007
Thoracic Spine (T7-L1)	0.30	0.56	0.035	0.00007

By considering table 4.62, we can conclude that a significant association was noted for the findings of examiners in Group B, in the upper half (T1-T7) of the thoracic spine. There was not sufficient evidence to suggest that the data recorded by the examiners was associated for the findings in Group A. The data recorded by the examiners in the lower half (T7-L1) of the thoracic spines of infants with colic (Group A) and without colic (Group B), had a significant association, at a 5% level of significance. (T1-T7= Group A, P-value = 0.166; Group B, P-value = 0.007) (T7-L1= Group A, P-value = 0.035; Group B, P-value = 0.00007).

In the upper (T1-T7) half of the thoracic spine, we therefore reject the null hypothesis (p-value is < 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, for Group B (p-value = 0.007), at a 5% level of significance. However, we fail to reject the null hypothesis (p-value is ≥ 0.05, at the α level of significance), for the findings in Group A (p-value = 0.166), and thus conclude that there is no association in the data recorded by examiner 1 and examiner 2, at a 5% level of significance.

In the lower (T7-L1) half of the thoracic spine, we therefore reject the null hypothesis (p-value is < 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, for Group A (p-value = 0.035) and Group B (p-value = 0.00007), at a 5% level of significance.

B) Upper (T1-T5), Mid (T5-T9) and Lower (T9-L1) Thoracic Spine

Table 4. 63 *The table below illustrates the results of the Cramer's V measure of association (1 degree of freedom, α= 0.05) and P-values, calculated for the findings of the researchers (Examiner 1 and Examiner 2).*

Spinal Area	Cramer's V		P-value	
	GROUP A	GROUP B	GROUP A	GROUP B
Thoracic Spine (T1-T5)	0.17	0.22	0.232	0.117
Thoracic Spine (T5-T9)	0.32	0.36	0.022	0.012
Thoracic Spine (T9-L1)	0.46	0.55	0.001	0.0001

By considering table 4.63, we can conclude that there was insufficient evidence to suggest that there was a significant association between the findings of the examiners in the upper (T1-T5) thoracic spines of infants with colic (Group A) and without colic (Group B). However, the data recorded by the examiners, for spinal joint dysfunctions in the mid (T5-T9) and lower (T9-L1) thoracic spines of infants with colic (Group A) and without colic (Group B), have a significant association at a 5% level of significance. (T1-T5= Group A, P-value = 0.232; Group B, P-value = 0.117) (T5-T9 = Group A, P-value = 0.022; Group B, P-value = 0.012) (T9-L1= Group A, P-value = 0.001; Group B, P-value = 0.0001).

In the upper (T1-T5) thoracic spine, we fail to reject the null hypothesis (p-value is $\geq$ 0.05, at the α level of significance), as there was insufficient evidence to suggest that there was a significant association between the findings of the examiners in Group A (p-value = 0.232) and Group B (p-value = 0.117), at a 5% level of significance.

In the mid (T5-T9) thoracic spine, we therefore reject the null hypothesis (p-value is $<$ 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, for Group A (p-value = 0.022) and Group B (p-value = 0.012), at a 5% level of significance.

In the lower (T9-L1) half of the thoracic spine, we therefore reject the null hypothesis (p-value is $<$ 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, for Group A (p-value = 0.001) and Group B (p-value = 0.0001), at a 5% level of significance.

4.4.1.7 Chi-squared tests for the different areas of the lumbar spine

The lumbar spines of the infants were initially divided into two halves, the upper (L1-L3) and lower (L3-L5) levels. The chi-squared tests were run on each of these sections of the lumbar spine, for each of the researchers' findings, to determine if there was a significant association between the occurrence of spinal joint dysfunctions and infantile colic.

If $p \geq \alpha = 0.05$, at the α level of significance, we fail to reject H_0 and therefore we have insufficient evidence to reject the hypothesis of independence, hence determining that infantile colic and spinal joint dysfunction are not associated. If $p < \alpha = 0.05$, at the α level of significance, we reject H_0 and therefore we have sufficient evidence to reject the hypothesis of independence, hence determining that infantile colic and spinal joint dysfunction are associated.

Hypotheses

- **H_0**: There is no association between spinal joint dysfunctions and infantile colic.
- **H_1**: There is an association between spinal joint dysfunctions and infantile colic.
- α = 0.05 = level of significance.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject H_0.

If $p < \alpha$, at the α level of significance, we reject H_0.

A) Upper (L1-L3) and Lower (L3-L5) Lumbar Spine

Table 4. 64 *The contingency table below illustrates the number of spinal joint dysfunctions in the upper (L1-L3) lumbar spine, noted by examiner 1.*

EX 1 Lumbar Spine (L1-L3)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	22	28	50
Group B	7	43	50
	29	71	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	14.5	35.5	50
Group B	14.5	35.5	50
	29	71	100

Table 4.64 illustrates that examiner 1 found that 44% of the infants in Group A (colic) had the spinal joint dysfunctions, while 14% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 65 *The contingency table below illustrates the number of spinal joint dysfunctions in the upper (L1-L3) lumbar spine, noted by examiner 2.*

EX 2 Lumbar Spine (L1-L3)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	20	30	50
Group B	6	44	50
	26	74	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	13	37	50
Group B	13	37	50
	26	74	100

Table 4.65 illustrates that examiner 2 found that 40% of the infants in Group A (colic) had the spinal joint dysfunctions, while 12% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 66 *The contingency table below illustrates the number of spinal joint dysfunctions in the lower (L3-L5) lumbar spine, noted by examiner 1.*

EX 1 Lumbar Spine (L3-L5)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	8	42	50
Group B	1	49	50
	9	91	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	4.5	45.5	50
Group B	4.5	45.5	50
	9	91	100

Table 4.66 illustrates that examiner 1 found that 16% of the infants in Group A (colic) had the spinal joint dysfunctions, while 2% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 67 *The contingency table below illustrates the number of spinal joint dysfunctions in the lower (L3-L5) lumbar spine, noted by examiner 2.*

EX 2 Lumbar Spine (L3-L5)			
Observed Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	8	42	50
Group B	2	48	50
	10	90	100
Expected Frequency			
	SPINAL JOINT DYSFUNCTION	**NO SPINAL JOINT DYSFUNCTION**	
Group A	5	45	50
Group B	5	45	50
	10	90	100

Table 4.67 illustrates that examiner 2 found that 16% of the infants in Group A (colic) had the spinal joint dysfunctions, while 4% of the infants in Group B (non colic) had spinal joint dysfunctions.

Table 4. 68 *The table below illustrates chi squared calculated for the occurrence of spinal joint dysfunctions in the upper (L1-L3) and lower (L3-L5) lumbar spine, (1 degree of freedom, α= 0.05).*

Chi Square calculated for Upper Lumbar Spine (L1-L3)

	Chi Square	P-value
EX 1	10.93	0.0009
EX 2	10.19	0.001

Chi Square calculated for Lower Lumbar Spine (L3-L5)

	Chi Square	P-value
EX 1	5.98	0.014
EX 2	4.00	0.046

By considering table 4.68 we conclude that there is a significant association between spinal joint dysfunction in the upper (L1-L3) and lower (L3-L5) lumbar spines and infantile colic for both examiners at a 5% level of significance. (L1-L5 = Examiner 1, P-value = 0.0009; Examiner 2, P-value = 0.001.) (L3-L5 = Examiner 1, P-value = 0.014; Examiner 2, P-value = 0.046.)

In the upper (L1-L3) half of the lumbar spine, we reject the null hypothesis (P-value is $<$ 0.05 at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.0009) and examiner 2 (p-value= 0.001), at a 5% level of significance.

In the lower (L3-L5) half of the lumbar spine, we reject the null hypothesis (P-value is $<$ 0.05 at the α level of significance), and thus conclude that there is a significant association between the infants who suffer from infantile colic and whether or not they have spinal joint dysfunctions, as noted by examiner 1 (p-value= 0.014) and examiner 2 (p-value= 0.046), at a 5% level of significance.

4.4.1.8 Cramer's V measure of association

The Cramér's V were used to measure the association between the findings of examiner 1 and examiner 2 in the lumbar spines of the infants, hence constituting an inter-examiner reliability test. The Cramer's V measure of association was run on the data, for each of the researchers' findings to determine if there was a significant association between the findings recorded by each researcher. The areas of the lumbar spine tested for association were: the upper (L1 – L3) and lower (L3 – L5) lumbar levels.

The achieved value of Cramer's V ranges from zero to 1, with zero indicating no association between the examiners' findings and a value close to 1 indicating a high degree of association between the examiners findings. Cramer's V can attain a value of 1 and 0 for tables of any dimension (Fisher and van Belle: 278). The p-value will be used for decision-making.

Hypotheses

- **H_0:** There is no association in the data recorded by examiner 1 and examiner 2.
- **H_1:** There is an association in the data recorded by examiner 1 and examiner 2.
- $\alpha = 0.05$ = level of significance.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject H_0.

If $p < \alpha$, at the α level of significance, we reject H_0.

A) Upper (L1 – L3) and Lower (L3 – L5) Lumbar Spine

Table 4. 69 *The table below illustrates the results of the Cramer's V measure of association (1 degree of freedom, α= 0.05) and P-values, calculated for the findings of the researchers (Examiner 1 and Examiner 2).*

Spinal Area	Cramer's V		P-value	
	GROUP A	GROUP B	GROUP A	GROUP B
Lumbar Spine (L1-L3)	0.59	0.21	0.00003	0.146
Lumbar Spine (L3-L5)	0.55	0.03	0.00009	0.837

By considering table 4.69, we can conclude that the data recorded by examiner 1 and 2, for spinal joint dysfunctions in the upper (L1-L3) and lower (L3-L5) lumbar spines of infants with colic (Group A), have a significant association at a 5% level of significance. There was not sufficient evidence to suggest that the examiners' findings for Group B in the upper (L1-L3) and lower (L3-L5) lumbar spines showed a significant association. (L1-L3 = Group A, P-value = 0.00003; Group B, P-value = 0.146) (L3-L5 = Group A, P-value = 0.00009; Group B, P-value = 0.837).

In the upper (L1-L3) half of the lumbar spine, we reject the null hypothesis (p-value is < 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2,

for Group A (p-value = 0.00003), at a 5% level of significance. However, we fail to reject the null hypothesis (p-value is $\geq$ 0.05, at the α level of significance), as there was insufficient evidence to suggest that there was a significant association between the findings of the examiners in Group B (p-value = 0.146), at a 5% level of significance.

In the lower (L3-L5) half of the lumbar spine, we reject the null hypothesis (p-value is $<$ 0.05, at the α level of significance), and thus conclude that there is a significant association in the data recorded by examiner 1 and examiner 2, for Group A (p-value = 0.00009), at a 5% level of significance. However, we fail to reject the null hypothesis (p-value is $\geq$ 0.05, at the α level of significance), as there was insufficient evidence to suggest that there was a significant association between the findings of the examiners in Group B (p-value = 0.837), at a 5% level of significance.

4.4.2 OBJECTIVE TWO

4.4.2.1 Intra group analysis

Statistical analysis of the occurrence data involved the use of the binomial test (using two proportions) to perform a comparison of the occurrence of spinal joint dysfunction between locations within the same group. Thus the data in Group A and Group B was tested separately. The comparison between the locations in the intra group analysis was conducted within each group to determine which location had a significant occurrence of spinal joint dysfunctions as compared to other locations. The binomial tests for intra group comparison were only conducted at locations within the defined areas of the spine. The results of the two examiners were pooled to even out the results by creating a larger sample size. All tests were carried out at a 5% level of significance and p-values were used for decision-making.

BINOMIAL TEST USING TWO PROPORTIONS:

The binomial test (using two proportions) was used to compare the occurrence of spinal joint dysfunctions between locations within a group. The occurrence data collected by examiner 1 and 2 was put in spread sheet form by the location. The locations included: C0-C2, C2-C4, C4-C6, C6-T1, T1-T5, T5-T9, T9-L1, L1-L3, L3-L5 and the sacro-iliac joints.

- **H_0**: The population proportion at location 2 is equal to the population proportion at location 1. $\pi_1 = \pi_2$
- **H_1**: The population proportion is higher at location 2 as opposed to location 1. $\pi_1 < \pi_2$
- α = 0.05 = level of significance.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject $H_{0.}$

If $p < \alpha$, at the α level of significance, we reject $H_{0.}$

A) CERVICAL SPINE – GROUP A (COLIC)

Table 4. 70 *The table below demonstrates the intra group comparison between locations in the cervical spine, in the colic group. The locations have been ranked in an ascending order, according to the P-value.*

Cervical Spine – Group A					
Location 1	**Proportion for Location 1**	**Location 2**	**Proportion for Location 2**	**P-value**	**Decision**
C6-T1	0.07	C2-C4	0.66	0.000	Reject Ho:
C0-C2	0.21	C2-C4	0.66	6.917×10^{-11}	Reject Ho:
C4-C6	0.31	C2-C4	0.66	0.0000004	Reject Ho:
C6-T1	0.07	C4-C6	0.31	0.000008	Reject Ho:
C6-T1	0.07	C0-C2	0.21	0.002	Reject Ho:
C0-C2	0.21	C4-C6	0.31	0.053	Fail to Reject Ho:

The intra group data of the comparison of proportions between the different locations, for the cervical spines of colicky infants is illustrated in table 4.70. The cervical spine was divided into four sections, called locations for the purpose of statistical analysis. The table demonstrates the proportions of occurrence of spinal joint dysfunctions at each location, as well as the differences in proportions between locations.

The population proportion at C2-C4 (0.66) is significantly higher than the population proportion at C4-C6 (0.31) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at C2-C4 (0.66) as opposed to C4-C6 (0.31) at a 5% significance level.

Alternatively, it can be noted that at the location: C4-C6 (0.31) and C0-C2 (0.21), the p-value is ≥ 0.05, thus we do not reject H_O and therefore conclude that there is not sufficient evidence to suggest that the proportion of spinal joint dysfunction is significantly higher at C4-C6 (0.31) as opposed to C0-C2 (0.21) at a 5% significance level.

However, the population proportion at C4-C6 (0.31) is significantly higher than the population proportion at C6-T1 (0.07) respectively. It can be noted that

the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at C4-C6 (0.31) as opposed to C6-T1 (0.07) at a 5% significance level.

The population proportion at C0-C2 (0.21) is significantly higher than the population proportion at C6-T1 (0.07) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at C0-C2 (0.21) as opposed to C6-T1 (0.07) at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was as follows: C2-C4 (0.66), C4-C6 (0.31), C0-C2 (0.21) and C6-T1 (0.07). Thus in the cervical spines of colicky infants, it can be concluded that the location with the highest significant occurrence of spinal joint dysfunctions was C2-C4 (0.66). The proportion of this location (C2-C4) was significantly higher than the proportions of the other locations in the cervical spine as can be noted from the small p-values generated when comparing the different locations.

B) CERVICAL SPINE – GROUP B (NON-COLIC)

Table 4. 71 *The table below demonstrates the intra group comparison between locations in the cervical spine, in the non-colic group. The locations have been ranked in an ascending order, according to the P-value.*

Cervical Spine – Group B					
Location 1	**Proportion for Location 1**	**Location 2**	**Proportion for Location 2**	**P-value**	**Decision**
C6-T1	0.08	C2-C4	0.23	0.002	Reject Ho:
C0-C2	0.11	C2-C4	0.23	0.012	Reject Ho:
C6-T1	0.08	C4-C6	0.17	0.027	Reject Ho:
C0-C2	0.11	C4-C6	0.17	0.111	Fail to Reject Ho:
C4-C6	0.17	C2-C4	0.23	0.144	Fail to Reject Ho:
C6-T1	0.08	C0-C2	0.11	0.235	Fail to Reject Ho:

The intra group data of the comparison of proportions between the different locations, for the cervical spines of non-colicky infants is illustrated in table 4.71. The cervical spine was divided into four sections, called locations for the purpose of statistical analysis. The table demonstrates the proportions of occurrence of spinal joint dysfunctions at each location, as well as the differences in proportions between locations.

It can be noted that at the location: C2-C4 (0.23) and C4-C6 (0.17), the p-value is $\geq$ 0.05, thus we do not reject H_O and therefore conclude that there is not sufficient evidence to suggest that the proportion of spinal joint dysfunction is significantly higher at C2-C4 (0.23) as opposed to C4-C6 (0.17) at a 5% significance level.

The population proportion at C2-C4 (0.23) is significantly higher than the population proportion at C0-C2 (0.11) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at C2-C4 (0.23) as opposed to C0-C2 (0.11) at a 5% significance level.

At the location: C4-C6 (0.17) and C0-C2 (0.11), the p-value is $\geq$ 0.05, thus we do not reject H_O and therefore conclude that there is not sufficient evidence to suggest that the proportion of spinal joint dysfunction is significantly higher at C4-C6 (0.17) as opposed to C0-C2 (0.11) at a 5% significance level.

The population proportion at C4-C6 (0.17) is significantly higher than the population proportion at C6-T1 (0.08) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at C4-C6 (0.17) as opposed to C6-T1 (0.08) at a 5% significance level.

At the location: C0-C2 (0.11) and C6-T1 (0.08), the p-value is $\geq$ 0.05, thus we do not reject H_O and therefore conclude that there is not sufficient evidence to suggest that the proportion of spinal joint dysfunction is significantly higher at C0-C2 (0.11) as opposed to C6-T1 (0.08) at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was as follows: C2-C4 (0.23), C4-C6 (0.17), C0-C2 (0.11) and C6-T1 (0.08). Thus in the cervical spines of non-colicky infants, it can be noted that the location with the highest proportion of occurrence of spinal joint dysfunctions was C2-C4 (0.23). However, there was not sufficient evidence to conclude that the proportion at C2-C4 (0.23) was significantly higher than C4-C6 (0.17) in the cervical spine as can be concluded from the p-values generated when comparing the two locations.

C) THORACIC SPINE – GROUP A (COLIC)

Table 4. 72 *The table below demonstrates the intra group comparison between locations in the thoracic spine, in the colic group. The locations have been ranked in an ascending order, according to the P-value.*

Thoracic Spine – Group A					
Location 1	**Proportion for Location 1**	**Location 2**	**Proportion for Location 2**	**P-value**	**Decision**
T9-L1	0.22	T5-T9	0.49	0.00003	Reject Ho:
T1-T5	0.27	T5-T9	0.49	0.001	Reject Ho:
T9-L1	0.22	T1-T5	0.27	0.206	Fail to Reject Ho:

The intra group data of the comparison of proportions between the different locations, for the thoracic spines of colicky infants is illustrated in table 4.72. The thoracic spine was divided into three sections, called locations for the purpose of statistical analysis. The table demonstrates the proportions of occurrence of spinal joint dysfunctions at each location, as well as the differences in proportions between locations.

The population proportion at T5-T9 (0.49) was higher than the population proportion at T1-T5 (0.27) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at T5-T9 (0.49) as opposed to T1-T5 (0.27) at a 5% significance level.

Alternatively, at the location: T1-T5 (0.27) and T9-L1 (0.22), the p-value is $\geq$ 0.05, thus we do not reject H_O and therefore conclude that there is not sufficient evidence to suggest that the proportion of spinal joint dysfunction is significantly higher at T1-T5 (0.27) as opposed to T9-L1 (0.22) at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was as follows: T5-T9 (0.49), T1-T5 (0.27) and T9-L1 (0.22). Thus in the thoracic spines of colicky infants, it can be concluded that the location with the highest significant occurrence of spinal joint dysfunctions was T5-T9 (0.49). The proportion at this location (T5-T9) was significantly higher than the proportions of the other locations in the thoracic spine. This is noted from the p-values generated when comparing the different location proportions.

D) THORACIC SPINE – GROUP B (NON-COLIC)

Table 4. 73 *The table below demonstrates the intra group comparison between locations in the thoracic spine, in the non-colic group. The locations have been ranked in an ascending order, according to the P-value.*

Thoracic Spine – Group B					
Location 1	**Proportion for Location 1**	**Location 2**	**Proportion for Location 2**	**P-value**	**Decision**
T9-L1	0.07	T5-T9	0.24	0.0004	Reject Ho:
T9-L1	0.07	T1-T5	0.17	0.015	Reject Ho:
T5-T9	0.24	T1-T5	0.17	0.110	Fail to Reject Ho:

The intra group data of the comparison of proportions between the different locations, for the thoracic spines of non-colicky infants is illustrated in table 4.73. The thoracic spine was divided into three sections, called locations for the purpose of statistical analysis. The table demonstrates the proportions of occurrence of spinal joint dysfunctions at each location, as well as the differences in proportions between locations.

At the location: T5-T9 (0.24) and T1-T5 (0.17), the p-value is ≥ 0.05, thus we do not reject H_O and therefore conclude that there is not sufficient evidence to suggest that the proportion of spinal joint dysfunction is significantly higher at T5-T9 (0.24) as opposed to T1-T5 (0.17) at a 5% significance level.

The population proportion at T5-T9 (0.24) was higher than the population proportion at T9-L1 (0.07) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at T5-T9 (0.24) as opposed to T9-L1 (0.07) at a 5% significance level.

The population proportion at T1-T5 (0.17) was higher than the population proportion at T9-L1 (0.07) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at T1-T5 (0.17) as opposed to T9-L1 (0.07) at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was as follows: T5-T9 (0.24), T1-T5 (0.17) and T9-L1 (0.07). Thus in the thoracic spines of non-colicky infants, it can be concluded that the location with the highest proportion of occurrence of spinal joint dysfunctions was T5-T9 (0.24).

E) LUMBAR SPINE AND SACRO-ILIAC JOINTS – GROUP A

Table 4. 74 *The table below demonstrates the intra group comparison between locations in the lumbar spine, in the colic group. The locations have been ranked in an ascending order, according to the P-value.*

Lumbar Spine and Sacro-iliac Joints – Group A					
Location 1	**Proportion for Location 1**	**Location 2**	**Proportion for Location 2**	**P-value**	**Decision**
L3-L5	0.16	SI	0.47	0.000001	Reject Ho:
L3-L5	0.16	L1-L3	0.42	0.00003	Reject Ho:
L1-L3	0.42	SI	0.47	0.238	Fail to Reject Ho:

The intra group data of the comparison of proportions between the different locations, for the lumbar spines and sacro-iliac joints of colicky infants is illustrated in table 4.74. The lumbar spine was divided into two sections, called locations for the purpose of statistical analysis. The sacro-iliac joints are being compared to the locations in the lumbar spine as both the areas are considered to form part of the lower spinal area. The table demonstrates the proportions of occurrence of spinal joint dysfunctions at each location, as well as the differences in proportions between locations.

At the locations of the sacro-iliac joints (0.47) and L1-L3 (0.42), the p-value is ≥ 0.05, thus we do not reject H_O and therefore conclude that there is not sufficient evidence to suggest that the proportion of spinal joint dysfunction is significantly higher at the sacro-iliac joints (0.47) as opposed to L1-L3 (0.42) at a 5% significance level.

The population proportion at the sacro-iliac joints (0.47) was higher than the population proportion at L3-L5 (0.16) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at the sacro-iliac joints (0.47) as opposed to L3-L5 (0.16) at a 5% significance level.

The population proportion at L1-L3 (0.42) was higher than the population proportion at L3-L5 (0.16) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at L1-L3 (0.42) as opposed to L3-L5 (0.16) at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was as follows: S.I. joints (0.47), L1-L3 (0.42) and L3-L5 (0.16). Thus in the lower spinal area of colicky infants, it can be noted that the locations with the highest proportions of occurrence of spinal joint dysfunctions were the sacro-iliac joint (0.47) and the upper lumbar (L1-L3 = 0.42) spine areas.

F) LUMBAR SPINE AND SACRO-ILIAC JOINTS – GROUP B (NON-COLIC)

Table 4. 75 *The table below demonstrates the intra group comparison between locations in the lumbar spine, in the non-colic group. The locations have been ranked in an ascending order, according to the P-value.*

Lumbar Spine and Sacro-iliac Joints – Group B					
Location 1	**Proportion for Location 1**	**Location 2**	**Proportion for Location 2**	**P-value**	**Decision**
L3-L5	0.03	SI	0.26	0.000002	Reject Ho:
L3-L5	0.03	L1-L3	0.13	0.005	Reject Ho:
L1-L3	0.13	SI	0.26	0.010	Reject Ho:

The intra group data of the comparison of proportions between the different locations, for the lumbar spines and sacro-iliac joints of non-colicky infants is illustrated in table 4.75. The lumbar spine was divided into two sections, called locations for the purpose of statistical analysis. The sacro-iliac joints are being compared to the locations in the lumbar spine as both the areas are considered to form part of the lower spinal area. The table demonstrates the proportions of occurrence of spinal joint dysfunctions at each location, as well as the differences in proportions between locations.

The population proportion at the sacro-iliac joints (0.26) was higher than the population proportion at L1-L3 (0.13) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at the sacro-iliac joints (0.47) as opposed to L1-L3 (0.13) at a 5% significance level.

The population proportion at L1-L3 (0.13) was higher than the population proportion at L3-L5 (0.03) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at L1-L3 (0.13) as opposed to L3-L5 (0.03) at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was as follows: S.I. joints (0.26), L1-L3 (0.13) and L3-L5 (0.03). Thus in the lower

spinal areas of the non-colicky infants, it can be noted that the location with the highest proportion of occurrence of spinal joint dysfunctions was the sacro-iliac joint (0.26) area. The proportion at this location (sacro-iliac joint area) was significantly higher than the proportions of the other locations in the lower spinal area, as can be noted from the p-values generated by comparing the different locations.

4.4.2.2 Inter group comparison

Statistical analysis of the occurrence data involved the use of the binomial test (using two proportions) to perform a comparison of the occurrence of spinal joint dysfunction between parallel locations between groups. Therefore, parallel locations in Group A (colic) and Group B (non-colic) were compared. An example of the comparison of parallel locations between groups would be as follows: C0-C2 of Group A would be compared to C0-C2 of Group B. The comparison between parallel locations in the inter group analysis was conducted between groups to determine which group had a location with the highest significant occurrence of spinal joint dysfunctions. Thus determining if the occurrence of infantile colic in infants influenced the occurrence of spinal joint dysfunctions. The binomial tests for inter group comparison were only conducted at locations within the defined areas of the spine. The results of the two examiners were pooled to even out the results by creating a larger sample size. All tests were carried out at a 5% level of significance and p-values were used for decision-making.

BINOMIAL TEST USING TWO PROPORTIONS:

The binomial test (using two proportions) was used to compare the occurrence of spinal joint dysfunctions between locations between groups. The occurrence data collected by examiner 1 and 2 was put in spread sheet form by the location. The locations included: C0-C2, C2-C4, C4-C6, C6-T1, T1-T5, T5-T9, T9-L1, L1-L3, L3-L5 and the sacro-iliac joints.

- **H_0**: The population proportion at location 2 in group 1 is equal to the population proportion at location 2 in group 2. $\pi_1 = \pi_2$
- **H_1**: The population proportion is higher at location 2 in group 1 as opposed to location 2 in group 2. $\pi_1 < \pi_2$
- $\alpha = 0.05$ = level of significance.

Decision rule:

If $p \geq \alpha$, at the α level of significance, we fail to reject H_0.

If $p < \alpha$, at the α level of significance, we reject H_0.

A) CERVICAL SPINE – GROUP A VERSUS GROUP B

Table 4. 76 *Prevalence data, inter group comparison between locations in the cervical spine. The locations have been ranked in an ascending order, according to the P-value.*

CERVICAL SPINE				
Locations	**Proportion for Colic**	**Proportion for Non-Colic**	**P-value**	**Decision**
C2-C4	0.66	0.23	$5x10^{-10}$	Reject Ho:
C4-C6	0.31	0.17	0.010	Reject Ho:
C0-C2	0.21	0.11	0.027	Reject Ho:
C6-T1	0.07	0.08	0.394	Fail to Reject Ho:

The inter group comparison of proportions between the parallel locations, in the cervical spines of infants, in Group A and B, is illustrated in table 4.76. The table demonstrates the proportions of occurrence of spinal joint dysfunctions for each group, at each location, as well as the differences in proportions between parallel locations between groups.

The population proportion at C2-C4 (0.66) in Group A is significantly higher than the population proportion C2-C4 (0.23) in Group B respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at C2-C4 (0.66) in Group A as opposed to C2-C4 (0.23) in Group B at a 5% significance level.

The population proportion at C4-C6 (0.31) in Group A is significantly higher than the population proportion C4-C6 (0.17) in Group B respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at C4-C6 (0.31) in Group A as opposed to C4-C6 (0.17) in Group B at a 5% significance level.

The population proportion at C0-C2 (0.21) in Group A is significantly higher than the population proportion C0-C2 (0.11) in Group B respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at C0-C2 (0.21) in Group A as opposed to C0-C2 (0.11) in Group B at a 5% significance level.

Alternatively, it can be noted that at the location: C6-T1 (0.08) in Group A and C6-T1 (0.07) in Group B, the p-value is $\geq$ 0.05, thus we do not reject H_O and therefore conclude that there is not sufficient evidence to suggest that the proportion of spinal joint dysfunction is significantly higher at C6-T1 (0.08) in Group A as opposed to C6-T1 (0.07) in Group B at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was the same in both groups. The ranking by location, for Group A and B respectively, was as follows: C2-C4 (0.66; 0.23), C4-C6 (0.31; 0.17), C0-C2 (0.21; 0.11) and C6-T1 (0.07; 0.08). Thus in the cervical spines of infants, with and without colic, it can be concluded that the location with the highest significant proportion of occurrence of spinal joint dysfunctions was C2-C4 (0.66; 0.23) for Group A and B, respectively.

B) THORACIC SPINE – GROUP A VERSUS GROUP B

Table 4. 77 *Prevalence data, inter group comparison between locations in the thoracic spine. The locations have been ranked in an ascending order, according to the P-value.*

THORACIC SPINE				
Locations	**Proportion for Colic**	**Proportion for Non-Colic**	**P-value**	**Decision**
T5-T9	0.49	0.24	0.0001	Reject Ho:
T9-L1	0.22	0.07	0.001	Reject Ho:
T1-T5	0.27	0.17	0.044	Reject Ho:

The inter group comparison of proportions between the parallel locations, in the thoracic spines of infants, in Group A and B, is illustrated in table 4.77. The table demonstrates the proportions of occurrence of spinal joint dysfunctions for each group, at each location, as well as the differences in proportions between parallel locations between groups.

The population proportion at T5-T9 (0.49) in Group A was higher than the population proportion at T5-T9 (0.24) in Group B respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at T5-T9 (0.49) in Group A as opposed to T5-T9 (0.24) in Group B at a 5% significance level.

The population proportion at T1-T5 (0.27) in Group A was higher than the population proportion at T1-T5 (0.17) in Group B respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at T1-T5 (0.27) in Group A as opposed to T1-T5 (0.17) in Group B at a 5% significance level.

The population proportion at T9-L1 (0.22) in Group A was higher than the population proportion at T9-L1 (0.07) in Group B respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at T9-L1 (0.22) in Group A as opposed to T9-L1 (0.07) in Group B at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was the same in both groups. The ranking by location, for Group A and B respectively, was as follows: T5-T9 (0.49; 0.24), T1-T5 (0.27; 0.17) and T9-L1 (0.22; 0.07). Thus in the thoracic spines of infants, with and without colic, it can be concluded that the location with the highest significant proportion of occurrence of spinal joint dysfunctions was T5-T9 (0.49; 0.24) for Group A and B, respectively.

C) LUMBAR SPINE AND SACRO-ILIAC JOINTS – GROUP A VERSUS GROUP B

Table 4. 78 *Prevalence data, inter group comparison between locations in the lumbar spine. The locations have been ranked in an ascending order, according to the P-value.*

LUMBAR SPINE AND SACRO-ILIAC JOINTS				
Locations	**Proportion for Colic**	**Proportion for Non-Colic**	**P-value**	**Decision**
L1-L3	0.42	0.13	0.000002	Reject Ho:
L3-L5	0.16	0.03	0.001	Reject Ho:
SI	0.47	0.26	0.001	Reject Ho:

The inter group comparison of proportions between the parallel locations, in the lower spinal areas of infants, in Group A and B, is illustrated in table 4.78. The table demonstrates the proportions of occurrence of spinal joint dysfunctions for each group, at each location, as well as the differences in proportions between parallel locations between groups.

The population proportion at the sacro-iliac joints (0.47) in Group A was higher than the population proportion at the sacro-iliac joints (0.26) in Group B respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at the sacro-iliac joints (0.47) in Group A as opposed to the sacro-iliac joints (0.26) in Group B at a 5% significance level.

The population proportion at L1-L3 (0.42) in Group A was higher than the population proportion at L1-L3 (0.13) in Group B respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at L1-L3 (0.42) in Group A as opposed to L1-L3 (0.13) in Group B at a 5% significance level.

The population proportion at L3-L5 (0.16) in Group A was higher than the population proportion at L3-L5 (0.03) in Group B respectively. It can be noted

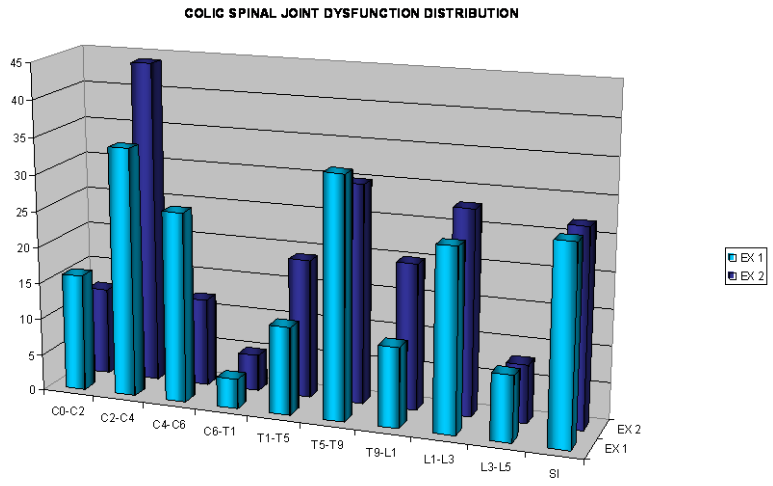
that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at L3-L5 (0.16) in Group A as opposed to L3-L5 (0.03) in Group B at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was the same in both groups. The ranking by location, for Group A and B respectively, was as follows: the sacro-iliac joints (0.47; 0.26), L1-L3 (0.42; 0.13) and L3-L5 (0.16; 0.03) . Thus in the lower spinal areas of infants, with and without colic , it can be concluded that the location with the highest significant proportion of occurrence of spinal joint dysfunction was the location of the sacro-iliac joints (0.47; 0.26) for Group A and B, respectively.

4.4.3 DISTRIBUTION OF SPINAL JOINT DYSFUNCTIONS

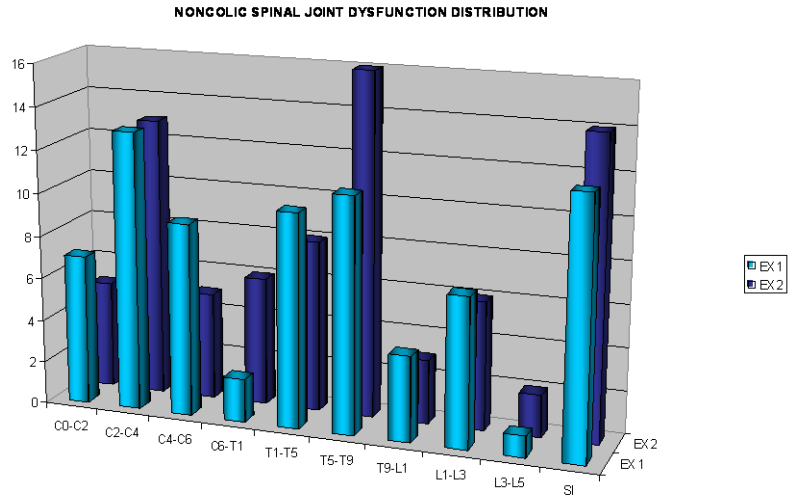
The charts below have been constructed to demonstrate the distribution of the spinal joint dysfunctions. The areas of the spine where the spinal joint dysfunctions commonly occur in the infants in both groups can be noted.

Figure 4. 1 *The distribution of spinal joint dysfunction in the experimental (colic) group.*



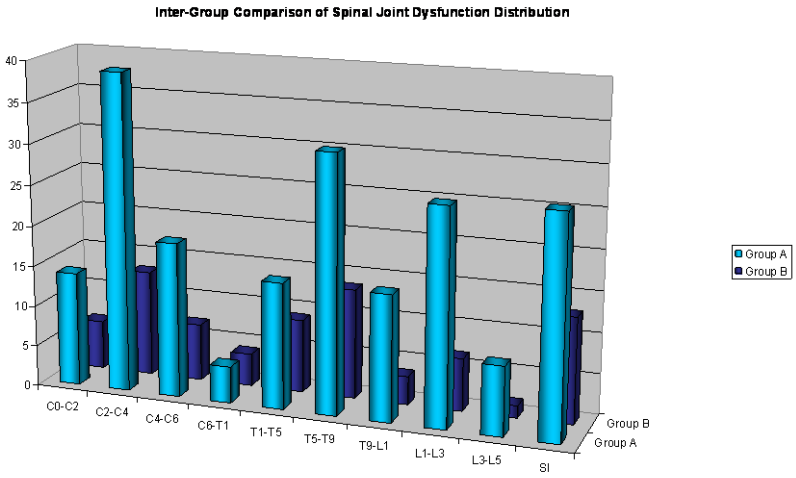
In figure 4.1, the levels of spinal joint dysfunctions demonstrating the most involvement in the experimental group were the C2-C4 levels, T5-T9, L1-L3 and the sacro-iliac joints. In conclusion these areas would consist of the upper cervical, mid thoracic, upper lumbar regions and the sacro-iliac joints.

Figure 4. 2 *The distribution of spinal joint dysfunction in the control (non-colic) group.*



In figure 4.2, the levels of spinal joint dysfunctions demonstrating the most involvement in the control group were the C2-C4 levels, T5-T9, T1-T5 and the sacro-iliac joints. In conclusion these areas would consist of the upper cervical, mid thoracic and upper thoracic regions, respectively and the sacro-iliac joints.

Figure 4. 3 *The comparison of the distribution of spinal joint dysfunction in the experimental (colic) and control (non-colic) group.*



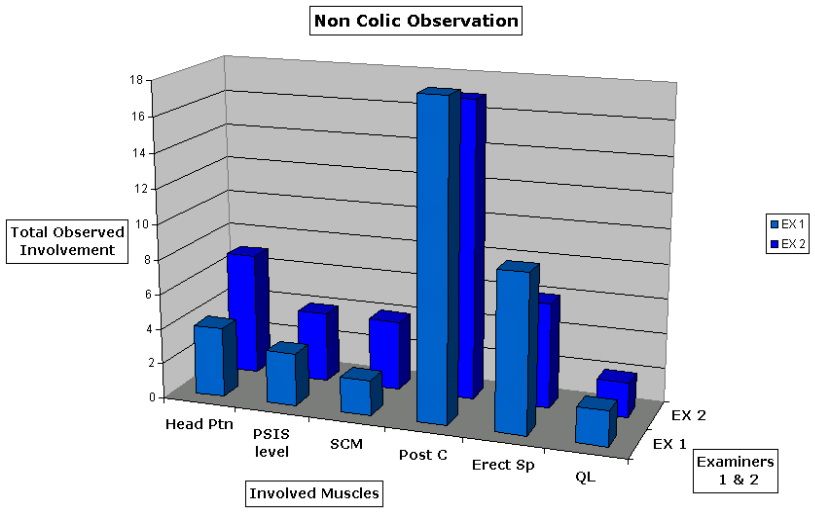
In figure 4.3, the levels of spinal joint dysfunctions of the common levels of involvement of the spinal joint dysfunctions. In conclusion these areas would consist of the upper cervical, upper thoracic, mid thoracic, upper lumbar and the sacro-iliac joints in the experimental and control group. The graph demonstrates the regions.

4.4.4 OBSERVED LANDMARKS AND MUSCLE GROUPS

The researchers noted the head position, posterior superior iliac spine (PSIS) levels and different muscle groups' involvement during the examination of the infants. The charts below demonstrate the involvement or the occurrence of the observed landmarks noted in the participating infants.

Figure 4.4 demonstrates the findings of the examiners when assessing the infants in the control group or Group B. The findings noted in this group are significantly less than in the experimental or colicky group. The posterior cervical muscle group showed significant involvement or a higher occurrence of spasm in the infants in the control group than the other muscle groups and landmarks. The sternocleidomastoid and quadratus lumborum muscle groups showed the least occurrence of spasm of the muscle groups in the control group.

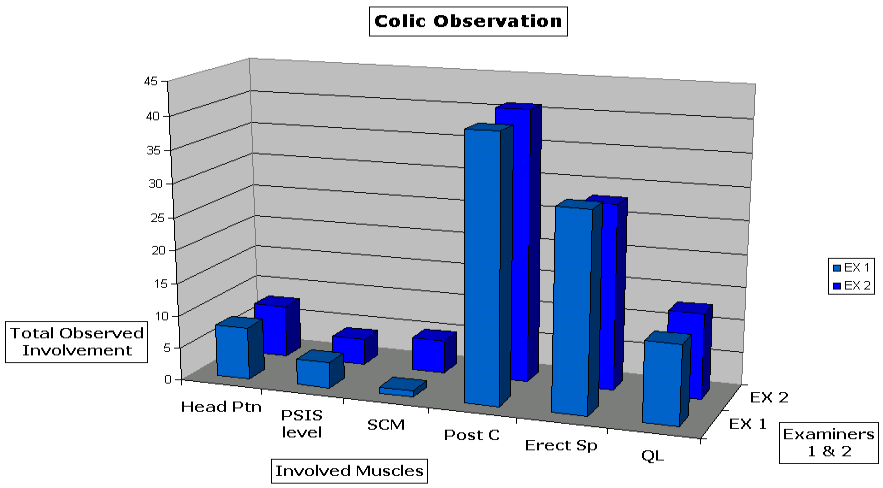
Figure 4. 4 *Observation of the control group*



The posterior cervical, erector spinae and quadratus lumborum muscle groups showed significant occurrence of spasm in the infants in the experimental group (figure 4.5). The muscle group showing the least occurrence of spasm in the experimental group was the sternocleidmastoid muscle group. It can be noted that the posterior cervical, erector spinae and quadratus lumborum

muscle groups demonstrated significantly higher occurrence of spasm in the experimental group than the control group.

Figure 4. 5 *Observation of the experimental group*



CHAPTER FIVE

5.0 DISCUSSION OF RESULTS

5.1 INTRODUCTION

This chapter will discuss the results obtained from the researcher's objective clinical findings presented in chapter four. Demographic data of the study population will also be discussed. General trends of the occurrence and distribution of spinal joint dysfunction will be analysed. The infants in the experimental group (Group A) were the infants suffering from infantile colic and the infants in the control group (Group B) did not have infantile colic.

5.2 DEMOGRAPHIC DATA

5.2.1 ETHINC, AGE AND GENDER DISTRIBUTION

Tables 4.1, 4.2 and 4.3, provide the breakdown of the ethnic, age and gender distribution (respectively) for Group A and B. In the ethnic distribution of the study population (table 4. 1), the largest group of participating infants were the black infants (64%) and the smallest group of infants were from the coloured population (1%). The number of black infants (64) participating in the study was more than double the second largest group of infants participating (28). The reason for the large number of black infants participating was that many of the rural government clinics included in the target area were busy clinics that serviced a large community and as a consequence contributed a significant number of the infant population required for the study. The white infants (28) were mainly recruited from small private antenatal clinics, which contributed a limited amount to the sample population.

As the nursing staff and the mothers visiting the various clinics became familiar with chiropractic and comfortable with the motion palpation procedure, the snowball sampling method came into effect. The communities in which the study was conducted became more chiropractically aware as the study progressed and each time the researchers presented at a clinic, a previous participant would encourage parents unfamiliar with the study, to participate. The communities were largely unaware of the benefits of chiropractic and through participation in the study many parents were willing to take their infant to a chiropractor, should the need arise.

The occurrence of infantile colic was equally common in all the participating ethnic groups, when comparing the ratios between the Group A and Group B. It was therefore noted that infantile colic was equally as common in the black (32%) community as the white (16%) community. The number of Indian and coloured infants participating in the study were not sufficient to contribute to the demographic data. On examination of the demographic data, colic was found to occur equally in both the rural and urban communities. It was noted that mothers in the rural communities were more reluctant to view the infant crying behaviour as problematic, than the mothers from the urban communities. Even though the colicky infants cried for extended periods of time at night, the rural mothers did not feel that it was a problem. The cultural perception of colic was noted to be varied in the different communities and should be a factor to take into consideration in further studies.

The average age of the participating infants in the study (table 4.2) was 46 days (6.5 weeks) for Group A and 49 days (7 weeks) for Group B. The average age of the infants in this study were in keeping with the studies completed by Wiberg et al. (1999), Mercer's (1999:34) and Klougart (1989), who noted the average ages of the infants to be between 5 and 6 weeks. A possible explanation for the consistency of the "6 weeks" average age of the infants participating in the various studies is that the first set of vaccinations are administered at 6 weeks and it is usually one of the first visits to the clinics for the majority of the mothers. This however would not include mothers attending private clinics, as visits occur on a weekly basis.

The youngest age group of participating infants ranged between 14 and 21 days and included 13% of the study population. This was made up of 5% of infants from Group A and 8% of infants from Group B. The oldest age group of participating infants ranged between 64 and 70 days and included 30% of the study population. This was made up of 10% of infants from Group A and 20% of infants from Group B. The majority of infants in Group A were aged 64-70 days (10%) and 36-42 days (9%) while the majority of infants in Group B were aged 64-70 days (20%). The explanation for the clustering of the ages of the participating infants noted to be around 6 and 10 weeks could possibly be the recommended vaccination dates. It must be noted that the mothers, especially in the rural communities, often delay in bringing infants to the clinics for the necessary vaccinations.

The gender distribution of the infants (table 4.3) in the study was 51% female and 49% male. The gender ratios of infants in Group A were 22 females and 28 males while Group B included 29 females and 21 males. The gender distribution of the infants in this study were in keeping with the gender distribution ratios in studies completed by Olafsdottir et al. (2001), Wiberg et al. (1999), Mercer's (1999:34) and Klougart (1989), who noted the ratio between male and female infants to be approximately equal. There is no evidence that colic may be more prevalent in one gender as compared to the other.

5.2.2 TYPE OF BIRTH vs. ETHNIC DISTRIBUTION

Tables 4.4, 4.5 and 4.6 demonstrate the types of births and the relation to the ethnic distribution. The majority of the participating infants (table 4.4) in the study were born by natural birth (63%) while the remaining infants (37%) were born by caesarean section. The comparison of natural and caesarean births in Group A (17 and 33) and Group B (20 and 30) revealed significant differences between the groups, respectively.

In table 4.5, the comparison of the ethnic distribution and the number of caesarean births (37%) were illustrated. It was noted that there was no significant difference in the number of caesarean births between Group A and Group B. The black participating infants, in Group A (11) and Group B (11) accounted for the largest group of infants (22%) born by caesarean section. The white infants were the second largest group born by means of caesarean where Group A (6) and Group B (8) revealed no significant differences. There were not sufficient infants from the coloured and Indian populations participating to contribute to the data.

In table 4.6, the comparison of the ethnic distribution and the number of natural births (63%) were illustrated. It was noted that there was no significant difference in the number of natural births between Group A and Group B. The black participating infants, in both Group A (21) and Group B (21) accounted for the largest group of infants (42%) born by natural birth. The white infants were the second largest group (14%) accounting for the natural birth group where Group A (10) and Group B (4) revealed the only notable difference (6).

When the total number of the ethnic groups were noted and compared to the ratio of caesarean (table 4.5) to natural (table 4.6) birth, the following was noted. In the black infant population (64) of the study, almost one third of the infants (22) in Group A and Group B were born by caesarean and two-thirds (42) of the population in Group A and Group B, were born by natural birth.

When the same comparison is run on the infants of the white population (28) of the study, just over half of the infants (14) in Group A and Group B were born by caesarean and the other half (14) of the population in Group A and Group B, were born by natural birth. The group of participating Indian infants accounted for 6% of the natural births and also revealed no significant difference between Group A (2) and Group B (4). There were not sufficient infants from the coloured populations participating to contribute to the data.

In the study completed by Olafsdottir et al. (2001), the natural birth to caesarean section rations were 77% to 9.7% in the control group and 75% to 12.5% in the experimental group, respectively. The results of this study are not in keeping with these findings. However, the findings of Olafsdottir et al. (2001) are in keeping with the average rate of caesarean deliveries in the Tygerberg Academic Hospital in the Western Cape, South Africa, from 1975 to 1994. In a retrospectively study completed by Steyn et al. (1998) it was noted that the rate of caesarean deliveries was kept at a constant rate of 13% over 20 years.

Qian et al. (2001) completed an evidence-based observation study on four hospitals in China and noted that the natural births accounted for 50% of the births (303 out of 599 births). The rates of caesarean births ranged from 30% to 73% in the different hospitals and of the total of 296 caesareans deliveries, 235 (79%) were as a result of emergencies such as foetal distress or abnormal positions. In view of the results from the study completed by Qian et al. (2001), where the results of natural (50%) versus caesareans (50%) births, the results are in keeping with the ratios between Group A (14) and B (14) in the white sample population. It may be noted that the sample population of this study (n=100) is to small to drawn conclusions from, regarding birth statistics, however, the results only are being used for the purpose of demographic comparison.

Matshidze et al. (1998) may offer a plausible explanation for the natural versus caesarean birth statistics noted in this study. Matshidze et al. (1998) completed a study on the caesarean section rates in Soweto-Johannesburg, South Africa and concluded that the possible differences in caesarean rates may be a reflection of a clinical bias in decision-making by doctors, different attitudes of the different groups of women towards childbirth and possibly their capacity to negotiate with their clinicians. Although caesarean rates of white and coloured women were higher than those of black women, Matshidze et al. (1998) noted that is was not because of differences in demographic risks or access to private health care.

5.2.3 METHOD OF FEEDING vs. ETHNIC DISTRIBUTION

Tables 4.7, 4.8, 4.9 and 4.10 provided a breakdown of the method of feeding and the comparison to the ethnic distribution. In table 4.7, the comparison of method of feeding between Group A and Group B revealed no notable differences. The breast fed infants accounted for the largest group of infants (55%), while the formula fed infants (21%) and the infants being both, breast and formula fed (24%) accounted for the remaining groups of infants. The respective order of the feeding methods used, as noted above is reflect in the findings of other spinal manipulative studies (Olafsdottir et al. 2001, Klougart 1989). A plausible explanation for this is that breastfeeding is the method of choice for infants, for both nutritional and hygienic purposes and is encouraged in antenatal clinics.

The feeding distribution ratios of the infants in this study were in keeping with the feeding distribution ratios in the study completed by Klougart (1989), who noted the ratio between breastfeeding, both breast and formula and formula alone, to be 67%, 15% and 18% respectively. It can be noted that the numbers of mothers who breastfed is slightly higher in the study by Klougart (1989) (67%) as compared to 55% in this study. In the study completed by Olafsdottir et al. (2001) the number of breastfed infants was significantly higher than the results obtained by Klougart (1989). The control (80%) and experimental (93.5%) group breastfeeding results indicate that the correct parental support and education, as provided during participation in the study,

can strongly influence the choice and effectiveness of the feeding method employed.

In table 4.8, the comparison of the number of breast fed infants to the ethnic distribution was illustrated. It was noted that there were no differences between Group A and B. The group of black infants accounted for the largest group of infants (38%) and the white infants formed the second largest group (13%). The Indian (3%) and coloured (1%) infants formed the remaining groups of infants. In evaluation of the breastfeeding data, no notable association seems visible between the prevalence of colic and breastfeeding as determined by Clifford et al. (2002). However, it must be noted that the sample is a too small to draw any significant conclusions from and statistical analysis would be necessary to accurately determine the observation.

Breastfeeding is the accepted method of choice for feeding young infants and this is noted in a study completed in Malawi, on HIV transmission through breastfeeding by Miotti, Taha, Kumwenda et al. in 1999 (as cited by Bowersox, 1999: online http://www.niaid.nih.gov/newsroom/releases/hivbreastfed.htm, from the National Institute of Allergy and Infectious Diseases). The study noted that breastfeeding is the recommended method of feeding in developing countries, as alternatives to breast milk are unavailable, unsafe or culturally unacceptable. The majority of the black infants in the study were from rural areas and received breast milk rather than formula, as the alternative means of feeding may not have been optional. With the prevalence of HIV in the adult population of Kwazulu Natal estimated to be 33.5% in 1999 (Smith, 2000), educational facilities need to be established to inform HIV infected mothers on the correct feeding methods suitable in such circumstances, to aid the prevention of HIV transmission to infants through breastfeeding. It is possible that a large number of the infants who participated in the study were breastfed by HIV infected mothers. However, the affordability and hence the availability of the alternative means to breastfeeding these infants would be a matter for further contention.

In table 4.9, the comparison of the number of formula fed infants to the ethnic distribution was illustrated. It was noted that there were no significant differences between Group A and B. The group of black infants accounted for the largest group of infants (12%) and the white infants formed the second largest group (7%). The Indian (2%) infants formed the remaining group of infants. When comparing the data of the white infants in table 4.8 and 4.9, it can be noted that half of the total number of white infants were being fed formula. The infants came from affluent areas and the mothers were educated in the most suitable method of feeding. A plausible explanation for this may be that the mothers preferred to feed the infants formula for convenience purposes, breast feeding difficulties or possible employment obligations.

In table 4.10, the comparison of the number of breast and formula fed infants in relation to the ethnic distribution was illustrated. No significant differences were noted between Group A and B. The group of black infants accounted for the largest group of infants (14%) and the white infants formed the second

largest group (7%). The Indian (2%) infants formed the remaining group of infants. The group of breast and formula feeding (table 4.10) was larger than the group where the infants only received formula (table 4.9). The possible explanation for this is that mothers appreciated the importance of breast milk, but were unable to produce sufficient amounts for daily feeds or had work obligations and so supplemented the infants' diets with formula.

5.2.4 MATERNAL AGE vs. ETHNIC DISTRIBUTION

Table 4.11 illustrated the breakdown of the maternal ages. When combining the groups of mothers, the overall results revealed that the youngest group of mothers was aged 18 to 20 years (17%), while the oldest group of mothers was over 35 years and accounted for 4%. The group aged 26-30 years was the largest with 32%, the second largest group was aged 21-25 years with 26% and thirdly followed by 23% from the group aged 31-35 years. The largest group aged 26-30 appears to be the most popular time for mothers to start having children. This age group was dominated by black mothers (12) in Group A (table 4.12) and by white mothers (6) in Group B (table 4.13). It may be noted that this age group (26-30) also roughly includes the average age of mothers with colicky infants as noted in previous studies Clifford et al. (2002) (29.4 years), Wiberg et al. (1999) (29 years) and Olafsdottir et al. (2001) (31 years).

The age group of mothers that constitutes the second largest group is the younger age group of 21-25 years. This group is dominated by the black mothers (9) in Group A (table 4.12) and in Group B (11) as can be noted in table 4.13. A possible explanation for the predominance of black mothers in this age group may be due to the rural lifestyle, African culture and poverty. As a result of these factors, the women aged 21-25 have children earlier and indirectly start families sooner than white women of the same age who seek a higher education or pursue careers. The oldest of the three age groups (31-35) may possibly include the women pursuing their careers or mothers having their second or third chid. As can be noted in tables 4.12 and 4.13 both black and white mothers of equal proportions contribute to this group.

The maternal age for the experimental group in this study was 25.9 years, which was slightly younger than the average maternal age noted by Clifford et al. (2002) (29.4), Wiberg et al. (1999) (29 years) and Olafsdottir et al. (2001) (31 years). The low average age of the mothers in this study may be attributed to the fact that a large number of the infants in the black population had mothers who were 25 years and under (15 mothers).

Sondergaard et al. (2000) found that the older women had a higher risk of having infants with infantile colic, however this was not observed in this study. The author further noted that the level of education, type of residence and cohabitation were not associated with infantile colic as previously believed (Crowcroft and Strachan 1997). However, in the sample population of the study completed by Clifford et al. (2002), the mothers participating were from affluent households with annual incomes in excess of $40 000 and 75% of the

mothers included had completed a higher education. Although the criteria according to Wessel et al. were used to diagnose colic, the prevalence of infantile colic was noted to be as high as 24%. The information revealed by Clifford et al. (2002) further suggests that higher education and an affluent background may still be a confounding factor in the development of infantile colic. Kibel and Wagstaff (1991:253) noted that in South Africa, on questioning mothers and experienced health care providers in the health clinics, colic occurred in sophisticated educated communities just as often as in unsophisticated uneducated communities. The authors concluded that the parents of the unsophisticated communities seldom sought advice for the typical colic behaviour and accepted it as normal. The demographic data collected during the study revealed that infantile colic occurred equally in affluent and rural areas. The explanation for this may be that the cultural perception of the community or the social support available to the mother may have influenced the mother's perception on the severity of infantile colic.

5.2.5 MATERNAL PARITY vs. ETHNIC DISTRIBUTION

Table 4.14 provides the maternal parity for the study population. The average maternal parity in Group A was 1.54 compared to 1.72 in Group B. The largest group to participate were mothers having their first child and made up 56% of the total participating infants. A comparison between the two groups for first child revealed no notable differences. It is believed that infantile colic is more prevalent in the first-born child (Kibel and Wagstaff 1991: 253) as can be noted in the results in table 4.14. A possible explanation for the large number of first born infants may be that the fact that the majority of participating mothers are young, or due to increased maternal anxiety during the learning curve of early motherhood. Rautava et al. (1993) explained that parental stress and dissatisfaction in marital relationships during colic did not explain the cause of colic, however, that families with low coping capabilities or dysfunctional family dynamics were more likely to have an infant who developed colic. The encouragement of parents through family difficulties by teaching coping mechanisms and nurturing skills enabled parents to manage screaming infants at home. The largest participating group were the younger black mothers and they did not perceive their infant's colicky behaviour as problematic even though their infants also cried for hours at a time. Although their culture is communal based, the support the mothers received may not have included coping mechanisms.

The number of second and third siblings revealed no significant differences in the groups and totalled at 32% and 12%, respectively. The rate of older siblings was slightly less that the findings of Olafsdottir et al. (2001) who noted that rates to be 62.5% for the control group and 58.7% for the experimental group.

The average maternal parity in Group A (Table 4.15) was lowest in the Indian and white ethnic groups with 1.5 infants, followed by the black ethnic group with 1.6 infants per mother. The minimum parity noted in all the participating ethnic groups was 1 while the highest parity noted was 5, noted in the black ethnic group. The average maternal parity in Group B (Table 4.16) was lowest

in the coloured ethnic group with 1 infant, followed by the Indian ethnic group with 1.2 infants per mother. The minimum parity noted in all the participating ethnic groups was 1 while the highest parity noted was 5, noted in the black ethnic group.

5.2.6 ONSET AND DURATION OF INFANTILE COLIC

Table 4.17 displays the onset and duration of infantile colic in the study population. The minimum observed age at which the infants developed infantile colic was the first day of life and the oldest infant participating in the study to develop colic was 63 days old. The average onset of infantile colic in Group A was 11.5 days (1.5 weeks). This is in keeping with the average age of onset of infantile colic in the studies by Wiberg et al. (1999), Mercer (1999:26) and Klougart et al. (1989), which were found to range between 1.2 to 2.2 weeks, 13 days and 2 weeks respectively. Research needs to further investigate the possible triggers or factors that influence the development of infantile colic such as the increase in protein levels in the breast milk at 2 weeks, changes in maternal diets or a peak in the sleep deprivation and hence anxiety levels in mothers at that time.

The average duration of infantile colic before the infants entered the study was 35.48 days. The minimum duration of an infant with infantile colic, before being included into the study was 4 days while the oldest infant with colic accepted into the study was 69 days old. The average duration of infantile colic before the infants entered the study was 35.48 days or 5 weeks and this was noted to be slightly higher than 3.7 weeks and 3.6 to 4.3 weeks as noted by Wiberg et al. (1999) and Olafsdottir et al. (2001), respectively. A possible explanation for the high average duration of colic in the study may have been that many of the colicky cases were severe and began on the first day of life. A few of the cases had persisted for many weeks before the infants participated in the study, hence the inclusion of the older infants still suffering from infantile colic.

5.2.7 DURATION OF CRYING SPELLS

Table 4.18 provides a breakdown of the duration of the crying spells of the study population. The average duration of crying spells of infants in Group A was 5.75 hours per day, compared to Group B where the average duration of crying per day was noted to be 16 minutes per infant. The average duration of crying spells of infants in Group A (5.75 hours) was noted to be similar to the duration of crying spells per day noted by Wiberg et al. (1999) and Olafsdottir et al. (2001), which were 4.3 - 5.2 hours and 4.9 - 5.3 hours respectively. Mercer (1999:34) noted the average duration of crying spells per day to be approximately 2 hours. The results were also in keeping with the definition of colic where crying had to occur for more the 3 hours a day.

The average duration per crying spell in Group A was 2.06 hours per spell compared to the 7.5 minutes per spell of the infants in Group B. The findings of Group A were noted to be similar to the average duration of crying per spell

noted by Wiberg et al. (1999), which varied between 3.4 – 3.9 hours. Mercer (1999:34) noted the average duration of crying per spell to be approximately 2 hours.

The minimum duration of crying in Group A was 30 minutes as compared to 0 minutes noted in Group B. The maximum duration of crying in Group A was 6 hours as compared to 30 minutes noted in Group B. It can be noted that 100% of the infants in Group B cried for less that 30 minutes per crying spell, whereas 99% of Group A cried for longer that 30 minutes per spell.

It was also noted that the mothers from the rural communities were reluctant to declare that the infant's crying was excessive. When questioning the mothers about the crying behaviour of their infants, it was not mentioned that the crying was a problem or that it occurred for extended periods of time. It was noted that the most effective way of extracting the information about the crying behaviour of the infants from the mothers was to ask them what time the infant began crying and what time it stopped. The mothers would then disclose that the crying began in the early hours of the evening and stopped in the early hours of the morning. In the urban communities it was noted that the mothers had no concerns declaring how much the infants cried. The main concern or perception of the mothers was that the infants seemed to be in pain when crying.

5.2.8 FREQUENCY AND OCCURRENCE OF CRYING SPELLS

Table 4.19 illustrates the breakdown of the frequency of crying spells in the study. The minimum frequency of crying noted in Group A was once per day as compared to zero times per day in Group B. The maximum frequency of crying per day noted in Group A was 10 times per day as compared to 8 times per day in Group B. The average frequency in Group A was 3.14 times per day as compared to 2.38 times per day in Group B. Klougart et al. (1989) noted that the average frequency of crying spells per day for the infants was 2.5 times per day. This was in keeping with the findings in Group A (3.14 times per day) and B (2.38 times per day). Group A reveal that the majority of infants experienced crying spells between 2 (15%) to 3 (15%) times per day as compared to Group B where the most common frequency of crying spells was twice (20%) per day.

The majority of the crying noted in the participating infants (Table 4.20 and 4.21), occurred in the evening period of the day and totalled at 60%. There was a significant difference noted between Group A (35) and B (25). This difference noted in percentage is as follows: Group A (70%) and Group B (51%). The second largest group of infants to cry in Group B, cried in the morning (16%) as compared to Group A, which revealed the infants to cry in the afternoon and evening (12%). The consistent diurnal crying pattern of 70% noted in the Group A (colicky infants) was in keeping with the results of Olafsdottir et al. (2001), who noted crying in the evenings to range between 85 to 88.6% and Klougart et al. (1989) who note 91%. Mercer (1999:35) only noted 45% of the infants to crying in the evening hours. A possible

explanation for this may have been that the mothers misinterpreted questions while answering questionnaires or forgot to record the infant's crying spells at night.

5.3 OBJECTIVE ONE

To determine if there is an association between infantile colic and the location of spinal joint dysfunctions in the spines of colicky infants by comparing healthy colicky and non-colicky infant populations in terms of clinical findings.

5.3.1 RESULTS OF CHI SQUARED TEST AND CRAMER'S V MEASURE OF ASSOCIATION

A) THE CERVICAL SPINE, THORACIC SPINE, LUMBAR SPINE AND SACRO-ILIAC JOINTS.

The results of the chi square tests (Table 4.26 and 4.31) showed a significant association between the occurrence of spinal joint dysfunction and infantile colic, for both the examiners' findings on analysis of the spinal regions (C0-T1, T1-L1, L1-L5 and the sacro-iliac joints). These results indicate that the infants that have a high occurrence of spinal joint dysfunction are associated with infants that have infantile colic. Therefore the occurrence of spinal joint dysfunction in healthy infants suffering from infantile colic is higher than in non-colicky infants.

The results of Cramer's V (Table 4.32) showed that there was a significant measure of association for the examiners' findings, for both Group A and Group B in the spinal regions analysed (C0-T1, T1-L1, L1-L5 and the sacro-iliac joints). However, no measure of association was determined for the findings of the examiners for Group B of the lumbar spine. Therefore the examiners showed good inter-examiner reliability for the spinal regions tested except for Group B of the lumbar spine. The reason for this was that the examiners each found a total of eight spinal joint dysfunctions in the lumbar spines of the infants in Group B but only agreed on two of the locations. Therefore no level of inter-examiner reliability was determined.

B) THE CERVICAL SPINE

- **Upper (C0-C4) and Lower (C4-T1) Cervical Spine**

The results of the chi square tests (Table 4.37) showed a significant association between the occurrence of spinal joint dysfunction and infantile colic, for both the examiners' findings, in the upper half (C0-C4) of the cervical spine. The association in the lower half (C4-T1) of the cervical spine was only noted by examiner 1 and not by examiner 2. The reason for this was that examiner 2 noted slightly more spinal joint dysfunctions above C4 and fewer below C4 on examination of the colicky infants in Group A, thus resulting in no

association between colic and spinal joint dysfunctions at that location for examiner 2. It must be noted that the difference in the recording of the spinal joint dysfunctions was negligible as the examiners findings were still shown to have a significant level of inter-examiner reliability. The chi square results therefore indicate that the infants that have a high occurrence of spinal joint dysfunction in the upper half (C0-C4) of the cervical spine are associated with infants that have infantile colic. Therefore it can be noted that the occurrence of spinal joint dysfunction in the upper half (C0-C4) of the cervical spines of healthy infants suffering from infantile colic is higher than in non-colicky infants.

The results of Cramer's V (Table 4.48) showed that there was a significant measure of association for the examiners' findings, for both Group A and Group B, in the upper (C0-C4) and lower (C4-T1) halves of the cervical spine. Therefore a significant measure of inter-examiner reliability was achieved between the examiners in the upper (C0-C4) and lower (C4-T1) halves of the cervical spine.

- **Upper (C0-C2), Mid-Upper (C2-C4), Mid-Lower (C4-C6) and Lower (C6-T1) Cervical Spine**

The results of the chi square tests (Table 4.42 and 4.47) showed a significant association between the occurrence of spinal joint dysfunction and infantile colic, for both the examiners' findings, in the mid-upper (C2-C4) cervical spine. An association was also noted for the findings of examiner 1 in the mid-lower cervical spine (C4-C6). No association was found in the upper (C0-C2) and lower (C6-T1) cervical spine for both the examiners or in the mid-lower (C4-C6) cervical region for examiner 2. A possible explanation for the differences in examiner findings was that examiner 2 noted the majority of spinal joint dysfunctions of the colicky infants to occur between C2-C4 where as examiner 1 noted spinal joint dysfunctions to occur all locations, with concentrations at C2-C4, but also including C0-C2 and C4-C6.

The chi square tests results therefore indicate that the infants that have a high occurrence of spinal joint dysfunction in the mid-upper (C2-C4) cervical spine are associated with infants that have infantile colic. Therefore the occurrence of spinal joint dysfunction in the mid-upper (C2-C4) cervical spines of healthy infants suffering from infantile colic is higher than in non-colicky infants.

The results of Cramer's V (Table 4.49) showed that there was a measure of association for the examiners' findings, for both Group A and Group B, in the upper (C0-C2) and mid-lower (C4-C6) cervical spine. An association was also noted for the examiners' findings for Group B in the mid-upper (C2-C4) and lower (C6-T1) cervical spine but not for Group A. The differences in inter-examiner reliability can be explained as a result of the findings of examiner 2 noting a concentration of spinal joint dysfunctions that was far greater than that noted by examiner 1. This resulted in a discrepancy in the results, even though the examiners findings both demonstrated that C2-C4 had the strongest association with infantile colic. Therefore the results of the Cramer's

V determined that a significant measure of inter-examiner reliability was determined for the examiners' findings for the upper (C0-C2) and mid-lower (C4-C6) cervical spine regions.

C) THE THORACIC SPINE

- **Upper (T1-T7) and Lower (T7-L1) Thoracic Spine**

The results of the chi square tests (Table 4.54) showed an association between the occurrence of spinal joint dysfunction and infantile colic, for both the examiners' findings, in the upper half (T1-T7) of the thoracic spine and in the lower half (T7-T12) of the thoracic spine for examiner 2 but not examiner 1. This occurred as a result of examiner 1 not finding as many spinal joint dysfunctions in the lower thoracic spine as examiner 2.

The results therefore indicate that the infants that have a high occurrence of spinal joint dysfunction in the upper half (T1-T7) of the thoracic spine are associated with infants that have infantile colic. Therefore the occurrence of spinal joint dysfunction in the upper half (T1-T7) of the thoracic spines of healthy infants suffering from infantile colic is higher than in non-colicky infants.

The results of Cramer's V (Table 4.62) showed that there was a measure of association for the examiners' findings, for Group B in the upper half (T1-T7) of the thoracic spine. The lack of inter-examiner reliability in Group A occurred as a result of a difference on agreement of locations of seventeen out of fifty spinal joint dysfunctions. A measure of association for the examiners' findings was also noted for both groups in the lower half (T7-T12) of the thoracic spine. Therefore a measure of inter-examiner reliability was achieved for Group B in the upper half (T1-T7) of the thoracic spine and in both groups in the lower (T7-L1) half of the thoracic spine.

- **Upper (T1-T5), Mid (T5-T9) and Lower (T9-L1) Thoracic Spine**

By considering table 4.61 we conclude that there is an association between spinal joint dysfunction and infantile colic, in the upper (T1-T5) thoracic spine for examiner 2, at a 5% level of significance. An association was also noted in the mid (T5-T9) thoracic spine for examiner 1 and in the lower (T9-L1) thoracic spine for examiner 2. Therefore, the infants in Group A (colic) had a higher occurrence of spinal joint dysfunctions than the infants in Group B (non colic), in the upper (T1-T5) thoracic spine as noted by examiner 2, in the mid (T5-T9) thoracic spine as noted by examiner 1 and the lower (T9-L1) thoracic spine as noted by examiner 2.

A possible explanation for the results noted above is that the area of the thoracic spine, when collapsing the levels further becomes too large of the small sample of the study and the differences in the findings of the examiners become apparent. It may be noted that although the differences in the chi

squared results seem notable, as no association was noted between spinal joint dysfunction and infantile colic, the findings of the examiners were still noted to have a significant measure of inter-examiner reliability.

The results of Cramer's V (Table 4.63) showed that a measure of association was achieved for the examiners' findings, for both Group A and Group B, in the mid (T5-T9) and lower (T9-L1) thoracic spine regions. No measure of association was noted for Group A and B for the upper (T1-T5) thoracic region. Therefore a measure of inter-examiner reliability was achieved for in the mid (T5-T9) and lower (T9-L1) thoracic spine regions.

D) THE LUMBAR SPINE

- **Upper (L1-L3) and Lower (L3-L5) Lumbar Spine**

The results of the chi square tests (Table 4.68) showed an association between the occurrence of spinal joint dysfunction and infantile colic, for both the examiners' findings, in the upper (L1-L3) and lower (L3-L5) lumbar spine.

The results indicate that the infants that have a high occurrence of spinal joint dysfunction in the upper (L1-L3) and lower (L3-L5) lumbar spine are associated with infants that have infantile colic. Therefore the occurrence of spinal joint dysfunction in the upper (L1-L3) and lower (L3-L5) lumbar spine of healthy infants suffering from infantile colic is higher than in non-colicky infants.

The results of Cramer's V (Table 4.69) showed that in the upper (L1-L3) and lower (L3-L5) lumbar spine, there was a measure of association for the examiners' findings, for Group A at both levels and no measure of association for Group B, at both levels. The explanation for the lack of association of the examiners' results in Group A at L1-L3 occurred as a result of locations of ten spinal joint dysfunctions that the examiners did not agree on and six for the location L3-L5. Although the number of disagreements were not large the corresponding numbers of agreed-locations that were already present (16 and 5 respectively) where small in comparison. A large part of the inter-examiner reliability was determined by the agreement on the lack of spinal joint dysfunctions in a location. Therefore a measure of inter-examiner reliability was achieved for Group A in the upper (L1-L3) and lower (L3-L5) lumbar spine, and not for Group B.

5.4 OBJECTIVE TWO

To determine the occurrence[1] of spinal joint dysfunctions in otherwise healthy infants suffering from infantile colic as compared to the occurrence of spinal joint dysfunctions in healthy non-colicky infants, in terms of clinical findings.

5.4.1 INTRA GROUP COMPARISON

A) CERVICAL SPINE – GROUP A (COLIC)

The intra group data of the comparison of proportions between the different locations, for the cervical spines of colicky infants is illustrated in table 4.70.

The population proportion at C2-C4 (0.66) is significantly higher than the population proportion at C4-C6 (0.31) respectively. It can be noted that the p-value is < 0.05, therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at C2-C4 (0.66) as opposed to C4-C6 (0.31) at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was as follows: C2-C4 (0.66), C4-C6 (0.31), C0-C2 (0.21) and C6-T1 (0.07). Thus in the cervical spines of colicky infants, it can be noted that the location with the highest significant occurrence of spinal joint dysfunctions was C2-C4 (0.66). The proportion of this location (C2-C4) was significantly higher than the proportions of the other locations in the cervical spine as can be noted from the small p-values generated when comparing the different locations. It can therefore be concluded that in the cervical spines of colicky infants, the location most likely to present with spinal joint dysfunctions is C2-C4.

B) CERVICAL SPINE – GROUP B (NON-COLIC)

The intra group data of the comparison of proportions between the different locations, for the cervical spines of non-colicky infants is illustrated in table 4.71.

It can be noted that at the location: C2-C4 (0.23) and C4-C6 (0.17), the p-value is ≥ 0.05, thus we do not reject H_O and therefore conclude that there is not sufficient evidence to suggest that the proportion of spinal joint dysfunction is significantly higher at C2-C4 (0.23) as opposed to C4-C6 (0.17) at a 5% significance level. The population proportion at C2-C4 (0.23) is significantly higher than the population proportion at C0-C2 (0.11) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at C2-C4 (0.23) as opposed to C0-C2 (0.11) at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was as follows: C2-C4 (0.23), C4-C6 (0.17), C0-C2 (0.11) and C6-T1 (0.08). Thus

[1] The statistician has recommended the use of the word “occurrence” in objective 2 and hypothesis 2, as objective 1 (association) and objective 2 (occurrence) combined would determine the “prevalence” referred to in the title.

in the cervical spines of non-colicky infants, it can be noted that the location with the highest proportion of occurrence of spinal joint dysfunctions was C2-C4 (0.23). However, there was not sufficient evidence to conclude that the proportion at C2-C4 (0.23) was significantly higher than C4-C6 (0.17), the second highest proportion. The proportion at C2-C4 (0.23) was however significantly higher than C0-C2 (0.11), the third highest proportion. It can also be noted that there was not sufficient evidence to conclude that C4-C6 (0.17), the second highest proportion, was significantly higher than C0-C2 (0.11), the third highest proportion. As a result of the lack of significant differences between the proportions of the ranked locations, it can therefore be concluded that no one location is significantly more likely to have a spinal joint dysfunction than another. However, C2-C4, the highest-ranking proportion, is significantly more likely to present with spinal joint dysfunctions than the third (C0-C2) and fourth (C6-T1) ranking proportions. Due to the fact that C2-C4 and C4-C6 do not have significantly different proportions, either location is likely to present with spinal joint dysfunctions in non-colicky infants.

C) THORACIC SPINE – GROUP A (COLIC)

The intra group data of the comparison of proportions between the different locations, for the thoracic spines of colicky infants is illustrated in table 4.72.

The population proportion at T5-T9 (0.49) was higher than the population proportion at T1-T5 (0.27) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at T5-T9 (0.49) as opposed to T1-T5 (0.27) at a 5% significance level. It can be noted that at the location: T1-T5 (0.27) and T9-L1 (0.22), the p-value is ≥ 0.05, thus we do not reject H_O and therefore conclude that there is not sufficient evidence to suggest that the proportion of spinal joint dysfunction is significantly higher at T1-T5 (0.27) as opposed to T9-L1 (0.22) at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was as follows: T5-T9 (0.49), T1-T5 (0.27) and T9-L1 (0.22). Thus in the thoracic spines of colicky infants, it can be concluded that the location with the highest proportion of occurrence of spinal joint dysfunctions was T5-T9 (0.49). The proportion at this location (T5-T9) was significantly higher than the proportions of the other locations in the thoracic spine. T5-T9 is therefore the location at which spinal joint dysfunctions are mostly likely to present in colicky infants.

D) THORACIC SPINE – GROUP B (NON-COLIC)

The intra group data of the comparison of proportions between the different locations, for the thoracic spines of non-colicky infants is illustrated in table 4.73.

At the location: T5-T9 (0.24) and T1-T5 (0.17), the p-value is ≥ 0.05, thus we do not reject H_O and therefore conclude that there is not sufficient evidence to suggest that the proportion of spinal joint dysfunction is significantly higher at

T5-T9 (0.24) as opposed to T1-T5 (0.17) at a 5% significance level. The population proportion at T5-T9 (0.24) was higher than the population proportion at T9-L1 (0.07) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at T5-T9 (0.24) as opposed to T9-L1 (0.07) at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was as follows: T5-T9 (0.24), T1-T5 (0.17) and T9-L1 (0.07). Thus in the thoracic spines of non-colicky infants, it can be noted that the location with the highest proportion of occurrence of spinal joint dysfunctions was T5-T9 (0.24). However, there was not sufficient evidence to conclude that the proportion at T5-T9 (0.24) was significantly higher than T1-T5 (0.17), the second highest proportion. The proportion at T5-T9 (0.24) was however significantly higher than T9-L1 (0.07), the third highest proportion. It can also be noted that T1-T5 (0.17), the second highest proportion was significantly higher than T9-L1 (0.07), the third highest proportion. However, T5-T9 (0.24), the highest-ranking proportion, is significantly more likely to present with spinal joint dysfunctions than the third (T9-L1, 0.07) ranking proportion. Due to the fact that T5-T9 and T1-T5 do not have significantly different proportions, either location is likely to present with spinal joint dysfunctions in non-colicky infants.

E) LUMBAR SPINE – GROUP A (COLIC)

The intra group data of the comparison of proportions between the different locations, for the lumbar spines and sacro-iliac joints of colicky infants is illustrated in table 4.74.

At the locations of the sacro-iliac joints (0.47) and L1-L3 (0.42), the p-value is $\geq$ 0.05, thus we do not reject H_O and therefore conclude that there is not sufficient evidence to suggest that the proportion of spinal joint dysfunction is significantly higher at the sacro-iliac joints (0.47) as opposed to L1-L3 (0.42) at a 5% significance level. The population proportion at the sacro-iliac joints (0.47) was higher than the population proportion at L3-L5 (0.16) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at the sacro-iliac joints (0.47) as opposed to L3-L5 (0.16) at a 5% significance level.

The population proportion at L1-L3 (0.42) was higher than the population proportion at L3-L5 (0.16) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at L1-L3 (0.42) as opposed to L3-L5 (0.16) at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was as follows: S.I. joints (0.47), L1-L3 (0.42) and L3-L5 (0.16). Thus in the lower spinal area of colicky infants, it can be noted that the locations with the highest proportions of occurrence of spinal joint dysfunctions were the sacro-iliac joint (0.47) and the upper lumbar (L1-L3 = 0.42) spine areas. However, there was not sufficient evidence to conclude that the proportion at the sacro-

iliac joint (0.47) was significantly higher than L1-L3 (0.42), the second highest proportion. The proportion at the sacro-iliac joint (0.47) was however significantly higher than L3-L5 (0.16), the third highest proportion. It can also be noted that L1-L3 (0.42), the second highest proportion was significantly higher than L3-L5 (0.16), the third highest proportion. It can therefore be concluded that the locations in the lower spine where infants with colic are most likely to present with spinal joint dysfunctions are the sacro-iliac joints and the upper lumbar locations.

F) LUMBAR SPINE – GROUP B (NON-COLIC)

The intra group data of the comparison of proportions between the different locations, for the lumbar spines and sacro-iliac joints of non-colicky infants is illustrated in table 4.75.

The population proportion at the sacro-iliac joints (0.26) was higher than the population proportion at L1-L3 (0.13) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at the sacro-iliac joints (0.47) as opposed to L1-L3 (0.13) at a 5% significance level. The population proportion at L1-L3 (0.13) was higher than the population proportion at L3-L5 (0.03) respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at L1-L3 (0.13) as opposed to L3-L5 (0.03) at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was as follows: S.I. joints (0.26), L1-L3 (0.13) and L3-L5 (0.03). Thus in the lower spinal areas of the non-colicky infants, it can be noted that the location with the highest proportion of occurrence of spinal joint dysfunctions was the sacro-iliac joint (0.26) area. The proportion at this location (sacro-iliac joint area) was significantly higher than the proportions of the other locations in the lower spinal area, as can be noted from the p-values generated by comparing the different locations. Therefore the sacro-iliac joint is the location where spinal joint dysfunctions are most likely to present in non-colicky infants.

5.4.2 INTER-GROUP COMPARISON

A) CERVICAL SPINE – GROUP A VERSUS GROUP B

The inter group comparison of proportions between the parallel locations, in the cervical spines of infants, in Group A and B, is illustrated in table 4.76.

The population proportion at C2-C4 (0.66) in Group A is significantly higher than the population proportion C2-C4 (0.23) in Group B respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at C2-C4 (0.66) in Group A as opposed to C2-C4 (0.23) in Group B at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was the same in both groups. The ranking by location, for Group A and B respectively, was as follows: C2-C4 (0.66; 0.23), C4-C6 (0.31; 0.17), C0-C2 (0.21; 0.11) and C6-T1 (0.07; 0.08). Thus in the cervical spines of infants, with and without colic, it can be concluded that the location with the highest significant proportion of occurrence of spinal joint dysfunctions was C2-C4 (0.66; 0.23) for Group A and B, respectively. Therefore infants with colic have a significantly higher proportion of spinal joint dysfunctions than non-colicky infants at C2-C4.

B) THORACIC SPINE – GROUP A VERSUS GROUP B

The inter group comparison of proportions between the parallel locations, in the thoracic spines of infants, in Group A and B, is illustrated in table 4.77.

The population proportion at T5-T9 (0.49) in Group A was higher than the population proportion at T5-T9 (0.24) in Group B respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at T5-T9 (0.49) in Group A as opposed to T5-T9 (0.24) in Group B at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was the same in both groups. The ranking by location, for Group A and B respectively was as follows: T5-T9 (0.49; 0.24), T1-T5 (0.27; 0.17) and T9-L1 (0.22; 0.07). Thus in the thoracic spines of infants, with and without colic, it can be concluded that the location with the highest significant proportion of occurrence of spinal joint dysfunctions was T5-T9 (0.49; 0.24) for Group A and B, respectively. Therefore infants with colic have a significantly higher proportion of spinal joint dysfunctions than non-colicky infants at T5-T9.

C) LUMBAR SPINE AND SACRO-ILIAC JOINTS – GROUP A VERSUS GROUP B

The inter group comparison of proportions between the parallel locations, in the lower spinal areas of infants, in Group A and B, is illustrated in table 4.78.

The population proportion at the sacro-iliac joints (0.47) in Group A was higher than the population proportion at the sacro-iliac joints (0.26) in Group B respectively. It can be noted that the p-value is < 0.05 therefore we reject H_O and conclude that the proportion of spinal joint dysfunction is significantly higher at the sacro-iliac joints (0.47) in Group A as opposed to the sacro-iliac joints (0.26) in Group B at a 5% significance level.

The ranking of the locations by proportion from the highest to the lowest was the same in both groups. The ranking by location, for Group A and B respectively, was as follows: the sacro-iliac joints (0.47; 0.26), L1-L3 (0.42; 0.13) and L3-L5 (0.16; 0.03). Thus in the lower spinal areas of infants, with and without colic, it can be concluded that the location with the highest significant proportion of occurrence of spinal joint dysfunction was the location

of the sacro-iliac joints (0.47; 0.26) for Group A and B, respectively. Therefore infants with colic have a significantly higher proportion of spinal joint dysfunctions than non-colicky infants at the sacro-iliac joints.

5.4.3 DISTRIBUTION OF SPINAL JOINT DYSFUNCTIONS

The figures 4.1, 4.2 and 4.3, in chapter four have been constructed to demonstrate the distribution of the spinal joint dysfunctions. The areas of the spine where the spinal joint dysfunctions commonly occur in the infants in both groups can be noted.

In figure 4.1, the levels of spinal joint dysfunctions demonstrating the most involvement in the experimental group (Group A) were the C2-C4 levels, T5-T9, L1-L3 and the sacro-iliac joints. In conclusion these areas would consist of the upper cervical, mid thoracic, upper lumbar regions and the sacro-iliac joints. In figure 4.2, the levels of spinal joint dysfunctions demonstrating the most involvement in the control group (Group B) were the C2-C4 levels, T5-T9, T1-T5 and the sacro-iliac joints. In conclusion these areas would consist of the mid-upper cervical, mid thoracic, upper thoracic regions, and the sacro-iliac joints. In figure 4.3, the levels of spinal joint dysfunctions of the experimental and control group are illustrated. The chart demonstrates the common levels of involvement of the spinal joint dysfunctions in the general population of infants. In conclusion these areas or locations would consist of the upper cervical, mid thoracic, upper lumbar regions and the sacro-iliac joints. It can be noted that the trend observed in the results of the study suggests that if an infant is to present with a spinal joint dysfunction, it is most likely to occur in the noted locations.

The distribution of spinal joint dysfunctions in the control group (Group B) had a very similar trend to the distribution of the spinal joint dysfunctions as the experimental group (Group A). The only difference between the groups was that the experimental (colicky) group had a much higher occurrence of spinal joint dysfunctions in the locations of the spine compared to the control (non-colicky) group. The locations with the highest occurrence of spinal joint dysfunctions were possibly areas of the spine with increased movement or function, as this trend was present in both groups. The significance of these spinal joint dysfunctions is supported by Stierwalt[*] (pp: 2, 5), who cited that these areas were of prime interest due to their location in the high stress areas of the spine and their influence on the sympathetic (motor) nerve supply to the gut.

The results of the statistical analysis of the data are similar to the trends noted in the graphs (figures 4.1, 4.2, 4.3). The question arises as to what the causative factor or trigger is, that would result in the colicky infants developing a significantly higher occurrence of spinal joint dysfunctions than non-colicky

[*] Stierwalt DD. Adjusting the child. Distributed by: The Copy Shop, 628 Harrison Street, Davenport, Iowa 52803, pp1, 2, 5-9, 36-55 pp. No further information is known about this reference.

infants. Findings that may provide more insight to this question may be noted in section 4.4.3 (figures 4.4 and 4.5). The examiners' findings on the palpation of muscle spasm of the large muscles groups were displayed in chart form. It was noted that the colicky infants as compared to the non-colicky infants, had a significantly higher occurrence of muscle spasm in the posterior cervical, erector spinae and quadratus lumborum muscle groups. It was also noted that the involved muscle groups had similar locations to the locations of the prevalent spinal joint dysfunctions. The observation that the prolonged tensing of colicky infants' bodies during crying spells (5.75 hours) as compared to non-colicky infants (16 minutes) may be a possible explanation for the increased muscle spasm noted. However, further statistical analysis needs to be completed to determine if the muscle spasm was statistically associated with infantile colic and spinal joint dysfunctions.

5.5 OBJECTIVE THREE

To identify the areas of high prevalence of spinal joint dysfunctions in the spines of infants who suffer from infantile colic as compared to previous studies completed (Klougart et al. 1989, Mercer 1999, Wiberg et al. 1999).

5.5.1 COMPARISON WITH PREVIOUS STUDIES

The results of this study are compared to the findings of studies previously complete chiropractic studies on infantile colic completed by Olafsdottir et al. (2001), Mercer's (1999:31), Wiberg et al. (1999) and Klougart et al. (1989). The comparison to previous studies is open to interpretation as the exact levels discussed by the studies previously were not defined but merely described. In the study completed by Olafsdottir et al. (2001), no descriptions of the treated areas of the spine were disclosed.

The areas of the spine in which spinal joint dysfunctions were most commonly located or distributed as compared to previously completed studies, were found to be in the upper cervical and mid-thoracic areas, as determined by Mercer (1999: 40) and Klougart et al. (1989) and the upper and mid-thoracic areas determined by Wiberg et al. (1999).

In conclusion the distribution of spinal joint dysfunctions in the experimental (colicky) group of infants were in keeping with the findings of Mercer (1999: 40) and Klougart et al. (1989), with respect to the thoracic spine. It may be noted however, that the highest occurrence of spinal joint dysfunctions occurred at C2-C4 region of the upper cervical spine in this study and not C0-C2 as noted by Mercer (1999: 40) and Klougart et al. (1989). The mid thoracic areas however correspond to the findings of Mercer (1999: 40) and Klougart et al. (1989).

Wiberg et al. (1999) found that the spinal joint dysfunctions in colicky infants commonly occurred in the upper and mid thoracic region, followed by the lower thoracic and lumbar spine areas. The findings of this study are in keeping with the findings of Wiberg et al. (1999). However, it may be noted

that the upper thoracic region did not demonstrate a significant occurrence of spinal joint dysfunctions as compared to the mid-thoracic region. The high occurrence of spinal joint dysfunction in the upper lumbar spine and sacro-iliac joints is not in keeping with the findings of previous studies (Mercer 1999: 40, Wiberg et al. 1999 and Klougart et al. 1989).

5.6 CONCLUSION OF ABOVE DATA

The following results were noted when the areas where the spinal joint dysfunctions were associated with infantile colic were compared to the distribution of spinal joint dysfunctions, as well as the findings of previous studies:

A) CERVICAL SPINE

The levels at which spinal joint dysfunctions in infants showed association with infantile colic were the upper (C0-C4) cervical regions and more specifically the mid-upper (C2-C4) areas. This was not in keeping with the findings of Mercer (1999: 40) and Klougart et al. (1989), with respect to the spinal joint dysfunctions in colicky infants occurring in the upper cervical areas. Mercer (1999:31) noted that 31% of the spinal joint dysfunction observed in the infants, involved the atlas. Klougart et al. (1989) noted that 94% of the spinal joint dysfunction noted in the infants occurred between C0-C2. A possible reason for the difference in the specific locations of the spinal joint dysfunctions (C0-C2 vs. C2-C4) may be due to examiner inexperience in this study and a lack of extensive rehearsals. An examiner bias in this study as well as previous studies may also have been introduced, as it is hypothesised that these areas were associated with colic. The findings of Wiberg et al. (1999) support this statement as few spinal joint dysfunctions were noted to be present in the cervical spine.

The location at which spinal joint dysfunctions most frequently occurred in the cervical spine, for the experimental and control groups was also noted to be the mid-upper (C2-C4) cervical spine region. Therefore the location C2-C4 is associated with infantile colic and has the highest occurrence of spinal joint dysfunctions in the cervical spine in infants with and without colic. In conclusion, the results indicate that if an infant is found to have a spinal joint dysfunction in the cervical spine, it is mostly likely to occur at C2-C4. If an infant suffers from infantile colic, the first area in the cervical spine that should be assessed for spinal joint dysfunctions is the C2-C4 location.

B) THORACIC SPINE

The levels at which spinal joint dysfunctions in infants showed association with infantile colic were the upper (T1-T7) thoracic regions. This location was not in keeping with the findings of Mercer (1999: 40) and Klougart et al. (1989), who noted that the spinal joint dysfunctions in colicky infants occurred

in the mid-thoracic areas. The findings were in keeping with Wiberg et al. (1999), who found that the involved levels were the upper and mid-thoracic areas. Wiberg et al. (1999) did not however define any exact levels of vertebral involvement.

Klougart et al. (1989) noted that the 41% of all the spinal joint dysfunctions noted, included a cervical as well as a thoracic spinal joint dysfunction. The authors noted that the thoracic spinal joint dysfunction levels that were most commonly involved were T4 -T5 and T8-T9. Mercer (1999:31) found that the vertebral levels in the thoracic spine that were most commonly involved were T7 (19%), T8 (22%) and T9 (10%). It was noted that T4 (0.4%) and T5 (1%) did not have a significant involvement in Mercer's (1999:31) study as previously determined in the study by Klougart et al. (1989).

Furthermore, in conclusion, the location at which spinal joint dysfunctions most frequently occurred in the thoracic spine, for infants in both the experimental and control groups was noted to be the mid thoracic (T5-T9) region of the spine. The mid thoracic (T5-T9) region of the spine was in keeping with the findings of Mercer (1999: 40), Klougart et al. (1989) and Wiberg et al. (1999) but was not determined to have a significant association with infantile colic. A possible reason why the location of high prevalence (T5-T9) may be different to the location (T1-T7) associated with colic may be that the sample size of this study was not large enough to produce sufficient data to accommodate the further collapsing of the spinal levels in the thoracic spine. The examiner inexperience or the lack of a third examiner may possibly have highlighted rather than cushioned or accommodated the difference as well as the lack of extensive examination technique rehearsals.

In conclusion, the results indicate that if an infant is found to have a spinal joint dysfunction in the thoracic spine, it is mostly likely to occur at T5-T9. If an infant suffers from infantile colic, the first area in the thoracic spine that should be assessed for spinal joint dysfunctions is the T1-T7 location. Additional research needs to be completed to further determine the relationship between common locations of spinal joint dysfunctions and locations associated with infantile colic.

C) LUMBAR SPINE

The spinal levels at which the occurrence of spinal joint dysfunctions in infants showed an association with infantile colic were the upper (L1-L3) and lower (L3-L5) lumbar regions which were not in keeping with the findings of previous studies Mercer's (1999:31), Wiberg et al. (1999) and Klougart et al. (1989).

Mercer (1999:31) found that only 2% of the spinal joint dysfunction involved the lumbar spine, more specifically, L1. Klougart et al. (1989) noted that 6% of the spinal joint dysfunction noted in the infants (apart from the 94% at C0-C2) occurred in the rest of the spine. Wiberg et al. (1999) did mention the involvement of spinal joint dysfunctions in the lumbar spine, but the levels were not specified and the extent of involvement was not discussed.

Furthermore, the location at which spinal joint dysfunctions most frequently occurred was the upper (L1-L3) lumbar region of the spine. The upper (L1-L3) lumbar region of the spine was not in keeping with the findings of Mercer (1999: 40), Klougart et al. (1989) and Wiberg et al. (1999) but was determined to have a significant association with infantile colic. A possible explanation for this may be the examiner inexperience as well as the lack of extensive examination technique rehearsals. Another plausible explanation that may have been the fact that the size of the sample population was not sufficient to produced enough data for accurate analysis, since the lumbar spine had the lowest prevalence of spinal joint dysfunctions of the four regions of the spine.

In conclusion, the results indicate that if an infant is found to have a spinal joint dysfunction in the lumbar spine, it is mostly likely to occur at L1-L3. If an infant suffers from infantile colic, the first area in the lumbar spine that should be assessed for spinal joint dysfunctions is the L1-L3 location.

D) SACRO-ILIAC JOINTS

The sacro-iliac joints showed a significant association with infantile colic and the examiners' findings were shown to have a significant measure of association. The sacro-iliac joints have not been determined to have significant involvement in previous studies by Mercer (1999:31), Wiberg et al. (1999) and Klougart et al. (1989). Mercer's (1999:31) for example, noted that the sacro-iliac joints only contributed to 6% of the total occurrence of spinal joint dysfunctions.

Furthermore, in conclusion, joint dysfunctions were found to occur commonly in the sacro-iliac joints. The occurrence of spinal joint dysfunctions at the sacro-iliac joints were not in keeping with the findings of Mercer (1999: 40), Klougart et al. (1989) and Wiberg et al. (1999) but were determined to have a significant association with infantile colic. A possible explanation for this could be the way the infants were carried by their mothers. A large percentage of the sample population were from the rural population, which would have differed from previous studies (Mercer 1999: 34, Klougart et al. 1989 and Wiberg et al. 1999). These infants would have been transported prone on their mother's backs and not supine in baby chairs and prams, as in the urban population. The abduction of the hips possibly resulted in added stress on the sacro-iliac joints.

5.7 CONCLUSION

From the above data it can be concluded that the proportion of occurrence of spinal joint dysfunctions are associated with infantile colic. The occurrence of spinal joint dysfunctions in the control group (Group B) had a very similar trend in the occurrence of the spinal joint dysfunctions in the experimental group (Group A). The only difference between the groups was that the

experimental group had a far higher occurrence of spinal joint dysfunctions in the areas of the spine.

In conclusion, the common areas of spinal joint dysfunction, in the experimental and control group were both in keeping with the findings of Mercer (1999: 40), Wiberg (1999) and Klougart et al. (1989), with the exception of the upper lumbar spine and the sacro-iliac joints. The areas with the highest occurrence of spinal joint dysfunction were not always associated with infantile colic. However the prevalence of spinal joint dysfunctions was consistently higher in the colicky infants than the non-colicky infants and this stems for the need for further research into this field.

In view of the results of this study, it can be concluded that spinal joint dysfunctions are associated with infantile colic. This is supported by the fact that previous studies (Mercer 1999: 40, Wiberg 1999 and Klougart et al. 1989) noted an improvement in the treatment groups where spinal joint dysfunctions were removed. This implies that infantile colic may be a musculoskeletal condition that produces symptoms that mimic or manifest as gastrointestinal symptoms, since spinal manipulative therapy removes these symptoms, and is effective in treating musculoskeletal conditions. Research still needs to determine if spinal joint dysfunctions cause symptoms that mimic those of infantile colic.

5.8 STUDY LIMITATIONS

5.8.1 PROBLEMS WITH DEMOGRAPHICS DATA

The data collected was subject to parental perception and a recall bias may have been introduced as a result. Another possible reason for this it that parents could have wanted to please the researcher when answering questionnaires thereby possibly overstating the symptoms of their infant. This is known as the “Hawthorne effect” (Mouton, 1996: 152).

5.8.2 PROBLEMS WITH THE RESEARCHERS’ OBJECTIVE CLINICAL DATA

The researchers’ objective clinical findings of the spinal examinations may not have been accurate due to examiner inexperience. A third examiner of the same experience may be advisable for future studies and completion of extensive examination-technique rehearsals. Another factor contributing to inter-examiner reliability may have been the fact that the vertebral levels collapsed into locations for analysis may have been too small for accurate analysis. This is clearly evident on reflection of the results of this study, where the inter examiner reliability was good until the locations became too small.

The results of the examiners were pooled for the statistical analysis of objective two, to level out the findings and to create a larger sample size, to produce more reliable findings.

CHAPTER SIX

6.0 RECOMMENDATIONS AND CONCLUSIONS

6.1 RECOMMENDATIONS

Should a similar study be repeated, the researcher recommends that the following changes be considered:

6.1.1 THE SAMPLE POPULATION

As this study was a preliminary trial, a limitation was the small sample size (n=100). A sample population of about 300 would have been more effective in achieving reliable results. This may allow for a more accurate representation of the common distributions of spinal joint dysfunctions. This would also have provided enough data to accommodate the further collapsing of the vertebral levels, giving more defined levels of involvement, which may have allowed for further defining the association between infantile colic and spinal joint dysfunctions.

6.1.2 DEMOGRAPHIC DATA

The short fall with the questions chosen for the study were that they were limited to a small number as a result of time constraints, varying translation interpretations and a lack of parental antenatal education. A lot more valuable information could have been obtained by including a few more detailed questions, however these would have been subject to varying interpretations resulting in inaccurate information and the main focus of the study would have been detracted from.

Examples of necessary questions for future studies on infantile colic include more information about the method of birth, with regard to instrumentation used. In the rural communities this would not always be possible due to the lack of antenatal education and familiarity with the standard instruments used to assist during births. Other helpful questions would be the duration of the gestation period, birth weight, marital status and whether or not the mother or father smoked. All of these questions would have been subject to parental interpretation, introducing an unavoidable recall bias since medical records would not be an obtainable option.

It was also noted that the mothers from the rural communities were reluctant to declare that the infant's crying was excessive. When questioning the mothers about the crying behaviour of their infants, it was not mentioned that the crying was a problem or that it occurred for extended periods of time. It was noted that the most effective way of extracting the information about the crying behaviour of the infants from the mothers was to ask them what time the infant began crying and what time it stopped. Unconcerned, the mothers would then disclose that the crying began in the early hours of the evening and stopped in the early hours of the morning. In the urban communities it was noted that the mothers had no concerns declaring how much the infants cried. The main concern or perception of the mothers was that the infants seemed to be in pain when crying.

On examination of the demographic data, colic was found to occur equally in both the rural and urban communities. Even though the mothers in the rural communities were either reluctant to acknowledge, or did not perceive that their infants' crying behaviour as problematic. The nursing staff at the rural clinics also conceded that it was very rare for the mothers to complain about colicky symptoms. The cultural perception of problematic behaviour of infants or the lack of higher education is the only basis for this conclusion. Even though the colicky infants cried for extended periods of time at night, the mothers from the rural communities did not feel that it was a problem. This highlights the need for antenatal education in the different communities.

6.1.3 FURTHER RESEARCH

The trend of common locations of spinal joint dysfunctions in colicky and non-colicky infants was very similar, the only difference between the groups being the higher occurrence of spinal joint dysfunctions in the colicky group. Further research has to be conducted into the this area to determine if these regions are associated with colic or if they are simply areas of the spine that are subject to the function of daily movements (McMullen 1994: 287) and therefore more prone to spinal joint dysfunctions or if they are truly associated with colic. Additional research into this field is necessary to further investigate the musculoskeletal relationship between spinal joint dysfunctions and infantile colic to determine if spinal joint dysfunctions cause symptoms that mimic those of infantile colic. It is also suggested that any additional research is conducted using random sampling as this may alleviate any possible problems caused by bias.

6.1.4 BLINDING

The introduction of a second examiner was used to validate the findings of the first examiner. The researchers were blinded from each others' findings and the grouping of the infants. Information that may have been suggestive about the behaviour of infants was revealed to the researcher in some instances, when communicated with the parents and explaining the procedure of the

study. This resulted in an observer bias being introduced to the one researcher. An external observer should have completed the data collection and collation, to further diminish the observer bias. Due to the great numbers of clinics that accommodated the researchers and the varying numbers of clinic staff involved, a selection bias may have been introduced. It is recommended that future studies be conducted at a single venue, using the same staff for the duration of the study.

6.1.5 ACCURACY OF MOTION PALPATION

The accuracy of the motion palpation in this study may be deemed as questionable due to the fact that the accurate assessment of infants is very subjective and both the participating researchers were equally inexperienced. It must however be noted that the findings of the examiners were determined to have a measure of association or inter-examiner reliability for a significant amount of the statistical analysis completed. This indicated that the reliability between the examiners was fairly good, even though the study was conducted on 2 to 10 week old infants.

Completing a study with motion palpation of the one group and spinal manipulation of the other is also necessary to further determine the effect of motion palpation as compared to manipulation, in the treatment of infantile colic and other conditions.

6.2 CONCLUSION

The purpose of this preliminary study was to determine the prevalence of spinal joint dysfunction in healthy infants suffering from infantile colic as compared to the prevalence of spinal joint dysfunction in healthy non-colicky infants in terms of (objective) clinical findings.

The population size comprised of one hundred healthy infants, fifty colicky and fifty non-colicky infants from the greater Durban area. The infants were selected by means of a combination of convenience and snowball sampling and the assessment of the infants stopped when the sample requirements were met. All the healthy infants aged between 2 to 10 weeks, whose parents were interested in participating in the study, were included, on condition that the inclusion criteria were fulfilled.

The participating infants were assessed for signs of infantile colic. If all of the criteria governing the diagnosis of infantile colic (3.3.1.1) were met, the infants were placed in Group A (the experimental group). If the participating infants did not meet the criteria governing the diagnosis of infantile colic, the infants were placed in Group B (the control group). The participating infants, in both Group A and B, received a single assessment by each of the blinded researchers who were unaware of the infants' grouping. The assessments

included a physical examination of the spine and pelvis, to detect the presence of spinal joint dysfunctions.

The examination of the statistical data revealed that there was an association between infantile colic and the occurrence of spinal joint dysfunctions in specific regions in the spines of infants. The association was noted to be in the upper half of the cervical (C0-C4) spine, the upper half of the thoracic (T1-T7) spine, the upper half of the lumbar (L1-L3) spine and the sacro-iliac joints.

On further examination of the statistical data, it was noted that a higher proportion of occurrence of spinal joint dysfunctions was noted in the colicky group of infants. The areas where the higher occurrence of spinal joint dysfunctions was noted to be in the upper cervical (C2-C4) spine, the upper half of the thoracic (T5-T9) spine, the upper half of the lumbar (L1-L3) spine and the sacro-iliac joints. The common levels of involvement of the spinal joint dysfunctions in the general population of infants, with and without colic, were noted to include the upper cervical (C2-C4), mid thoracic (T5-T9), upper lumbar (L1-L3) regions and the sacro-iliac joints. These areas are noted to partially be in keeping with the findings of Mercer (1999:40), Wiberg et al. (1999) and Klougart et al. (1989), since the similar areas are mentioned although the levels are not entirely defined. However, the upper lumbar (L1-L3) regions and the sacro-iliac joints areas were not in keeping with the findings over previous studies (Mercer 1999:40, Wiberg et al. 1999 and Klougart et al. 1989).

In view of the results of this study, it can be concluded that spinal joint dysfunctions are associated with infantile colic. This is supported by the fact that previous studies (Mercer 1999: 40, Wiberg 1999 and Klougart et al. 1989) noted an improvement in the treatment groups where spinal joint dysfunctions were removed. This implies that infantile colic may be a musculoskeletal condition that produces symptoms that mimic or manifest as gastrointestinal symptoms, since spinal manipulative therapy removes these symptoms, and is effective in treating musculoskeletal conditions. Research still needs to determine if spinal joint dysfunctions cause symptoms that mimic those of infantile colic.

The information collected in this study would contribute to the demographic data of infantile colic in South Africa, especially in the Durban area as the study covered a large distribution of the communities in Durban. This study may provide a foundation for further investigations into the musculoskeletal association of infantile colic, as the results strongly imply the connection.

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Appendix A:

The letter of information explaining the research project to the parents.

Dear Parents

You are invited to participate in a research study to assess how restrictions in the spine and associated discomfort in healthy babies maybe linked to infantile colic.

I am currently a student at the Durban Institute Of Technology's Chiropractic Day Clinic and conducting a research project on infantile colic. The study is will be a blinded study, which means that the second examiner and myself will be unaware of which infants have infantile colic and which don't. The number of infants to participate in the study will be 100 (50 colicky and 50 non-colicky) and the infants must be healthy and thriving, between the ages of 2 and 10 weeks.

This study will be one of the first of its kind in South Africa and will encompass assessing healthy infants in the greater Durban area for painful spines and sore muscles by means of palpation (touching) of the neck, mid and lower back. The information collected will hopefully clear up some of the controversy surrounding the condition, infantile colic.

You have been invited to participate in the study because your infant is healthy and thriving, between the ages of 2 and 10 weeks. The research procedure is very simple and will only take a few minutes of your time. There is no charge for participation in this study. You are not under any obligation to participate and free to withdraw at any time. The assessments that your baby will undergo are risk free and safe and will be conducted under the supervision of a qualified chiropractor.

<u>The research procedure</u>:

1. If you are willing to allow your baby to participate, you are to sign a consent form (Appendix B), giving us written permission to assess your infant.
2. The procedure will then begin by the nursing sister assessing your infant to ensure that it is healthy.
3. Once all the necessary information is recorded, the second examiner and myself will assess your infant for pain and discomfort along its spine, at the Chiropractic Day Clinic if possible or at the designated clinic.
4. It is very important that you do not tell us anything about your baby at any time.

5. Once the assessment is complete, we will record our findings in Appendix D. Once this last assessment is over, your participation in the study is complete. The information collected will remain confidential.
6. If your infant is found to have infantile colic, you will be granted four free treatments, over a two-week period, at Chiropractic Day Clinic, once the study is complete.

It is important that you know, if you change your mind about participating or are uncomfortable with any of the proceedings in the study, you are more than welcome to withdraw from the study at anytime. You are under no obligation what so ever to participate in the study. The authorities from the Durban Institute Of Technology's Chiropractic Day Clinic may inspect my records at any time and if you wish to lodge a complaint with the Durban Institute Of Technology's Research Ethics Committee, or communicate with my Supervisor, Head of Department or Clinic Director, you may do so without fear of any negative consequences. The contact details will be given below.

Your participation in this study will aid in contributing to this commonly occurring, painful condition called infantile colic.

Thank you for your interest and support.

Yours Sincerely

. . . .

Caroline van Lingen Chiropractic Intern	Dr Junaid Shaik Research Supervisor
0824693143	2042588

ISAHLUKO A:

INCWADI EYAKUMZALI UMNTWANA ENIKA ULWAZI NGOCWANINGO.

Mzali Othandekayo

Uyacelwa ukuba ungenele ucwaningo lwenziwa ikliniki yase Durban Institute of Technology. Lolucwaningo luzama ukuxazulula inkinga yokukhala kwezingane zilunywa izisu okwenzeka kusukela ingane izelwe kuze kube inezinyanga ezintathu.

Awuphoqelekile ukulungenela lolucwaningo. Kanthi mangabe ulungenela unalo ilungelo lokuyeka mona nini mawuzizwa ungasathandi noma ungakhululekile.

Kuyaqala kuleli laseMzansi Afrika ukuba kwenziwe uncwaningo olufana nalolu. Kulolucwaningo kuzohlolwa izingane ezingu 100 eziphilile nezikhula kahle.

Umtwana ongenele lolucwaningo uzohlolwa. Ukuhlolwa kuthatha imizuzu embalwa, kuphephile futhi akukho buhlungu obuyozwiwa umtwana wakho. Udokotela uyiChiropractor uzobekhona.

Uhlelo:

1. Uyacelwa ukuba usayine imvume yokuthi umtwana wakho angenele lolucwaningo

2. Umhlengikazi uyohlola umtwana wakho ukwenza isiqiniseko sokhuthi uphila kahle kanti futhi ukhula kahle.

3. Mangabe eseqedile nawe umhlengikazi uzobe esehlola umtwana wakho ekliniki yase Durban Institute of Technology noma khona.

4. Umcwaningi awumtsheli lutho ngomntwana wakho.

5. Umcwaningi uzobe esebhala phansi konke akubonile noma akutholile ngomntwana wakho.

6. Uma kutholakala ukuthi umtwana wakho unezimpawu zokungaphili kahle, uvumelekile ukuthi angalashwa mahala eChiropractic Clinic.

Khumbula, siyojabula uma ungenela lolucwaningo kodwa awuphoqelekile kanti futhi mawusufuna ukuyeka noma ungasathandi noma ungakhululekile.

Uma uzizwa ungagculisekile ngendlela umcwaningi ahlole ngayo ingane yakho ungathintana be Chiropractic Clinic eDurban Institute of Technology – kulezinombolo ezingezantsi.

Ngiyabonga

Yimna Ozithobayo

. . . .

UCaroline Van Lingen Chiropractic Intern	Udokotela Junaid Shaik Research Supervisor
0824693143	2042588

Appendix B:

DURBAN INSTITUTE of TECHNOLOGY

INFORMED CONSENT FORM
(To be completed by parent)

Date:

Title of research project:

A study to determine if the prevalence of spinal joint dysfunctions is influenced by whether or not infants suffer from infantile colic.

Name of supervisor:	**Dr Shaik**	**Tel no: 2042588**
Name of research student:	**Caroline van Lingen**	**Tel no: 082 4693143**

Please circle the appropriate answer

		YES	**NO**
1.	Have you read the research information sheet?	Yes	No
2.	Have you had an opportunity to ask questions regarding this study?	Yes	No
3.	Have you received satisfactory answers to your questions?	Yes	No
4.	Have you had an opportunity to discuss this study?	Yes	No
5.	Have you received enough information about this study?	Yes	No
6.	Do you understand the implications of your involvement in this study?	Yes	No
7.	Do you understand that you are free to withdraw from this study? at any time without having to give any a reason for withdrawing, and without affecting your future health care.	Yes	No
8.	Do you agree to voluntarily participate in this study	Yes	No
9.	Who have you spoken to? _____		

Please ensure that the researcher completes each section with you.
If you have answered NO to any of the above, please obtain the necessary information before signing.

Please Print in block letters:

Infant's Name:_____

Parent's Name:_____Signature:_____

Relationship to infant? :_____

Witness Name:_____Signature:_____

Research Student Name:_____Signature:_____

ISAHLUKO B:

INCWADI EGUNYAZAYO

Usuku: _____

Isihloko socwaningo:

Isifundo sokuqhathanisa izinsana eziphile kahle nalezo ezikhala njalo, ngenxa yokungasebenzi kahle kwemisipha esemathanjeni omgogodla.

_____

Igama lika supervisor: Dr Shaik Tel no: 2042588

Igama lomfundi ongumcwaningi: Caroline van Lingen Tel no: 082 469 3143

_____

Uyacelwa ukuba ukhethe impendulo	**Yebo**	**Cha**
1. Ulifundile yini iphepha elinolwazi ngocwaningo?	Yebo	Cha
2. Ube naso yini isikhathi sokubuza imibuzo mayelana nocwaningo?	Yebo	Cha
3. Wanelisekile yini izimpendulo ozitholile emibuzweni yakho?	Yebo	Cha
4. Ube nalo yini ithuba lokuthola kabanzi ngocwaningo?	Yebo	Cha
5. Uyithole yonke imininingwane eyanele ngalolucwaningo?	Yebo	Cha
6. Uyayiqonda imiphumela yokuzimbhandakanya kwakho kulolucwaningo?	Yebo	Cha
7. Uyaqonda ukuthi ukhululekile ukuyeka lolucwaningo? noma inini ngaphandle kokunika isizathu sokuyeka ngaphandle kokubeka impilo yakho ebungozini	Yebo	Cha
8. Uyavuma ukuvolontiya kulolucwaningo?	Yebo	Cha
9. .Ukhulume nobani? _____		

Ngicela wenze isiqiniseko sokuthi umcwaningi usigcwalisa nawe lesisiqephu. Uma uphendule ngokuthi cha kokungaphezulu, sicela uthole ulwazi ngaphambi kokusayina.

BHALA NGAMAGAMA AMAKHULU:

Igama lomntwana:_____

Umzali:_____ Sayina: _____

Nizwana noma nitholana kanjani nengane yakho ? _____

Igama lomfakazi:_____ Sayina: _____

Igama lomfundi ongumcwaningi:_____ Sayina: _____

Appendix C:

Group:……

CASE HISTORY FORM:

Infant's name:……. Sex: ……

Infant's age in days:…… Ethnic Group……..

Age of onset of colic:…….

To be completed by the nursing sister:

Criteria governing the diagnosis of infantile colic:

- The infant may not show symptoms that could be a sign of any disease other than infantile colic.
- The infant must have 1 or more violent spells of crying per day.
- These crying spells must be at least 3 hours long per day and must have been present at least 5 of the 7 previous days.
- Apart from the attacks of infantile colic, the infant must show normal behaviour.
- The infant must show typical colic behaviour during the spells of crying:
  - Motor unrest;
  - Often flexing knees against the abdomen;
  - Extending the trunk, neck and extremities.
- During the attacks the infants cannot (or only temporarily) be comforted by:
  - Being picked up;
  - Walked;
  - Cradled;
  - Change of diaper;
  - Being offered a dummy.

Infant information sheet / Imininingwane yosana:

To be completed by the parents. Ukuyenzelwa ngabazali.

Infant behavior / **Ukuziphata kosana**:

How many times per day does the infant experience crying spells? Ikhala kangaki ingane yakho imini nobusuku?			
What is the duration of the crying spells? Ikhala isikhati esingakanani ingane yakho?			
At what time of the day does the majority of crying occur? Isiphi isikhati osukwini akhala ngaso kakhulu (kaningi)?	Morning Ekuseni	Afternoon Entambama	Evening Ebusuku

Infant feeding routine / Indlela usana oludla ngayo:

Is the infant breast or bottle-fed? Ingabe luncela ibele noma ibhodlela?	

Infant birth / Ukubelethwa kosana:

How was the baby born? By means of natural birth or caesarian section? Wabeletha ngemvelo noma ngokuhlinzwa?	

Maternal history / Umlando wokukhulelwa kukamama:

Age: Uneminyaka emingaki?	
Total number of children? Bangaki abantwana sekuhlangene nalabo abashona (amasu)?	

Appendix D:

DATE:……

INFANT'S NAME:……

Observation:	**RIGHT**			**LEFT**				**RIGHT**			**LEFT**		
Supine:							**Prone:**						
Head Position							PSIS alignment						
Involved Muscles:	**RIGHT**			**LEFT**				**RIGHT**			**LEFT**		
SCM							Erector Spinae						
Posterior cervical							QL						
Static Palpation:	**RIGHT**			**LEFT**				**RIGHT**			**LEFT**		
Cervical Spine:	**A**	**S**	**T**	**A**	**S**	**T**	**Thoracic Spine:**	**A**	**S**	**T**	**A**	**S**	**T**
C0-C1							T1-T2						
C1-C2							T2-T3						
C2-C3							T3-T4						
C3-C4							T4-T5						
C4-C5							T5-T6						
C5-C6							T6-T7						
C6-C7							T7-T8						
C7-T1							T8-T9						
							T9-T10						
Lumbar Spine:							T10-T11						
L1-L2							T11-T12						
L2-L3							T12-L1						
L3-L4													
L4-L5							**SI Joints:**						
Motion Palpation:	**RIGHT**			**LEFT**				**RIGHT**			**LEFT**		
Cervical Spine:	**A**	**S**	**T**	**A**	**S**	**T**	**Thoracic Spine:**	**A**	**S**	**T**	**A**	**S**	**T**
C0-C1							T1-T2						
C1-C2							T2-T3						
C2-C3							T3-T4						
C3-C4							T4-T5						
C4-C5							T5-T6						
C5-C6							T6-T7						
C6-C7							T7-T8						
C7-T1							T8-T9						
							T9-T10						
Lumbar Spine:							T10-T11						
L1-L2							T11-T12						
L2-L3							T12-L1						
L3-L4													
L4-L5							**SI Joints:**						