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RESEARCH ARTICLE

ASSOCIATION BETWEEN SUBJECTIVE NECK PAIN AND CHARACTERISTICS OF THE NECK REGION AMONG FEMALE SEWING MACHINE OPERATORS.

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Abstract

Operating a sewing machine is an identified occupational risk for neck disorders. The scope of this study was to identify whether there is an association between neck pain and characteristics of the neck (range of motion, muscle strength, height and circumference) among female sewing machine operators. A cross sectional, descriptive study was carried out among 100 female sewing machine operators with an age range of 25-35 years in a garment factory in Katunayake Free Trade Zone, Sri Lanka. An interviewer administered questionnaire was used to find out the neck pain distribution. Physical assessment was conducted to assess neck characteristics. Characteristics of the neck among 'neck pain' group (who complained of neck pain within last two years) and 'no neck pain' group (who had not neck pain within last two years) were analyzed with independent sample t test using SPSS (Statistical Package for Social Sciences) version 17. Study revealed that 49% had neck pain within last two years, while neck range of motion, neck muscle strengths of extensor and left and right rotators, neck height and circumference were significantly reduced in 'neck pain' group when compared with 'no neck pain' group. The study concluded that high proportions of sewing machine operators had neck pain; and there is an association between neck pain and some characteristics of the neck (range of motion, muscle strengths of extensor and left and right rotators, height and circumference) as these characteristics were significantly reduced in 'neck pain' group when compared to 'no neck pain' group.

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Introduction:-

Neck pain can be defined as the sensation of discomfort in the neck area (Medicine Net. 2015). For the purposes of this study, neck pain was defined as any momentary neck ache or discomfort, due to working as a sewing machine operator within the last 2 years, persisting for more than 2 minutes, and that did or did not require treatment.

According to Ilson (2000) neck region is more prone to developing problems than other areas of the body and operating a sewing machine is an identified occupational risk for neck disorders. There is a high prevalence of neck

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problems among sewing machine operators and a major component of these neck problems is neck pain (Kaergaard and Andersen, 2000; Schibye et al, 1995; Wang et al, 2007; and Vihma, Nurminen and Mutane, 1982)(Neck is a highly affected body part of sewing machine operators (Vihma, Nurminen and Mutane, 1982). They have to work long hours to achieve their production targets, keeping the neck in a static posture for a prolonged period of time. Women have a higher prevalence of having neck disorders than men (Kilbom, n.d.). Consequently the risk may further increase in female sewing machine operators.

Literature indicates that characteristics of the neck are reduced in people having neck pain. Most of the studies have concluded that subjects with neck pain have decreased neck range of motion than those who have not neck pain (Houck et al, 1997; Hagen et al, 1997; Oord et al, 2010 and Lee et al, 2004). According to Vasavada et al (2001); neck muscle strength is lessened in pathological conditions. Isometric neck muscle strength in all directions is significantly lower among the participants who complained of neck pain than that of non-symptomatic subjects (Oord, 2010 and Vasavada, 2001; Ylinen, 2004; and Bussieres, 1994). A study by Loose D (2009) has revealed that there is no significant difference in neck muscle strength between healthy pilots and those with neck pain. However, there are no articles in the literature that investigate the differences of neck circumference and height between subjects with and without neck pain.

If the sewing machine operators develop neck problems it will result in loss of working hours and this will adversely affect the productivity of the garment industry. This may lead to reduced productivity and income of the country since garment industry has become major export earning industry in many countries such as Sri Lanka (Dheerasinghe R, 2003).

In the literature, studies on the physical characteristics of the neck region among sewing machine operators are less. Though there are several researches on neck problems, these studies have used questionnaire generated data rather than data from physical assessment (Lee et al, 2004). Hence is the reason for this study that investigates the subjective neck pain and characteristics of the neck region among female sewing machine operators in Sri Lanka.

Objectives of this study were:-

To find out the distribution of neck pain among female sewing machine operators and to compare the differences in characteristics of the neck (range of motion, muscle strength, and neck circumference and height) between the 'neck pain' group and the 'no neck pain' group

Methods:-

A cross sectional, descriptive study was carried out in a garment factory in Katunayake Free Trade Zone, Sri Lanka using 100 female sewing machine operators within an age range of 25 to 35 years, and with a minimum of two years of experience as a sewing machine operator. The machine operators who were pregnant or who had congenital neck problems or identified neck problems- not due to work were excluded. The first fifteen consenting sewing machine operators, who came out of the door to take the lunch each day, and who fulfilled the inclusion criteria were recruited for the study. No randomization was possible because the management of the garment factory could not afford to release a large number of sewing machine operators for a longer period of time per day.

Data were first collected using an interviewer-administered questionnaire, and then physical assessment was carried out.

The questionnaire, developed using the available literature consisted of open and closed ended questions (Babatunde O A A, 2004 and Salik Y and Ozcan A, 2004). It was piloted to ascertain clarity and appropriateness prior to data collection. The first few questions of the questionnaire were to collect the personal details; e.g. age, marital status. The next question was to find out whether the respondent had neck pain within the last two years due to work. This question helped in excluding those who had neck problems, which were not due to work. When asking from the participants whether they had neck pain due to work within last two years; neck pain was clearly and descriptively defined as "any momentary neck ache or discomfort persisting for more than 2 minutes that did or did not require treatment, within the last two years due to working as a sewing machine operator". Subjects who had neck pain according to the above definition were categorized into 'neck pain' group and those who had no neck pain were categorized into 'no neck pain' group.

The physical assessment was conducted (among both in 'neck pain' group and 'no neck pain' group) to assess the following characteristics of the neck: range of motion of the neck using a hand held goniometer, neck muscle strength using a modified dynamometer; and height and width of the neck using a measuring tape.

Validity and reliability of measurement tools used in this study:-

Even though the CROM (Cervical Range of Motion) device is a more validated and reliable tool in measuring cervical range of motion when compared with the hand held goniometer and tape, the CROM device is relatively larger in size and more costly than the hand held goniometer and tape measure which are relatively inexpensive and user friendly Youdas et al,(1992).

Physical Assessment:-

Range of motion of the neck:-

Range of motion of the neck was measured using goniometer to assess all the movements of the neck (flexion, extension, left lateral flexion, right lateral flexion, left rotation and right rotation) The assessment was performed by one observer (principle investigator) while another person standing in front of the subject took the reading to improve the accuracy of measurement. First session was used as a trial run, to allow the subjects to become familiar with the procedure. Then three measurements were taken for each direction. The subject was instructed to perform three consecutive free active movements starting from neutral position of the neck in different six direction; up ,down, right left side and left and right rotation as far as they could, and to return to neutral position each time, with a 10-second rest in between each movement, and 2-minute rest between different directions. The average and the maximum degrees of motion of the three measurements were calculated for each direction.

The method of assessment of the neck muscle strength:-

The neck muscle strength was measured by using a modified dynamometer. The modified dynamometer was validated by a pretest, prior to using in the study, with randomly selected 20 persons from the community. Since the measurements were similar to standard measurements produced internationally, the modified dynamometer was used in this study.

The neck muscle strength was measured in the flexor, extensor, left lateral flexor, right lateral flexor, left rotator and right rotator muscle groups using the modified dynamometer.

Measurement of isometric neck muscle strength was taken after a 10-minute break following completion of the measurement of range of motion. Again, three measurements were taken for each of the six directions randomly (flexion, extension, right and left lateral flexion, left rotation and right rotation) at each session. The subject was instructed to do three consecutive steady contractions (in different directions, for testing different muscle groups) as hard as possible, with a 10-second rest between each contraction and a 2-minute rest between different directions, to avoid fatigue. The measurements were taken by the scale of the dynamometer that recorded as the isometric neck muscle strength. The average isometric strength for each direction was calculated based on the three measurements.

The method of assessment of the neck height and circumference of the neck:-

The height and the circumference of the neck were measured using a measuring tape. The subject was sitting in a chair with armrest and back support, but without head support. The subject was instructed to keep their head up and to look straight ahead. The therapist stood in front of the subjects to take measurements. When recording, the tape was not too tight or too loose, and was lying flat on the skin. Neck height measurement was taken with a measuring tape, and was measured from the external prominence of occipital protuberance to the C7 (seventh cervical vertebra) spinous process (Reynolds J et al, 2009). The neck circumference was measured anteriorly at the level of cricoid cartilage and spinous process of the C6 posteriorly. Then the average measurement was calculated after obtaining three measurements (Reynolds Jet al, 2009).

Data Analysis and ethics considerations:-

The data were analyzed using the computer software, Statistical Package for the Social Sciences (SPSS) version 17. Neck pain distribution was estimated using frequencies. The differences in the characteristics of the neck among 'neck pain' group and 'no neck pain group' were analyzed using independent sample t test at a significance level of $p < 0.05$.

Ethics clearance was obtained from the Ethics Review Committee, Faculty of Medicine, University of Colombo with the research proposal prior to conduct the research study. Permission was obtained from the managing directors of the garment factory to conduct the research on their employees. The data was collected after obtaining informed written consent. The interviewing and taking measurements were carried out by protecting the privacy.

Results:-

Neck pain distribution among sewing machine operators:-

In the study group, age range was between 25-35 years and mean age was 29.6 years.

Out of 100 female sewing machine operators, 49 (49%) subjects reported that they had neck pain within last two years due to work as sewing machine operators.

Subjects who complained neck pain hereafter are referred as 'neck pain' group and the other group as 'no neck pain' group.

The difference of neck range of motion between 'no neck pain' group and 'neck pain' group:-

The analysis of the results of neck range of motion of 'no neck pain' group and the 'neck pain' group in this study using the independent sample t test, together with the means, standard deviations and p values are shown in Table 1.

Table1:-The difference of neck range of motion between 'no neck pain' group and 'neck pain' group (N=number of subjects, SD- Standard deviation, p value for significance)

Variable	'no neck pain' group N=51 Mean +_SD	'neck pain' group N=49 Mean +_SD	p value	Significance/ Non-Significance
Range of motion of neck flexion	53.73+_8.49	45.84+_9.50	0.000	Significant
Range of motion of neck extension	56.86+_10.41	45.14+_10.82	0.000	Significant
Range of motion of left lateral flexion of the neck	51.27+_8.99	46.20+_7.67	0.003	Significant
Range of motion of right lateral flexion of the neck	50.61+_8.28	47.10+_8.45	0.039	Significant
Range of motion of left rotation of the neck	66.90+_9.26	59.10+_11.15	0.000	Significant
Range of motion of right rotation of the neck	64.90+_9.62	52.27+_10.68	0.000	Significant

According to the results, all the neck ranges of motion (flexion, extension, left and right lateral flexion, left rotation and right rotation) were significantly ($p < 0.05$) reduced in the 'neck pain' group than in the 'no neck pain' group.

The difference of the neck muscle strength between 'no neck pain' group and 'neck pain' group:-

The analysis of the results of the muscle strength of 'no neck pain' group and the 'neck pain' group in this study using the independent sample t test, together with the means, standard deviations and p values, are shown in Table 2.

Table 2:-The difference of the neck muscle strength between 'no neck pain' group and 'neck pain' group (N=number of subjects, SD- Standard deviation, p value for significance)

Variable	"no neck pain" group N=51 Mean +_SD	"neck pain" group N=49 Mean +_SD	p value	Significance/ Non-Significance
Strength of neck flexor muscles	57.83+_8.80	56.11+_9.43	0.349	Non-significant
Strength of neck extensor muscles	66.85+_10.21	56.31+_10.29	0.000	Significant
Strength of neck left lateral flexor muscles	55.34+_9.59	52.89+_10.41	0.222	Non-significant
Strength of neck right lateral flexor muscles	54.06+_9.22	52.77+_11.11	0.525	Non-significant
Strength of neck left rotator muscles	61.77+_9.79	54.25+_10.04	0.000	Significant
Strength of neck right rotator muscles	61.13+_9.61	54.18+_10.54	0.001	Significant

According to the results, neck muscle strengths of extensor and left and right rotators were significantly ($p < 0.05$) reduced in 'neck pain' group compared to 'no neck pain' group. Neck flexor and neck left and right lateral flexors muscle strengths were also reduced in 'neck pain' group compared to 'no neck pain' group but the difference was insignificant ($p > 0.05$).

The difference of neck circumference between 'no neck pain' group and 'neck pain' group:-

The analysis of the results of neck circumference of 'no neck pain' group and the 'neck pain' group in this study using independent sample t test, together with the means, standard deviations and p values are shown in Table 3.

Table3:-The difference of neck circumference between 'no neck pain' group and 'neck pain' group. (N=number of subjects, SD- Standard deviation, p value for significance)

Variable	'no neck pain' group N=51 Mean +_SD	'neck pain' group N=49 Mean +_SD	p value	Significance/ Non- Significance
Neck circumference	30.8+_2.05 cm	29.96+_2.02cm	0.043	Significant

According to the results, neck circumference among 'neck pain' group was reduced than the 'no neck pain' group. And the difference between the two groups was significant ($p < 0.05$).

The difference of neck height between 'no neck pain' group and 'neck pain' group:-

The analysis of the results of neck height of 'no neck pain' group and the 'neck pain' group in this study using independent sample t test, together with the means, standard deviations and p values, is shown in Table 4.

Table 4:-The difference of neck height between 'no neck pain' group and 'neck pain' group. (N=number of subjects, SD- Standard deviation)

Variable	'no neck pain' group N=51 Mean +_SD	'neck pain' group N=49 Mean +_SD	p value	Significance/ Non- Significance
Neck height	9.1+_1.28cm	8.46+_0.99cm	0.007	Significant

According to the results, neck height among 'neck pain' group was significantly ($p < 0.05$) reduced than the 'no neck pain' group.

Discussion:-

Neck pain distribution among sewing machine operators:-

According to this study 49% reported neck pain within last two years.

Literature too stated that the sewing machine operators are a high risk group of having neck disorders (Andersen J, 2000; Schibye B, 1995 and Wang P C,2007; Vihma T et al,1982; Fredriksson K et al ,2002; Korhonen T et al, 2003; and Leclerc et al,1999). Further female gender is highly prone to neck (Kilbom, nd). However the neck pain distribution of other studies in literature ranges from 24%, to 62.8% (Kaergaard A and Andersen J, 2000; Schibye B,1995 and Wang P C,2007). The wide variation in results of different studies may be due to socio cultural habits of sitting posture and body stature variations.

The difference of neck range of motion between 'no neck pain' group and 'neck pain' group:-

According to the results of this study, the neck ranges of motion of the flexion, extension, left and right lateral flexion, left rotation and right rotation were significantly ($p < 0.05$) reduced in the 'neck pain' group than in the 'no neck pain' group. Many studies report the above result, though these studies have been carried out using different validated equipment with different sample sizes and different categories of participants (Houck J, Yack H J, and Mulhausen P, 1997; Hagen, 1997; Oord V D,2010; Lee et al, 2004 and; Chiu T T and Kai S, 2003). This is evident from the data in Table 5 that compare the ranges of motion of the neck in all directions in 'degrees' between people who complained of neck pain(second row) and healthy subjects(first row) in different studies.

Table 5:-Comparison of neck range of motion in all direction between 'neck pain' group and 'no neck pain' group in different studies. (SD- Standard deviation)

Research studies	Neck pain status	Flexion Mean +_SD	Extension Mean +_SD	Left lateral flexion Mean +_SD	Right lateral flexion Mean +_SD	Left rotation Mean +_SD	Right rotation Mean +_SD
Results of this study	No neck pain Neck	53.73+_8.49 45.84+_	56.86+_10.41 45.14+_10.82	51.27+_8.99 46.20+_7.67	50.61+_8.28 47.10+_8.45	66.90+_9.26 59.10+_11.15	64.90+_9.62 52.27+_10.68

	plain	9.51					
Chiu and Kai(2003)	No neck pain	68.0+_6.19	68.3+_7.33 60.1+_8.84	52.6+_7.6 50.3+_6.25	49.8+-7.47 45.8+_6.15	77.2+_7.63 72.8+-10.5	78.0+-6.41 74.8+-7.67
	Neck plain	64.0+_8.62					
Lee at al(2004)	No neck pain	58	75	45	45	73	75
	Neck plain	57	72	43	43	69	70

The difference of the neck muscle strength between ‘no neck pain’ group and ‘neck pain’ group:-

According to the results, neck muscle strengths of extensor and left and right rotators were significantly ($p<0.05$) reduced in ‘neck pain’ group compared to ‘no neck pain’ group. Neck flexor and neck left and right lateral flexors muscle strengths were also reduced in ‘neck pain’ group compared to ‘no neck pain’ group but the difference was insignificant ($p>0.05$).

The literature has concluded that the isometric neck muscle strength in all the directions is lower among participants who complained of neck pain than that of non-symptomatic subjects (Oord V D et al, 2010 ; Lee et al, 2004; Vasavada et al, 2001; Bussieres A, 1994; and Chiu T T and Kai S, 2003).

Comparison of neck muscle strength between ‘no neck pain’ group (first row) and ‘neck pain’ group (second row) in different studies is presented in table 6 but only one study revealed that no significant difference in neck muscle strength between healthy and neck pain (Loose D et al, 2009).

Table 6:-Comparison of neck muscle strength between ‘neck pain’ group and ‘no neck pain’ group in different studies.

Research studies	Neck pain status	Flexion Mean +_SD	Extension Mean +_SD	Left side flexion Mean +_SD	Right side flexion Mean +_SD	Left rotation Mean +_SD	Right rotation Mean +_SD
Results of this study	No neck pain	57.83+_8.80N	66.85+_10.21N	55.34+_9.59N	54.06+_9.22N	61.77+_9.79N	61.13+_9.61N
	Neck pain	56.11+_9.43N	56.31+_10.29N	52.89+_10.41N	52.77+_11.11N	54.25+_10.04N	54.18+_10.54N
	Neck plain						
Bussiere s; 1994	No neck pain Neck plain	4615+-1317kPa 1982+1250kPa	7927+-2128kPa 4336+-1516 kPa	Not reported	Not reported	Not reported	Not reported
Chiu and Kai(2003)	No neck pain Neck plain	74.5+_19.6N 56.7+_24.5N	93.3+_34.0N 67.4+_27.3N	66.9+_16.4N 50.6+_22.9N	65.7+_19.2N 52.4+_21.2N	Not reported	Not reported

(SD- Standard deviation)

The difference of neck circumference between ‘no neck pain’ group and ‘neck pain’ group:-

According to the results, neck height among ‘neck pain’ group was significantly ($p<0.05$) reduced than the ‘no neck pain’ group. The neck circumference among ‘neck pain’ group was reduced than the ‘no neck pain’ group. And the difference between the two groups was significant ($p<0.05$). Yet no articles were found that investigated the differences of neck height and circumference between people who complained of neck pain and healthy subjects in the literature.

Limitation of the study:-

The study sample does not represent all the sewing machine operators and all the factories in Katunayake Free Trade Zone, Sri Lanka. Proper randomization was not possible, since the management of the garment factory allowed limited time period per day and a limited number of days to do my study. The physical assessment of cervical muscle strength was carried out with a modified dynamometer. The literature shows that there are more reliable instruments; e.g. CROM device and hand held dynamometer than hand held goniometer, tape and modified dynamometer which were used in this study (Bussieres A, 1994).

Conclusion:-

Forty nine percent sewing machine operators reported that they had neck pain within last two years. Hence, higher proportion of sewing machine operators are prone to neck disorders.

The range of motion of neck flexion, extension, left and right lateral flexion, left and right rotation, muscle strengths of extensor and left and right rotators; and neck height were significantly reduced in 'neck pain' group when compared with 'no neck pain' group.

List of abbreviations:-

1. C7- seventh cervical vertebra.
2. CROM-Cervical range of Motion.
3. SPSS- Statistical Package for the Social Sciences.
4. P value- significance level.
5. N-number of subjects.
6. SD- Standard deviation.

Conflicts of Interest:-

The author(s) declare that they have no competing interests.

Authors' contribution:-

M D C Silva carried out the study; collected the data, did the statistical analysis and drafted the manuscript.
Dr. G GPonnamperuma designed the study, assisted in statistical analysis and drafted the manuscript.

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