COVER LETTER

This is an original journal article and is not under consideration for publication in another pre-reviewed medium.

I intend to submit this journal article to the Health SA Gesondheid. It should be considered to be published. The study is titled "Describing the effect of Chiropractic Cervical Manipulation on Disturbed Sleeping Patterns"

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ETHICAL CLEARANCE

UNIVERSITY OF JOHANNESBURG

FACULTY OF HEALTH SCIENCES

RESEARCH ETHICS COMMITTEE

NHREC Registration no: REC-241112-035

REC-01-182-2015

08 JUNE- 2015

TO WHOM IT MAY CONCERN:

STUDENT: Mc DONNELL, K
STUDENT NUMBER: 201002645

TITLE OF RESEARCH PROJECT: "Describing the Effect of Chiropractic Cervical Manipulation on Disturbed Sleeping Patterns"

DEPARTMENT OR PROGRAMME: CHIROPRACTIC

SUPERVISOR: Dr C Baster **CO-SUPERVISOR:**

The Faculty Research Ethics Committee has scrutinised your research proposal and confirm that it complies with the approved ethical standards of the Faculty of Health Sciences; University of Johannesburg.

The REC would like to extend their best wishes to you with your postgraduate studies.

Yours sincerely,

Marie Poggenpoel

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DESCRIBING THE EFFECT OF CHIROPRACTIC CERVICAL MANIPULATION ON DISTURBED SLEEPING PATTERNS

A dissertation presented to the Faculty of Health Sciences, University of Johannesburg,

as partial fulfilment for the Master's degree in Technology: Chiropractic

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Describing the Effect of Chiropractic Cervical Manipulation on Disturbed Sleeping Patterns

ABSTRACT

Purpose: To describe whether chiropractic cervical manipulation may have an effect on disturbed sleeping patterns.

Method: All volunteers were required to complete the Pittsburgh Sleep Quality Index, which ultimately resulted in the recruitment of ten participants who matched the inclusion and exclusion criteria. After the selection process had been completed, the first consultation was conducted. In this consultation, an information form was given to the participants, and each was asked to sign an informed consent form. Pre-consultation education regarding the use of the FitBit was also completed. Thereafter, a full case history was taken and a full physical exam as well as a cervical spine regional exam was performed. Each participant's FitBit data, personal comments, MLSEQ and LSEQ were used by the researcher to describe whether or not chiropractic cervical manipulation had an effect on each participant's disturbed sleeping pattern. Each participant attended six consultations over a period two weeks. Chiropractic treatment took place at four of the six consultations.

Procedure: At each consultation, the participants were required to report on any changes they had experienced from the previous consultation, whether it was related to chiropractic treatment or not. They were required to fill out the modified portion of the Leeds Sleep Evaluation Questionnaire, which was collected and compared at the end of the trial. The orthopaedic tests that presented positive on the first consult were re-tested to identify any changes or improvements. The participants were also treated with a chiropractic cervical manipulation from the second to the fifth visit.

At the end of the study, the participants were required to fill out the full Leeds Sleep Evaluation Questionnaire and return the FitBit. The modified Leeds Sleep Evaluation Questionnaire, the full Leeds Sleep Evaluation Questionnaire and the FitBit data were analysed and reported on.

Results: Clinically, rather limited trends or linear improvements were presented. Some participants showed an improvement on some nights of the study, but not often enough to comment on. Statistically, the results that presented were insignificant; this may be due to the small sample size and perhaps because the study did not take place over a long enough period.

Conclusion: The participants did not show sufficient objective changes over the course of the study to substantiate any evidence of change. Rather limited linear trends of improvements presented for all measures of

the FitBit. The participants showed subjective improvements over the course of the study, which could have been owing to a psychological or placebo effect of the chiropractic treatment. Therefore, it is believed that for this particular study, it cannot be said if chiropractic cervical manipulation has an effect on disturbed sleeping patterns, thus more research needs to be done into the topic.

Key Words: chiropractic, manipulation, cervical, effects, disturbed, sleep

INTRODUCTION

Approximately one hundred and fifty million people worldwide suffer from sleep disturbances. In South Africa, thirty one percent of women and twenty seven percent of men have reported difficulty with sleep (Breus, 2012).Sleep deprivation results in problems such as impaired brain activity, cognitive dysfunctions and, in some cases, serious health problems such as heart attacks, high blood pressure and strokes. It can also result in problems such as impaired memory, hallucinations, depression, moodiness, weakened immune response and weight gain (Boellard, Hoegendijk, Kloet, Klumpers, Lammerertsma, van Tol and Veltman, 2015).

There are many treatment approaches to sleep disturbances, ranging from psychology sessions to treatment with sleep medication There are also many claims in the form of patient's comments, observations by chiropractors, unpublished case studies and blogs that chiropractic treatment affects sleeping patterns. Despite these claims, no research has been done to validate them or to provide evidence to support theories of how manipulation could influence sleeping patterns.

MATERIALS AND METHODS

Selection Criteria

The sample consisted of ten participants recruited by means of flyers distributed at the University of Johannesburg as well as in the nearby sleep clinics. Snowball samplings were also used by regular patients of the clinic and were informed of the study by their existing chiropractors. The first ten participants who complied with the research criteria, both inclusion and exclusion, were chosen to represent the single sample group.

Inclusion Criteria

Both male and female, with disturbed sleeping patterns and cervical restrictions were recruited. The participants were over the age of eighteen, with no restriction placed on maximum age. This age group was selected owing to the fact that sleep disturbances may occur at any age and for many different reasons. In addition, they had to score five or more on the Pittsburgh Sleep Quality Index (PSQI). The participants also had at least one cervical restriction, which was found with motion palpation. Once all inclusion criteria were met, the participants were requested to read the information form and sign the consent form.

Exclusion Criteria

Participants who had started taking any new medication for sleep disturbances, as this may have interfered with the results of the study. It also excluded participants who had any contra-indications to chiropractic cervical adjustments (Gatterman, 2004). The signs and symptoms for the contra-indications were screened for during the physical examination.

Methodology

Participant Examination: This medium-term study was comprised of six visits (first initial consultation and five remaining consultations). All participants were allocated to the same treatment group undergoing the same treatment protocol throughout the study.

In the initial consultation:

- The participants were asked to complete the PSQI;
- The participants received the information form and signed the consent form;
- A case history was taken and a full physical examination as well as a cervical spine regional examination were performed on the participant;
- The use of the activity data logger (FitBit) was explained to the participant and they were instructed to wear the band every evening when going to sleep until the end of the study;
- Cervical spine restrictions were found using motion palpation; and
- No chiropractic treatment took place. The first two nights of data from the FitBit were used to obtain a baseline reading of the participant's normal sleeping pattern.

Participants were treated four times over a two week period. They then attended a sixth follow-up visit where no treatment was administered; only objective and subjective readings were taken.

In the follow-up visits:

- Participants were re-assessed before each treatment with emphasis on the cervical spine. Only the tests that presented positive, the range of motion and the myofascial trigger points found at the first consultation were re-examined;
- Participants were asked to complete a MLSEQ, as well report any changes since the previous consultation;
- Cervical spine restrictions were found upon motion palpation at consults one to five;
- Participants received chiropractic manipulation to the cervical spine at consultations two to five; and
- At the end of the study, at consult six, the participants were requested to return the FitBit and complete the LSEQ.

Methods of Measurement

The subjective data was collected by means of a MLSEQ, the full LSEQ as well as in-depth analysis of any changes experienced by the participant, whether the changes were sleep-related or not. The objective data was collected by means of an activity data logger (FitBit).

Modified Portion of the Leeds Sleep Evaluation Questionnaire

Two questions from the full LSEQ were used to create the modified portion. The first question asked how the participant feels upon waking and the second question asked how the participant at the present moment. Both questions were rated on a scale of one to ten, with one being very tired and ten being completely alert.

The Full Leeds Sleep Evaluation Questionnaire

The LSEQ consists of six sections with ten questions in total, all of which were rated on a scale of one to ten. The first section compares the way the participant currently falls asleep to the way he or she usually does, the second section compares the quality of the participant's sleep to his or her usual quality of sleep and the third section compares how the participant feels upon wakening to the way he or she usually feels. The fourth section asks how the participant feels when they wake up, the fifth section asks how the participant currently feels and the sixth section asks the participant to describe their balance and co-ordination upon awakening.

This questionnaire has been used in previous studies by Hindmarch and Parrot (1978) and Laudon, Tarrasch and Zisapel (2003) to identify and assess whether or not there had been an improvement in the participants' sleeping patterns. The Leeds Sleep Evaluation is therefore considered a valid and reliable instrument to determine that there had been an improvement in the participant's sleeping patterns. It was filled out on the last day when the participant returned the data logger (FitBit), because it is a retrospective type questionnaire.

FitBit

The FitBit was ordered online from Shop and Ship, at a cost of R1200 per device. It was worn around the wrist of each participant's non dominant hand while that participant was sleeping. The participants put the wristband on when they got into bed with the intention of going to sleep, and removed the armband when they woke up in the morning. The armband recorded the data, which was downloaded at the end of the study for statistical analysis. Based on the amount of movement detected by the armband during the night, the software calculated the total sleep time in minutes of each participant and the amount of time the participant was awake during the night.

The FitBit has been used in previous studies (Bahar, Guenther, Hunt, Napier, Pollock and Takacs 2014; Rutkin, 2015) to measure sleep quality and has been proved reliable for the measurement of activity data logging by both Bahar*et al.* (2014) and Rutkin (2015).The wristband has thus been validated as a sleep detection device and is not disruptive to sleep.

RESULTS

Because of the descriptive nature of the study, the data was analysed by the researcher in order to individually describe each participant and his or her results. The data was also analysed by the statistical department, STATKON, located at the University of Johannesburg, Kingsway Campus.

Each participant was described and analysed individually as a case study in order to obtain individual and personal results. Five of the ten participants are reported on in this article. Of the five, two of these participants showed the most favourable results, two showed the least favourable results and the fifth showed neutral results or no change. Participant 1 was described in the most detail, with the FitBit data represented in a table (Table 1) as well as graphs provided for each respective reading (Figures 1 - 5), as this participant showed the most interesting results according to the FitBit data.

The statistics were conducted and analysed and, although the overall results of the study were insignificant, the readings were used to identify if any trends presented over the duration of the study.

Descriptive Analysis

The same procedure was followed for all participants. There was no chiropractic treatment done on the first visit, as this visit served to establish if the participant was eligible to take part in the study and to explain the procedure to the participants.

Day 1 and Day 2 FitBit values were used to obtain a baseline reading of the participants' usual sleeping pattern; therefore there was no response to treatment after the first visit. The FitBit data over the duration of the study was presented in tables for each participant (Table 1 -5). The MLSEQ scores for visit 2, 3, 4 and 5 were represented in graphs for each participant (Figures 6 – 10).

Overview of Participant 1:

This participant showed the most promising results in all facets of study. However, from the graphs (Graphs 1 – 5), it could be seen that no linear improvements or trends were identified.

FitBit Data (Table 1) (Figures 1 – 5):

- The baseline sleep efficiency was averaged at 37% and then increased to 62% by the middle of the study (Day 7). It decreased slightly after that and measured 61% at the end of the study.
- The baseline time to fall asleep was averaged at 1hour and then decreased to 15minutes by day 7. It then remained relatively constant, finally averaging out at 13minutes.
- This participant showed an improvement in his sleeping pattern after every treatment.

Cervical spine regional examination:

- The participant started the study with decreased and painful ROM in flexion, extension and lateral flexion. At the fourth treatment, the participant's ROM was painful and decreased in all ROM. By the last treatment, the ROM had improved to better than it was before the first treatment. Flexion and lateral flexion had no pain but there was still muscle stretch present.
- The participant began the study with active myofascial trigger points (MFTrPs) in the right levator scapulae and right trapezuis muscle. By day7, they had active trigger points in both trapezuis and levator scapulae muscles. At the end of the study, the same trigger points were still present but they were passive rather than active MFTrPs.
- Upon motion palpation at the first treatment, posterior restrictions of LC2 and RC6 were found. As the study proceeded it became evident that a common C1 posterior restriction was found at each treatment. All other restrictions had improved over the study and even though the C1 vertebra was the primary restrictions in the neck it showed some improvement over the study.

Participant's personal comments:

- Over the course of the study the participant's comments were all positive. At visit 3 the participant stated that they had a stiff neck because of gym and stress but he still benefitted from the study in terms of his sleeping pattern. According to the participant, the biggest improvement was that he was sleeping for longer periods of time and with fewer disruptions. From the graphs it can be seen that the participant had no sleep disruptions, with only the exception of Day 7. This also provides evidence of the difference between subjective data and objective data. These comments correlate with the FitBit data.

LSEQ:

- The participant scored high on all LSEQ questions, which meant that he felt his sleeping had improved from before he had started the study.

Overview of Participant 2:

This participant showed the second most favourable results. She showed an improvement according to the FitBit data on all nights after the treatment. The values from the other nights remained constant and perhaps a slight improvement was noted throughout the study. Her personal comments, answers for the LSEQ and pain and MFTrPs all showed promising results.

FitBit Data (Table 2):

- The baseline sleeping pattern was averaged at 41.5% and, after each treatment, the values had improved from the previous night: night of first treatment: 56%; night of second treatment: 59%; night of

third treatment: 62%; and night of last treatment: 58%. These results show the participant responded favourably to chiropractic treatment on the days of treatment.

Cervical spine regional exam:

- The participant started the study with decreased and painful ROM in left lateral flexion, left rotation and flexion. By the end of the study, her ROM had improved. There were more full movements and less pain, but the issues were not completely resolved. If the participant were to carry on with chiropractic, there might have been a complete resolution of their ROM.
- The participant began the study with active trigger points in her trapezuis, sternocleidomastoid and levator scapulae muscles. By the end of the study, the trigger points had improved and all that remained were passive trigger points in the left trapezuis and levator scapulae muscles.
- At the start of the study, the participant had two large restrictions in her neck, with the left posterior of C4 being the primary restriction. At the end of the study, the primary restriction had completely resolved and all that remained was a small secondary restriction of C3.

Participant's personal comments:

- Over the course of the study the participant's comments were positive and she felt good after each treatment. She claimed the treatment had helped her to fall asleep quicker and to sleep with fewer disruptions. She commented that she felt more rested each morning and that her left side neck pain had improved greatly over the study.

LSEQ:

- The participant scored herself mostly 7/10 and 8/10 on all questions, which meant she felt her sleeping pattern had improved from before the start of the study.

Overview of Participant 3:

This participant showed the least favourable results. There was a decrease of sleep quality according to the FitBit data on three out of the four nights after treatment. The values from the other nights were erratic and no trend or pattern was noted throughout the study, yet his personal comments, answers to the LSEQ and pain and MFTrPs all showed promising results.

FitBit Data (Table 3):

- The baseline sleeping pattern was averaged at 53%. Three out of the four nights after treatment, his sleep efficiency had decreased from the previous night: night of first treatment: 47%; night of second

treatment: 48%; night of third treatment: 26%; and night of last treatment: 37%. These results show that the participant did not respond favourably to chiropractic treatment on the days of treatment.

Overview of Participant 4:

This participant showed the second least favourable results. She showed a decrease in her sleeping pattern on two out of the four nights after treatment. The values from the other nights were slightly erratic and no improvement could be noted throughout the study, although her personal comments, answers to the LSEQ and pain and MFTrPs all showed promising results.

FitBit Data (Table 4):

- The baseline sleeping pattern was averaged at 59.5%. Two out of the four nights showed an improvement and the other two showed a decline in their sleeping pattern: night of first treatment: 79%; night of second treatment: 56%; night of third treatment: 59%; and night of last treatment: 76%. These results show that the participant did not respond either favourably or non-favourably to chiropractic treatment on the days of treatment and showed no linear improvement over the course of the study.

Overview of Participant 5:

This participant showed no improvements nor decreases in the results over the course of the study and his sleeping pattern had remained relatively constant. He showed an improvement according to the FitBit data on two of the four nights after treatment. The values form the other nights remained relatively constant and no linear improvements were noted throughout the study, yet his personal comments, answers to the LSEQ and pain and MFTrPs all showed promising results.

FitBit Data (Table 5):

- The baseline sleeping pattern was averaged at 47%, and after each treatment the values had improved from the previous night: night of first treatment: 38%; night of second treatment: 70%; night of third treatment: 56%; and night of last treatment: 48%. These results show that the participant responded neither favourably or non-favourably to chiropractic treatment on the days of treatment.

No trends could be identified throughout the study for all measures of the FitBit.

Full Group Clinical Analysis

Mean Results

The mean results of the data over the duration of the study were analysed and recorded in order to identify if a trend presented over the duration of the study. The mean result for each measure of the Fitbit was represented in graphs (Figures 11 – 15). No trends for all measures of the Fitbit presented throughout the study.

Non-Parametric Tests

The non-parametric technique was used because of the small sample size. The Friedman Test was conducted on different measures of the FitBit and used for the study. The Friedman Test is used when the same sample of subjects or cases is measured at three or more points in time, or under three different conditions

The critical level or P-value was set at 95%. The test were set from 0.0 – 0.05. If the P-value was less than or equal to 0.05 ($P \leq 0.05$), the result was deemed statistically significant. If the P-value was greater than 0.05 ($P > 0.05$), the result was reported as statistically not significant.

The results of the Friedman Test for all measures of the FitBit indicated that there was a statistically insignificant difference in the test scores across the fourteen time points. The P-values for each measure of the Fitbit are represented in Table 6.

DISCUSSION

Clinical Analysis

Objective Changes

From the results presented in chapter four, it became apparent that there was not enough evidence to support the change in the overall sleeping pattern. The sleep efficiency was the overall assessment of the participant's sleeping pattern expressed as a percentage. Some of the participants showed an improvement in their sleep efficiency on some nights, but there was not enough of a change to comment on the effects of the chiropractic treatment.

None of the participants showed any trends or patterns or linear improvement for any measures of the FitBit. Therefore, a claim cannot be made that chiropractic cervical manipulation affects the participants' sleeping patterns. It was noted that most of the participants' sleeping patterns fluctuated throughout the study, occasionally appearing as if there was improvement but then often regressing thereafter. It may be possible that if the study was of a longer duration, a clearer pattern could be established and it could be determined if the intervention was influencing the participants' sleep or if it was only part of their natural sleeping variances. This aspect will be discussed in greater detail later under recommendations.

Subjective changes

All of the participants commented that they had slept better after the chiropractic treatment and at the end of the study. The MLSEQ and LSEQ were the subjective measures used in this study. The results of the MLSEQ after each treatment and the LSEQ at the end of the study had all improved. However, as noted above, spinal manipulation has four effects: neurologic effects, mechanical effects, psychological effects and soft tissue effects. Spinal manipulative therapy (manual therapy) involves the process of placing or "laying" of hands on the patient's body during examination and treatment, which may give the patient the "idea" that the clinician shows interest or has concern for them, making the patient feel "better" (Gatterman, 2005).

Many chiropractic patients who receive spinal adjustments to restore and maintain health become convinced that they have vertebrae out of place when they hear "popping" sounds during treatment. Chiropractic patients, and many chiropractors, interpret this sound as proof that a subluxated vertebra has been moved back into alignment. If a patient is told that the "pop" heard during spinal manipulation means that the cause of a problem has been corrected, this can have a very powerful placebo effect, which may relieve pain as well as convince the patient that the treatment is effective (Homola, 2001).

Placebo effects are especially prominent in unconventional healing because of personal attention, compassionate care, enhanced expectations and other effects of a close patient-physician relationship. A hands-on chiropractic adjustment to remove nerve interference caused by a subluxated vertebra will have a temporarily positive influence. When self-limiting conditions are involved, this placebo effect may outweigh the effects of an evidence-based treatment method (Nanseland Szlazak, 1995).It is thus possible that there was a psychological or placebo effect on the participants, therefore improving their perception of their sleeping patterns.

Interpretation of concomitant symptoms

When performing screening tests and conducting case summaries on the participants, it became evident that there were common signs, symptoms and familial traits among the participants that could have contributed to their disturbed sleeping patterns. The signs and symptoms common to all the participants were painful and decreased cervical range of motion; active myofascial trigger points; postural imbalances; increased stress levels and headaches or family history of headaches. All the symptoms listed are primarily pain conditions. It is possible that chiropractic treatment may affect and improve all of the above conditions, as the primary reaction to chiropractic treatment is typically pain relief (Knutson, 2003 & Haneline, 2006).

Sleep and pain have a reciprocal relationship. Not only can sleep deprivation manifest or exacerbate painful conditions, but pain also has a detrimental effect on sleep. It has also been shown that sleep deprivation can result in a hyperalgesic state, resulting in a heightened sense of pain the following day (Moldofsky, 2008). This painful state is thought to activate and maintain the awake state, resulting in a vicious cycle of sleep deprivation and enhanced pain. All the above mentioned conditions have been implicated in the production of pain (Gordon, Grimmer &Trott, 2007) therefore pain also has an effect of sleep.

Chiropractic may have had an indirect effect on some of the factors that cause disruption of sleep, therefore the improvement that was seen in some of the participants may not be a direct effect on the participants' disturbed sleeping patterns but rather an indirect effect on what was influencing their sleep. This, however, is speculation, and would need to be studied in further detail.

Statistical Analysis

Owing to the small size of the sample group and the nature of the study, no inferential statistics could be made. However, graphs of the mean values for all measures of the FitBit were used to identify if any trends had presented over the course of the study. None of the graphs showed any trends or linear improvements over the course of the study.

Clinical vs. Statistical Significance

Owing to the nature of the study, it is important to consider the difference between the statistical significance and the clinical significance. Statistical significance occurs when the hypothesis is tested using the Friedman Test. The Friedman Test is used when the same sample of subjects or cases is measured at three or more points in time, or under three different conditions. The results presented insignificant because there was not a strong enough improvement in the sleeping patterns, as well as owing to the small size of the study.

The clinical significance is both subjective and objective and can be observed. It was apparent from the clinical analysis that chiropractic cervical manipulation did not provide enough evidence to support any objective changes. The results of the subjective measures from the LSEQ and the MLEQ showed that chiropractic cervical manipulation may have an indirect effect on disturbed sleep, which is achieved by causing an improvement or resolution in some of the factors that contribute to a disturbed sleeping pattern.

This supports the fact that more research should be done on this topic and that over this time frame there was not enough evidence to justify whether or not chiropractic cervical manipulation had an effect disturbed sleep patterns.

CONCLUSION

The participants did not show sufficient objective changes over the course of the study to substantiate any evidence of change. Rather limited linear trends of improvements presented for all measures of the FitBit. The participants showed subjective improvements over the course of the study, which could have been owing to a psychological or placebo effect of chiropractic treatment. Therefore, it is believed that for this particular study, chiropractic cervical manipulation did not have an effect on disturbed sleeping patterns and more research would need to be done into the topic.

ACKNOWLEDGMENTS

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FIGURES

Figure 1: Line Graph Showing Total Hours Asleep for Participant 1 over the Duration of the Study

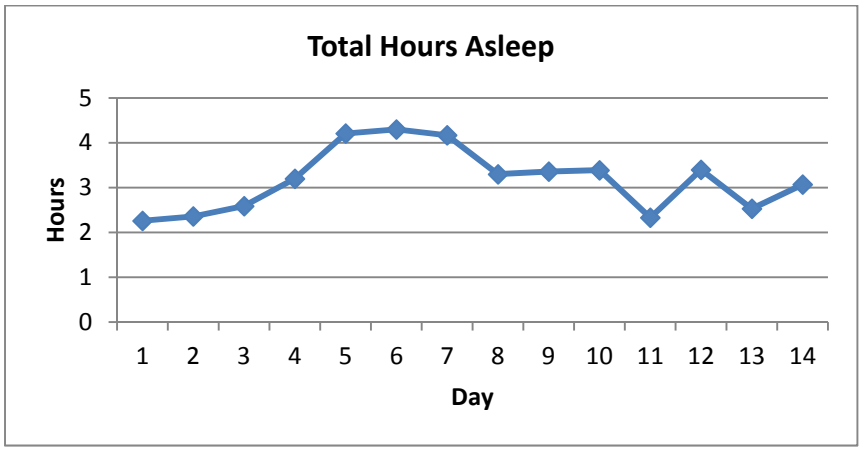


Figure 2: Line Graph Showing the Time to Fall Asleep (minutes) for Participant 1 over the Duration of the Study

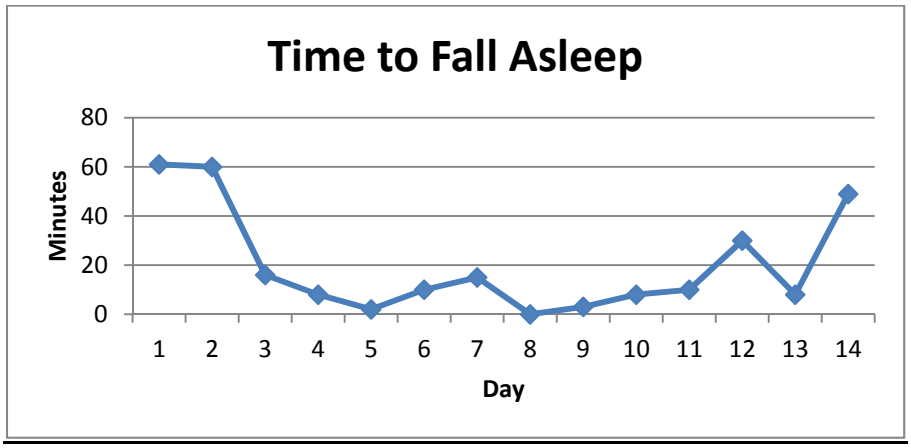


Figure 3: Line Graph Showing the Times Restless (occurrences) over the Duration of the Study for Participant 1

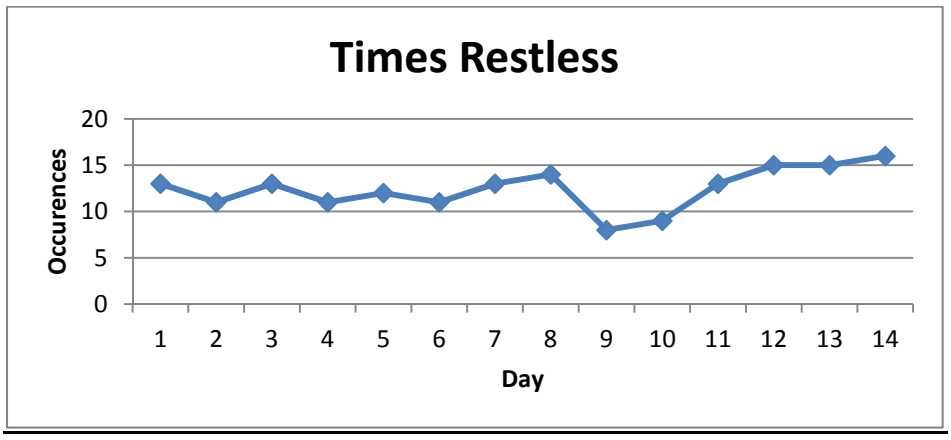


Figure 4: Line Graph Showing the Times Awakened (occurrences) over the Duration of the Study for Participant 1

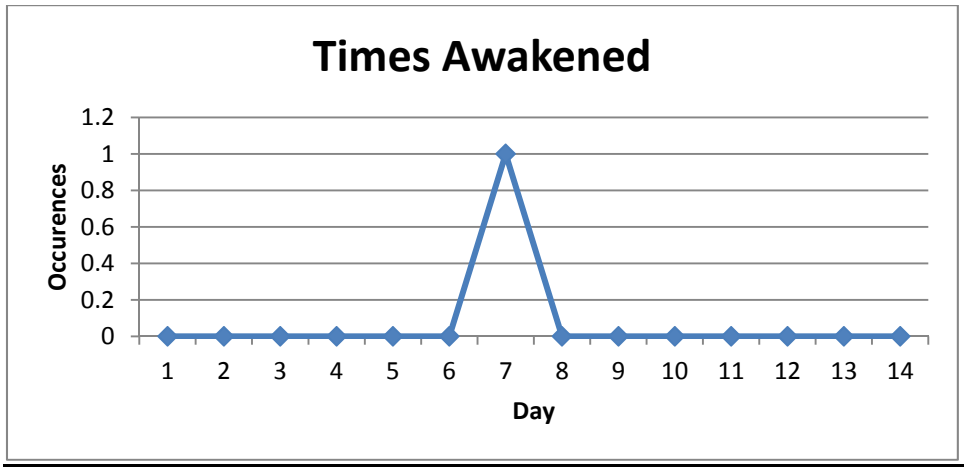


Figure 5: Line Graph Showing the Sleep Efficiency (%) over the Duration of the Study for Participant 1

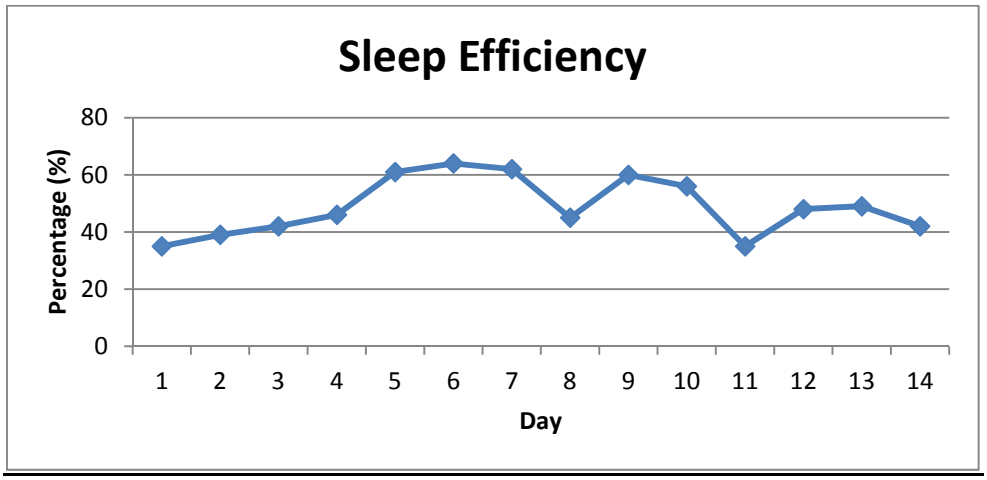


Figure 6: Line Graph Showing the Scores of the MLSEQ for Participant 1

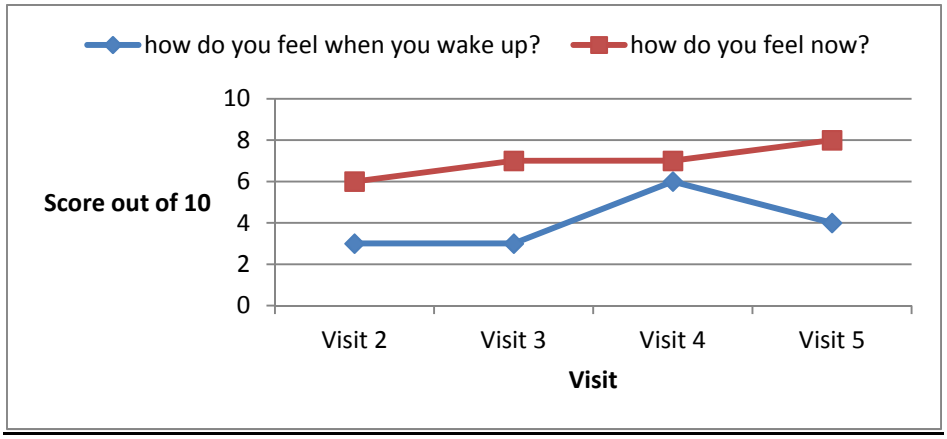


Figure 4.7: Line Graph Showing the Scores of the MLSEQ for Participant 2

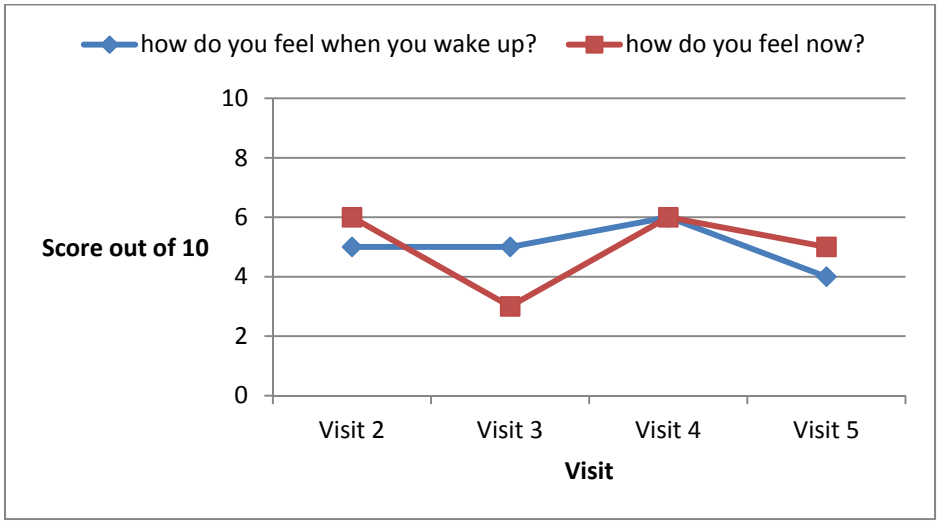


Figure 8: Line Graph Showing the Scores of the MLSEQ for Participant 3

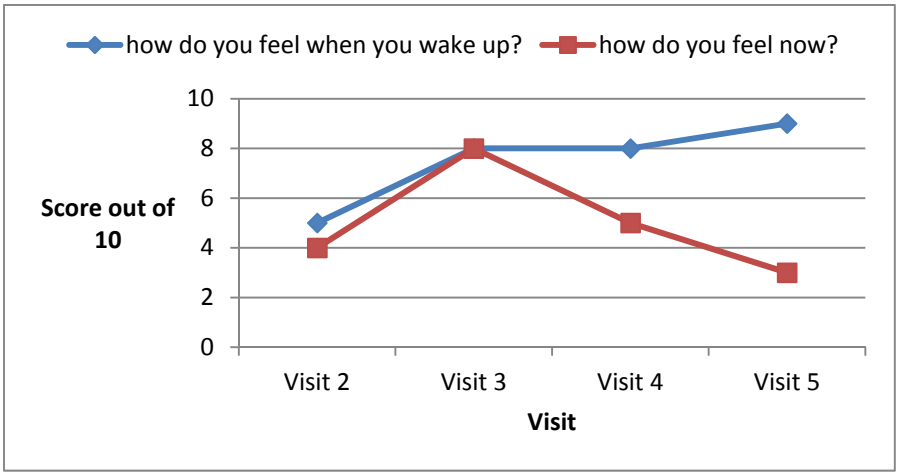


Figure 9: Line Graph Showing the Scores of the MLSEQ for Participant 4

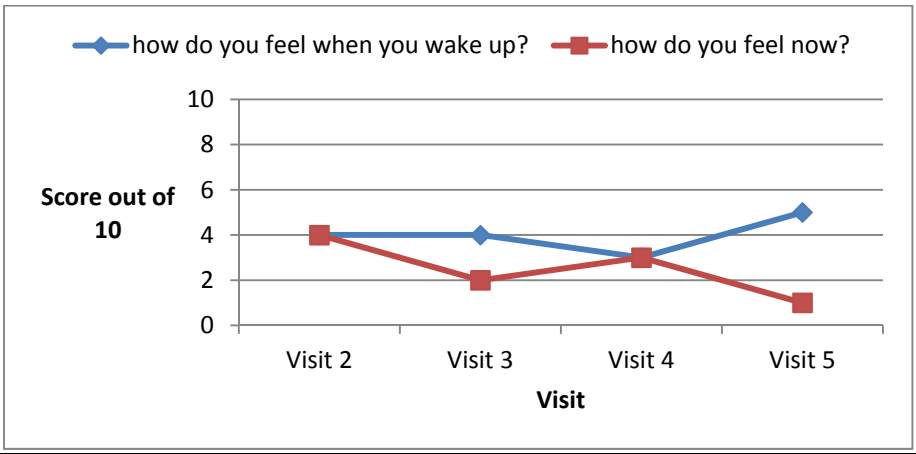


Figure 10: Line Graph Showing the Scores of the MLSEQ for Participant 5

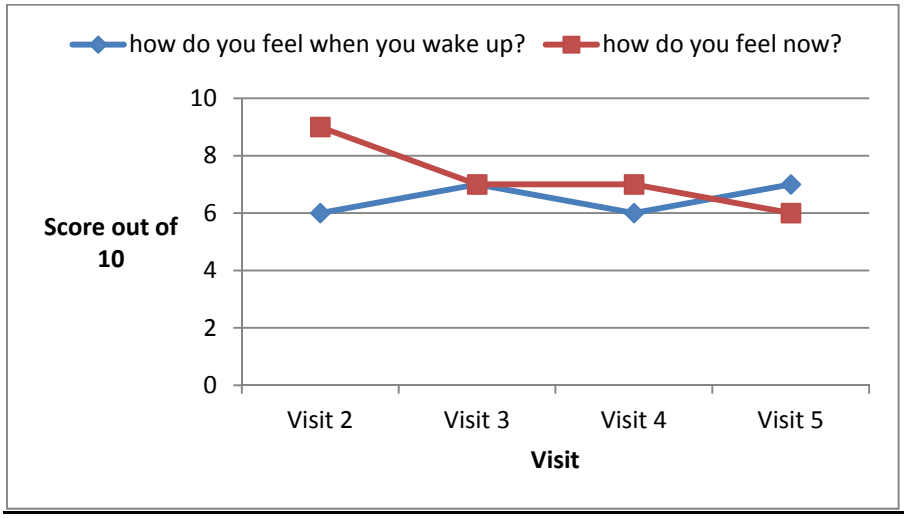


Figure 11: Line Graph Showing the Mean Total Time Asleep

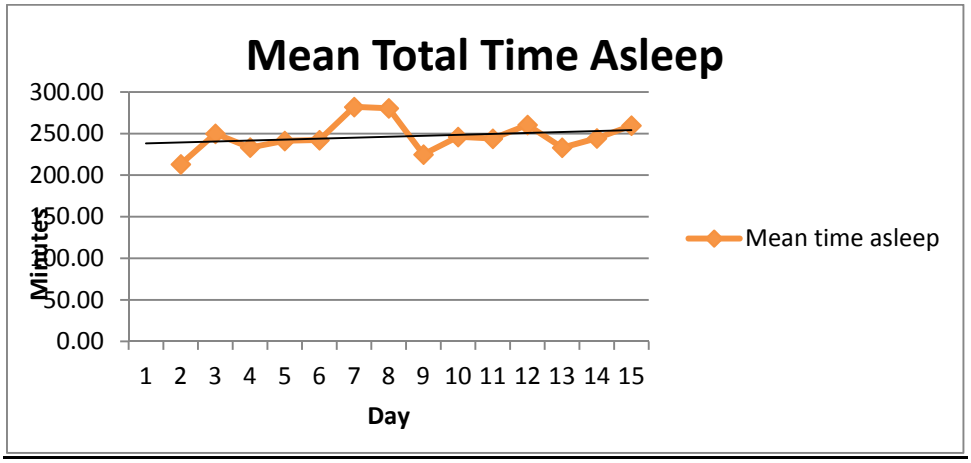


Figure 12: Line Graph Showing the Mean Time to Fall Asleep

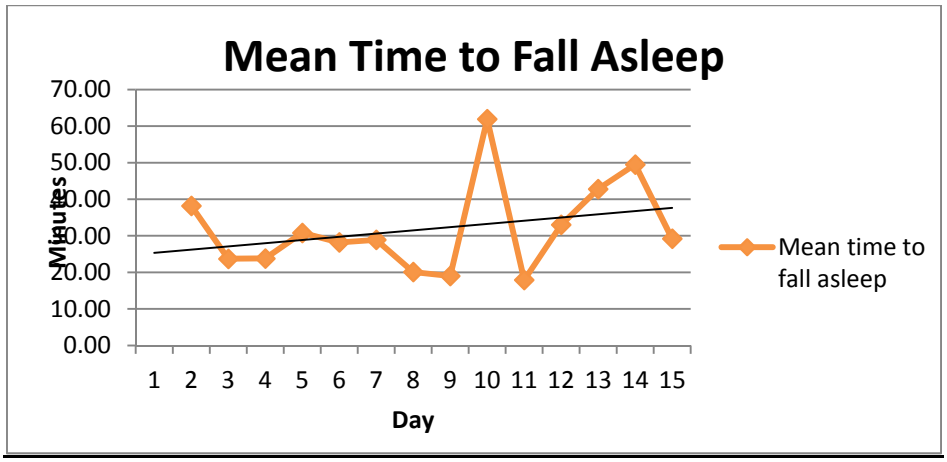


Figure 13: Line Graph Showing the Mean Times Awakened

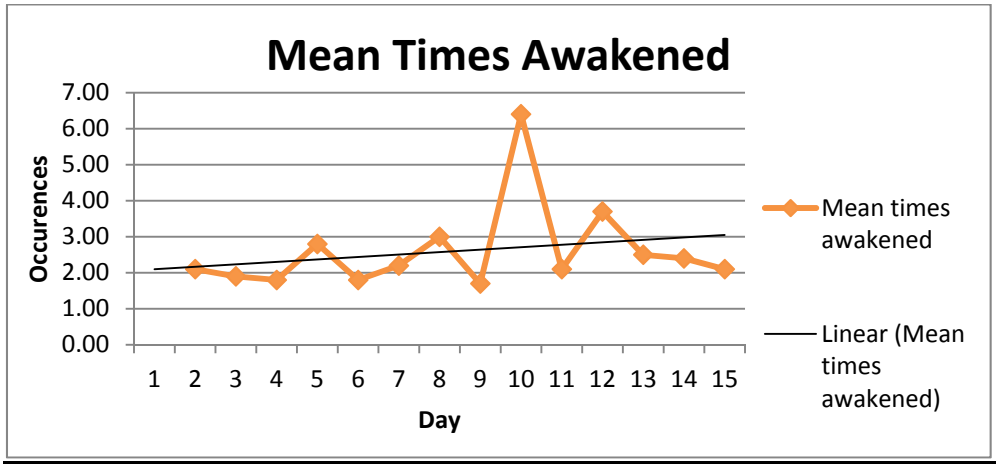


Figure 14: Line Graph Showing the Mean Times Restless

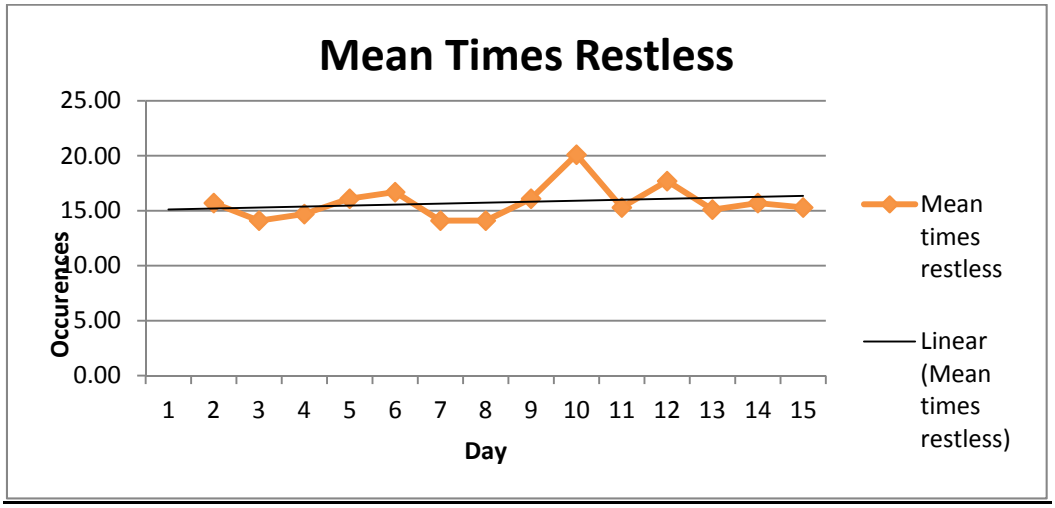
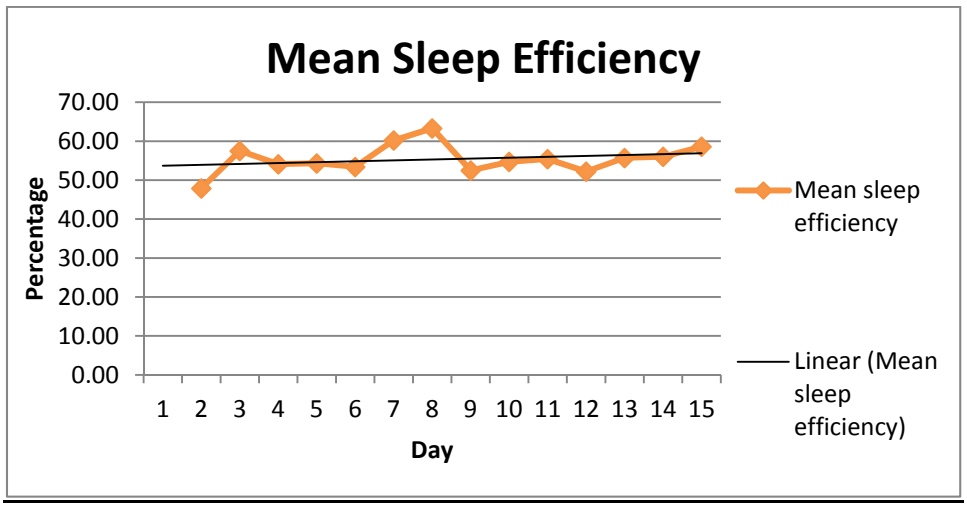


Figure 4.15: Line Graph Showing the Mean Sleep Efficiency



TABLES

Table 1: FitBit Data Results of Participant 1

	Total time asleep	Time to fall asleep	Times awakened (occurrences)	Times restless (occurrences)	Sleep efficiency
Day1	2hrs 26mins	1hr 01min	0	13	35%
Day2	2hrs 36mins	1hr 00mins	0	11	39%
Day3 (1st treatment)	2hrs 59mins	16mins	0	13	42%
Day4	3hrs 20mins	8mins	0	11	46%
Day5	4hrs 21mins	2mins	0	12	61%
Day6 (2ndtreatment)	4hrs 30mins	10mins	0	11	64%
Day7	4hrs 17mins	15mins	1	13	62%
Day8	3hrs 30mins	0mins	0	14	45%
Day9 (3rd treatment)	3hrs 36mins	3mins	0	8	60%
Day10	3hrs 39mins	8mins	0	9	56%
Day11	2hrs 33mins	10mins	0	13	35%
Day12 (4th treatment)	3hrs 40mins	30mins	0	15	48%
Day 13	3hrs 08mins	49mins	0	16	42%

Table 2: FitBit Data Results of Participant 2

	Total time asleep	Time to fall asleep	Times awakened (occurrences)	Times restless (occurrences)	Sleep efficiency
Day1	2hrs 42mins	18mins	0	11	46%
Day2	3hrs 23mins	1hr 10mins	3	13	60%
Day3 (1st treatment)	2hrs 53mins	17mins	2	13	47%
Day4	1hr 55mins	1hr 55mins	6	11	68%
Day5	4hrs 03mins	7mins	1	21	44%
Day6 (2nd treatment)	2hrs 43mins	7mins	1	8	48%
Day7	6hrs 20mins	8mins	1	4	92%
Day8	3hrs 10mins	12mins	1	15	37%
Day9 (3rd treatment)	3hrs 16mins	3hrs 30mins	44	55	26%
Day10	2hrs 34mins	14mins	1	11	49%
Day11	3hrs 22mins	1hr 09mins	18	33	32%
Day12 (4th treatment)	2hrs 18mins	1hr 15mins	1	15	38%
Day 13	1hr 37mins	3hrs 53	2	10	37%
Day14	6hrs 43mins	9mins	1	13	93%

Table 3: FitBit Data Results of Participant 3

	Total time asleep	Time to fall asleep	Times awakened (occurrences)	Times restless (occurrences)	Sleep efficiency
Day1	3hrs 19mins	17mins	3	21	36%
Day2	4hrs 03mins	8mins	1	18	47%
Day3 (1st treatment)	4hrs 28mins	11mins	1	14	56%
Day4	4hrs 41mins	39mins	4	13	61%
Day5	3hrs 26mins	10mins	1	14	50%
Day6 (2nd treatment)	3hrs 58mins	1hr 11mins	4	14	59%
Day7	4hrs 52mins	8mins	1	18	52%
Day8	4hrs 26mins	1hr 11mins	3	19	53%
Day9 (3rd treatment)	7hrs 56mins	25mins	3	26	62%
Day10	4hrs 16mins	9mins	1	15	46%
Day11	3hrs 16mins	1hr 34mins	4	14	55%
Day12 (4th treatment)	2hrs 37mins	20mins	1	12	42%
Day 13	4hrs 09mins	8mins	1	12	58%
Day14	3hrs 26mins	1hr 06mins	2	16	46%

Table 4: FitBit Data Results of Participant 4

	Total time asleep	Time to fall asleep	Times awakened (occurrences)	Times restless (occurrences)	Sleep efficiency
Day1	3hrs 03mins	22mins	1	13	47%
Day2	5hrs 11mins	9mins	2	13	72%
Day3 (1st treatment)	6hrs 31mins	20mins	3	15	79%
Day4	4hrs 56mins	8mins	3	17	59%
Day5	4hrs 50mins	20mins	3	12	76%
Day6 (2nd treatment)	3hrs 48mins	20mins	2	11	56%
Day7	6hrs 07mins	24mins	3	11	84%
Day8	5hrs 04mins	13mins	1	13	69%
Day9 (3rdtreatment)	5hrs 09mins	15mins	2	17	59%
Day10	5hrs 25mins	11mins	3	18	64%
Day11	6hrs 31mins	9mins	1	17	71%
Day12 (4th treatment)	5hrs 41mins	15mins	2	14	71%
Day 13	7hrs 19mins	8mins	2	17	76%
Day14	4hrs 30mins	17mins	2	17	59%

Table 5: FitBit Data Results of Participant 5

	Total time asleep	Time to fall asleep	Times awakened (occurrences)	Times restless (occurrences)	Sleep efficiency
Day1	2hrs 53mins	1hr 15mins	1	13	43%
Day2	3hrs 23mins	30mins	2	19	49%
Day3 (1st treatment)	1hr 56mins	17mins	1	15	38%
Day4	3hrs 49mins	11mins	2	18	45%
Day5	3hrs 51mins	1hr 59mins	2	20	53%
Day6 (2nd treatment)	11hrs 03mins	9mins	5	25	70%
Day7	3hrs 42mins	42mins	1	16	49%
Day8	4hrs 51mins	8mins	3	22	48%
Day9 (3rd treatment)	4hrs 32mins	6mins	1	17	56%
Day10	2hrs 53mins	26mins	1	10	61%
Day11	3hrs 51mins	15mins	1	13	56%
Day12 (4thtreatment)	4hrs 00mins	33mins	1	10	67%
Day 13	3hrs 36mins	1hr 05mins	2	19	48%
Day14	4hrs 35mins	12	3	16	63%

Table 4.6: P-values of the Friedman Test

	P-value
Total time asleep	0.91
Time to fall asleep	0.31
Times awakened	0.93
Times restless	0.82
Sleep efficiency	0.59

AUTHOR DECLARATION

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property.

We further confirm that any aspect of the work covered in this manuscript that has involved either experimental animals or human patients has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript.

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Dr. Charmaine Bester Date:

Author Agreement

I, Dr. Charmaine Bester,the corresponding author, certify that all authors have seen and approved the manuscript being submitted.

The article submitted is the authors' original work, has not received prior publication and is not under consideration for publication elsewhere.

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100 WORD ABSTRACT

Purpose: The aim of this study was to describe the effect of chiropractic cervical manipulation on disturbed sleeping patterns. The aim was determined by using a Fitbit wrist band and the Leeds Sleep Evaluation Questionnaire (LSEQ).

Method: The study consisted of 10 participants over the age of 18. The participants had to use the Fitbit each night for two weeks and had to complete the LSEQ at the end of the study.

Results: Clinically, rather limited trends or linear improvements were presented. Some participants showed an improvement on some nights of the study, but not often enough to comment on. Statistically, the results that presented were insignificant.

Full Title: Describing the Effect of Chiropractic Cervical Manipulation on Disturbed Sleeping Patterns

8 Word Title: The Effect of Cervical Manipulation on Disturbed Sleeping Patterns

Key Words: effects, chiropractic, cervical, manipulation, disturbed, sleep, Fitbit