

IV. RESULTS AND DISCUSSION

Recent reports and observational studies suggest that employees in the garment industry often work under difficult conditions that are unacceptable in industrialized countries. The present study reports the results of ergonomic study in selected garment manufacturing units in Tirupur to evaluate the working conditions of the unit from an ergonomics/human factors perspective and to suggest possible solutions to management for implementation. The findings of the study on “**Ergonomic Interventions to Promote Occupational Health and Safety among Workers Employed in Garment Industries**” are discussed under the following headings:

- A. Status assessment of garment workers
- B. Impact of awareness programme on occupational safety and health
- C. Assessment of workplace hazards and medical screening of the workers
- D. Evaluation of ergonomic furniture

A. Status Assessment of Garment Workers

Survey research helps to gather data from a relatively large number of cases at a particular time. The details on the findings of survey are discussed below:

1. Personal profile of the garment industry workers

The personal profile of the selected garment workers was collected through survey method and the data of five hundred and fourteen garment workers are presented in Table 9 and Figure 9.

Table 9: Personal profile of garment workers

Particulars	Frequency (N=514)	Percentage
Age (years)		
Up to 20	74	14.4
21 - 30	213	41.4
31 - 40	171	33.3
41 - 50	44	8.6
Above 50	12	2.3
Sex		
Male	294	57.2
Female	220	42.8
Marital status		
Married	311	60.5
Unmarried	195	37.9
Divorced	1	2.0
Widow	7	1.4
Education		
Illiterate	38	7.4
Can read and write	16	3.1
Primary	91	17.7
High school	290	56.4
Higher secondary	63	12.3
Diploma	7	1.4
Degree	9	1.8

It is clear from the above Table that the mean age of the garment workers ranged from 15 to 56 years with a mean of 30 years (± 8.7). This clearly implies that workforce was comprised of young people. Above half of the workers (57 per cent) were male and (43 per cent) were female. This might be due to insufficient income of the head of the family which necessitate women and also sometimes children to work in garment industries (Oldenziel, 2001). Sixty per cent of workers were married while 56 cent had high school education. It indicates that workers with minimum level of education were engaged in this job.

2. Family Profile

The family background of workers employed in garment industries is shown in Table 10.

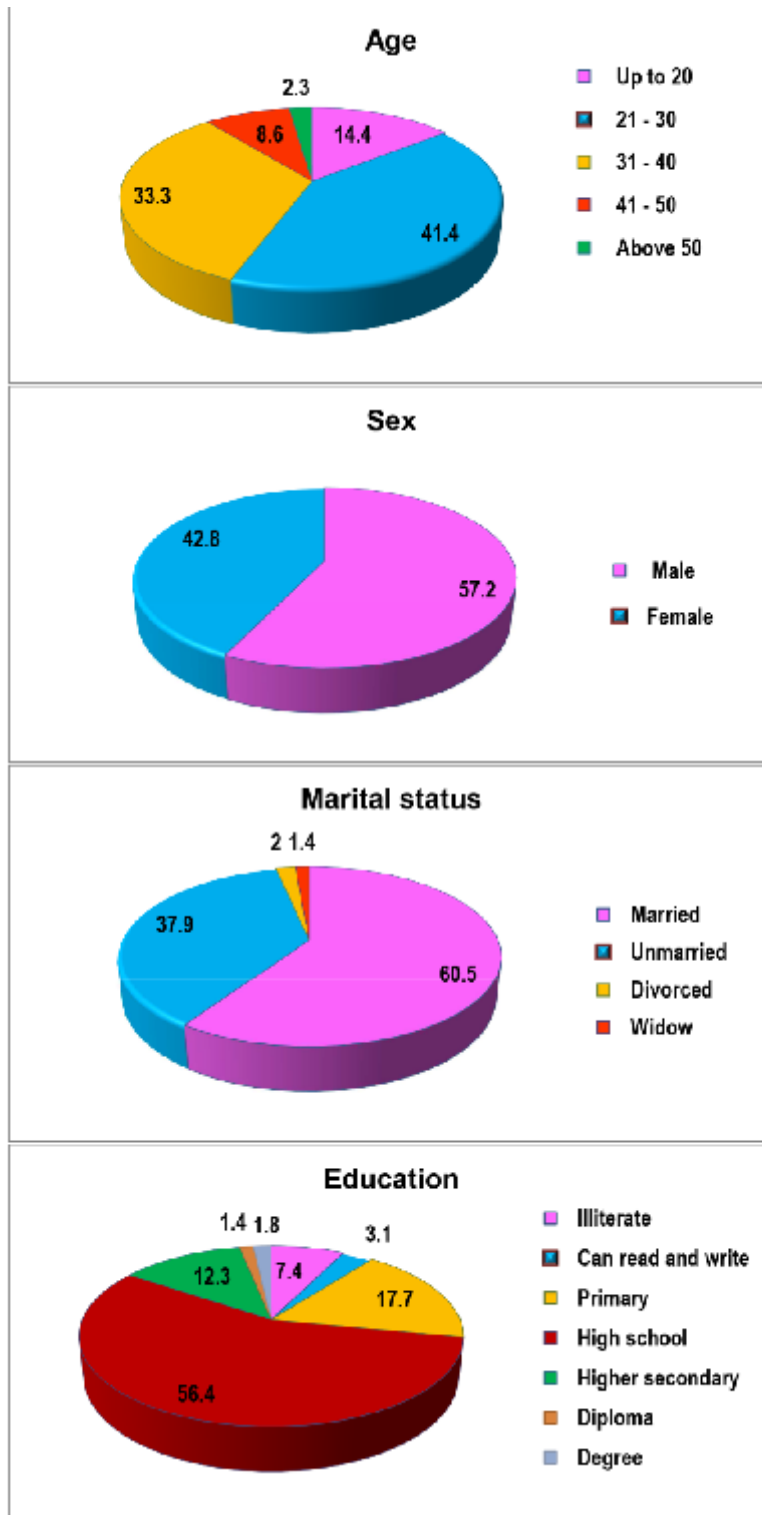


Figure 9: Personal profile of garment workers

Table 10: Family profile of garment workers

Particulars	Frequency (N=514)	Percentage
Type of family		
Nuclear	332	64.6
Joint	182	35.4
Size of family		
Small (1 - 3)	166	32.3
Medium (4 - 6)	300	58.4
Large (above 7)	48	9.3
Religion		
Hindu	467	90.9
Christian	18	3.5
Muslim	29	5.6
Community		
Backward caste	298	58.0
Most backward caste	152	29.6
Schedule caste	52	10.1
Schedule tribe	12	2.3
Head of the family		
Male	449	87.4
Female	65	12.6
Education of the head of the family		
Illiterate	99	19.3
Can read and write	34	6.61
Primary	111	21.6
High school	215	41.8
Higher secondary	42	8.17
Diploma	5	0.97
Degree	8	1.56
Occupation of the Head of the family		
Government employee	6	1.2
Private employee	369	73.7
Agricultural coolie	84	16.3
Others	45	8.8
Number of earners in the family		
One earner	93	18.1
Two earners	280	54.5
Three earners	108	21.0
Four earners	27	5.3
Five earners	5	1.0
Six earners	1	0.2
Total monthly family income (₹)		
Upto 2500	142	27.6
2500 - 5000	171	33.3
5001 - 7500	116	22.6
7501 - 10000	85	16.5

From the above Table it is clear that more than half of the workers (65 per cent) were from nuclear family and 35 per cent were from joint family. In the current familial scenario, the nuclear family system of living was gaining importance drastically irrespective of their economic status. Fifty eight per cent belonged to medium family with four to six members. Majority of the workers (91 per cent) were Hindu and 58 per cent of the workers were backward community. The head of the families were male and were educated upto high school level and employed in private sectors. Nearly half of the families (54 per cent) had double earners. The total monthly family income ranged from `1000 to `9000 with a mean of `4585±2.45.

3. Job history

Table 11 and Figure 10 present the job history of garment workers.

Table 11: Job history of garment workers

Particulars	Frequency (N=514)	Percentage
Age of entry (years)		
Up to 20	383	74.5
21 - 30	95	18.5
31 - 40	32	6.2
Above 40	4	0.8
Work experience (years)		
Up to 10	300	58.4
11 - 20	148	28.8
21 - 30	47	9.1
Above 30	19	3.7
Nature of activity		
Pattern making (manually)	7	1.4
Pattern making using CAD	4	0.8
Layout cutting	55	10.7
Stitching	245	47.7
Checking	143	27.8
Ironing	43	8.4
Packing	17	3.3
Work hours in regular days (hours)		
9 - 10	41	8.0
11 - 12	405	78.8
Above 12	68	13.2
Work hours in peak days (hours)		
11 - 12	37	7.2
Above 15	477	92.8

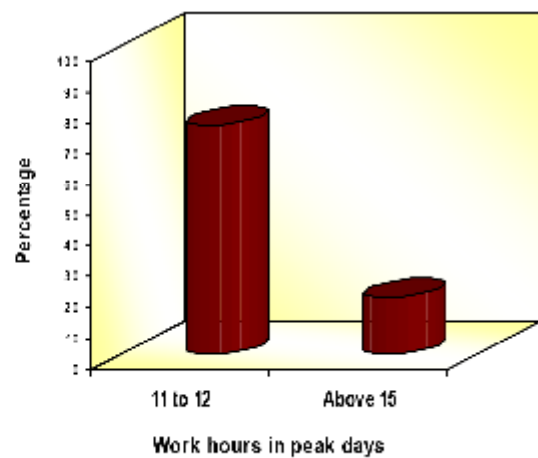
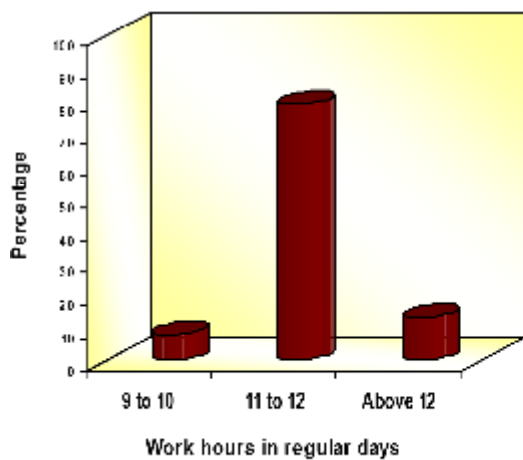
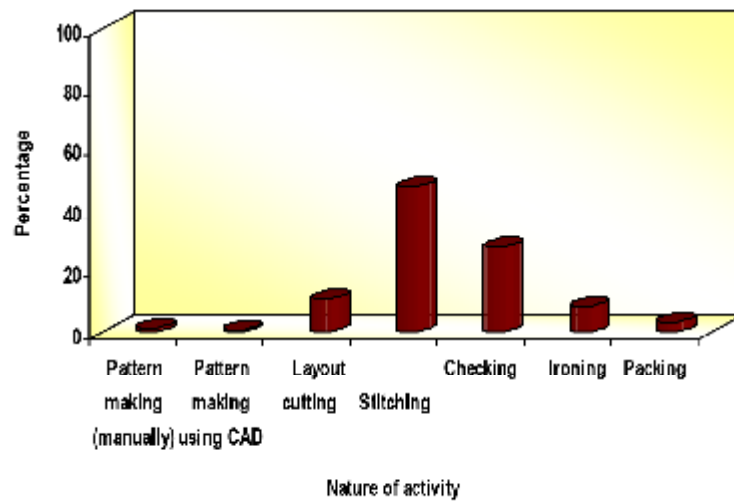
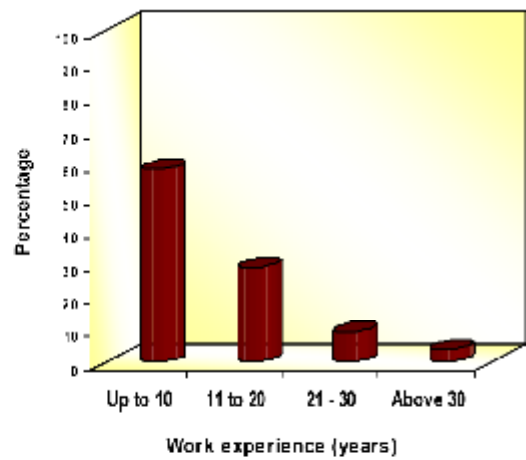
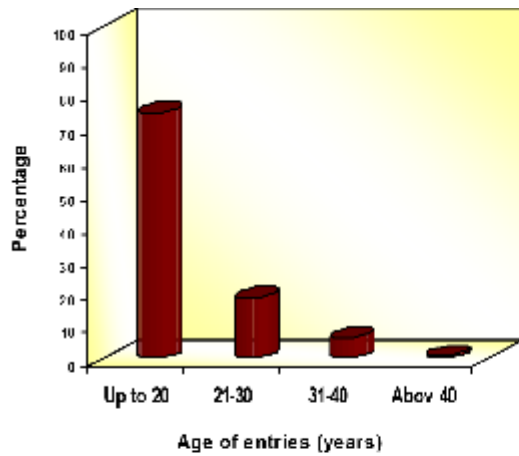


Figure 10: Job history of garment workers

The above Table reveals that minimum age of entry into garment industries was 10 years with a maximum of 45 years (19.77±5.82). The young workforce was mainly due to the prevalence of Sumangali Scheme and child workers. A study (Background Study Tirupur, 2004) reported that adolescent, unmarried young girls of 15 to 25 are preferred in the textile and garment industry for their efficiency in work output. Many girls are recruited under the Sumangali Scheme - earning dowry money for the girls' future marriages. Ranging in age from eight to 14 years old, migrant child workers were employed mainly as helpers, primarily in subcontracting production units. When parents were unable to find work, their children help support the family (Child Labour in India, 2005). Their mean work experience ranged from one to 40 years with a mean of 10 years (±8.7). Fifty eight per cent of the workers had up to 10 years of work experience followed by 29 per cent between 11 and 20 years.

More than 90 per cent of the workers had chosen garment manufacturing job due to the influence of their friends and relatives and also because of indoor work and nearness of work spot. Ninety one per cent of workers travelled upto 10 kilometers to reach their work spot by public transport (62 per cent), own (28 per cent) and company vehicle (10 per cent). Seventy per cent of the workers employed previously with a duration of 7 years (±6.2) before engaging in garment industries. The reason for shifting job was reported by the workers such as improving living standards (71 per cent), nearness of work spot (58 per cent) and attractive bonus (25 per cent). Sixty five per cent of the workers underwent training in private agencies before joining the present job for the period of 9 months (±11.6). The workers (35 per cent) who did not know the skill required in garment industries were given training at the work spot for a period of 6 months (±7.3).

The whole process in garment industry was categorized into three sections namely cutting, stitching and finishing (Plate 13). The cutting section included pattern making of fabric (both by manually or by using CAD) and its layout cutting while finishing section included checking of stitched fabric for damaged one, ironing and packing of garments. Working in stitching and finishing section was more or less equal. The former had 48 per cent and the



Ironing



Packing



Pattern making



Checking



Stitching



Cutting



Plate 13: Garment Making Process

latter 39 per cent. Only 13 per cent of workers were engaged in cutting section. On record, a shift companies eight hours of work, but in actual terms it was twelve hours, that is one-and-a-half shift. In other words, the regular working day was from 8.30 am till 5.30 pm, six days a week. On top of this there was usually overtime. Normal overtime is three hours per day. During peak season for work namely in September, October, November and December, the workers would work night shifts too until 1.30 am. Low season for work is February and March. In the present study, majority of the workers (97 per cent) agreed to work in shift system compulsorily (74 per cent) and by choice (26 per cent). This is because the latter mainly female workers and elderly workers. Fifty six per cent of the workers worked without rest or break for 3 hours at a stretch while 44 per cent worked for 4 hours per day. All the workers had tea break in the morning and evening for 15 minutes while lunch break 60 minutes (74 per cent) and 45 minutes (26 per cent). The former was practiced in export garment industries and the latter in medium and small scale industries. Several researchers (De Neve, 2009, Prithviraj, Roy, 2009 and SAVE, 2000) also reported increased working hours in garment industries.

4. Details on income and allowance

The details on income and other allowances of garment workers are presented in Table 12 and Figure 11.

Table 12: Income and other allowances of garment workers

Particulars	Frequency (N=514)	Percentage
Type of employment		
Permanent	211	41.1
Temporary	303	58.9
Mode of payment		
Piece rate	171	33.3
Fixed	3	0.6
Shift	340	66.1
Wage per week (₹)		
501 - 1000	271	52.7
1001 - 1500	156	30.4
1501 - 2000	77	15.0
2001 - 2500	8	1.6
Above 2500	2	0.4
Bonus during festivals		
Yes	294	57.2
No	220	42.8
Bonus amount (₹)		
Less than 2000	61	11.9
2001 - 4000	79	15.4
4001 - 6000	97	18.9
6001 - 8000	47	9.1
Above 8000	10	1.9
Any kind of incentives		
Yes	149	29.0
No	395	71.0
Nature of incentives		
Cash	20	71.0
Promotion	6	3.9
Cash and promotion	123	1.2
Enrolled in Provident Fund (PF)		
Yes	145	28.2
No	369	71.8
ESI Benefits		
Yes	147	28.6
No	367	71.4

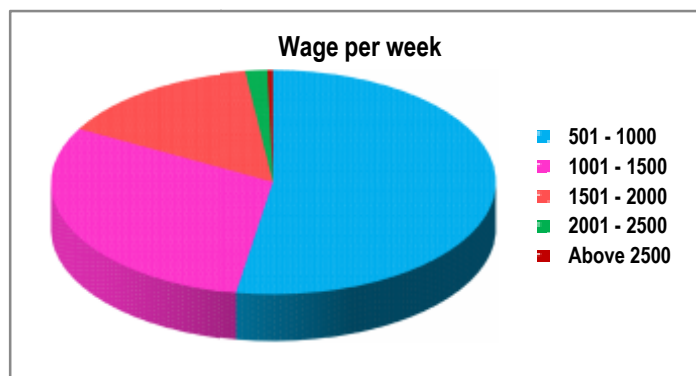


Figure 11: Wage per Week of Garment Workers

Due to contract system, most of the workers often shift from one garment industry to another. Hence their employment was naturally temporary. Exception was seen in some export garment industries where they were employed permanently. The mode of payment was either shift or piece-rate and paid weekly. The wage per week of the workers ranged from `550 to `3000 with a mean of `1263.25 (± 444.447). Any additional bonus or incentives, like attendance bonus, productivity bonus and incentive for reaching the target were not provided to the workers. Deepavali festival bonus was the only exception. Bonus was calculated on their basic pay, it varied from industry to industry. Eligibility for the bonus was that the workers must have worked for a minimum of four months. Minimum bonus was 8 per cent and the maximum was 30 per cent and most of the industries gave the bonus as 20 per cent on an average. However, many of the employers were evading payment of bonus by providing false information that the industry was running in loss. The workers (57 per cent) in the present study received bonus during festival which ranged from Rs.1000 to `10,000 with a mean of `4541 (± 2186.285). Only in export garment industries, workers were motivated to enroll themselves in Provident Fund (PF) and Employee's State Insurance (ESI), which offered health and insurance benefits. Twenty nine per cent of the workers received incentives in the form of cash and promotion and 28 per cent enrolled in PF.

5. Occupational safety and health

This part of the study deals with discomforts faced and ways to reduce, personal habits and safety in the industries.

a. Discomfort felt

Musculoskeletal disorders (MSDs) are a common health problem throughout the world and a major cause of disability (Meenaxi and Sudha, 2012). Nearly half of the workers developed the habit of consuming alcohol (53 per cent), smoking cigarette or bidi (49 per cent) and chewing tobacco (39 per cent) due to job stress or due to the influence of their peer groups. Table 13 shows discomforts as reported by the workers.

Table 13: Discomforts of garment workers

Particulars	Percentage of workers		
	No discomfort	Mild discomfort	Moderate discomfort
Neck	-	45.1	54.9
Shoulders	-	43.6	56.4
Upper back	-	5.3	94.7
Mid back	-	5.3	94.7
Low back	-	5.3	94.7
Buttocks	0.4	97.7	1.9
Thighs	0.4	97.7	1.9
Knees	-	4.7	95.3
Leg	-	0.2	99.8
Feet	-	0.2	99.8
Upper arm	-	50.6	49.4
Lower arm	-	51.0	49.0
Wrists	0.4	96.9	2.7
Palm	1.2	96.3	2.5
Fingers	1.2	96.3	2.5

It is clear from the Table that more than 90 per cent of the workers reported moderate discomfort in legs, feet, upper back, mid back and low back region. Since most of the workers in the present study were from stitching and finishing section and activities involved prolonged standing and sitting in awkward posture, they experienced pain in that region. On an average one half of the workers felt pain in shoulders, neck and arms. This is may be due to forward leaning and arm movements. Majority of the workers also reported mild discomfort in buttocks, thighs, wrists, palms and fingers. Veiersted and Westgaard (1993) stated that occupations with maintained postures and repetitive work tasks have been related to neck and shoulder complaints. Schibye et al. (1995) in their longitudinal study of 6 years among sewing machine operators found high prevalence of musculoskeletal symptoms of the neck and shoulders. The study is in agreement with Gupta et al., (2005) among textile workers of Shree Bapiro Deshmukh, Grinni, Dardha, India where 57 workers suffered from low back pain. Another study by Szymanska (1988) stated that textile industry which provides livelihood to a considerable section of population and also exposes to the occupational risk factors of back pain.

b. Periodicity of discomforts

Table 14 presents periodicity of discomforts as reported by garment workers.

Table 14: Periodicity of discomforts of garment workers

Parts of the body	Percentage of workers				
	Once in a week	Once in fortnight	Once in a month	Monthly but not everyday	Monthly but everyday
Neck	63.0	8.6	0.2	24.3	3.9
Shoulders	61.9	8.4	0.2	25.7	3.9
Upper back	26.3	1.0	0.2	63.6	8.9
Mid back	26.3	1.0	0.2	63.6	8.9
Low back	26.3	1.0	0.4	63.4	8.9
Buttocks	76.5	4.3	18.3	0.8	0.2
Thighs	76.7	4.1	18.1	1.0	0.2
Knees	22.2	1.2	0.8	60.1	15.8
Leg	19.6	0.4	0.2	64.0	15.8
Feet	19.6	0.4	0.2	64.0	15.8
Upper arm	64.0	12.5	0.6	19.3	3.7
Lower arm	64.6	12.3	0.6	18.9	3.7
Wrists	82.7	13.0	3.1	1.0	0.2
Palm	82.7	12.8	3.3	0.8	0.4
Fingers	82.7	12.8	3.3	0.8	0.4

The above Table presents the periodicity of the discomforts of workers using a modified form of Nordic Scale. Discomforts in the lower extremities such as knees, legs and feet were reported in 16 per cent for everyday during the previous month. This was mainly due to the finishing activities in garment industry which necessitates the workers to stand for a long period of time. Ergonomic interventions need to be made to reduce the severity level of these discomforts. The next predominant discomfort was reported in the upper back, mid back, low back and lower extremities by more than 60 per cent of the workers. These workers reported the discomforts during the previous month but were not regularly faced by the workers. More than 80 per cent of the workers revealed pain in wrists, palms and fingers once in a week. This could be attributed to the activities involving highly repetitive, monotonous and high speed precision tasks.

c. Pain relieving techniques

Table 15 shows the pain relieving techniques adopted by the garment workers to get rid of discomforts in their body parts.

Table 15: Pain relieving techniques adopted by garment workers

Parts of the body	Percentage of workers					
	Consul-tation with doctor	Applying pain relieving balm	Cessation of work	Absenteeis m	Complete rest	Others
Neck	0.8	0.2	-	-	99.0	-
Shoulders	0.4	0.4	-	0.2	99.0	-
Upper back	11.9	45.1	0.2	-	42.8	-
Mid back	11.9	45.1	-	0.2	42.8	-
Low back	11.9	44.9	-	-	43.2	-
Buttocks	-	-	-	-	100.0	-
Thighs	-	-	-	-	100.0	-
Knees	11.5	39.3	-	-	49.2	-
Leg	11.9	39.9	-	0.2	47.7	-
Feet	9.5	27.4	-	-	45.3	17.7
Upper arm	0.2	0.4	-	0.2	99.2	-
Lower arm	0.2	0.2	-	-	99.6	-
Wrists	-	-	-	-	100.0	-
Palm	-	-	-	-	100.0	-
Fingers	-	-	-	-	100.0	-

The above Table indicates that majority of the workers preferred to take complete rest after work hours till the next day morning. Two thirds of the workers used pain relieving balm to cope up with the discomfort in their back regions and lower extremities. Nearly 12 per cent of the workers reported consulting the doctors for relieving themselves from the pain. Absenteeism and temporary cessation of work were reported by less than one per cent of the workers, as this practice was not favoured by the employers. Eighteen per cent of the female workers employed in checking section dipped their feet in warm water to relieve pain.

Garment workers were asked to rate the discomfort level on a 5 point scale starting from no discomfort with a score of 1 to extreme discomfort with a score of 5. Majority (99 per cent) of the workers reported garment activities had resulted in moderate discomfort level.

d. Accidents in garment industries

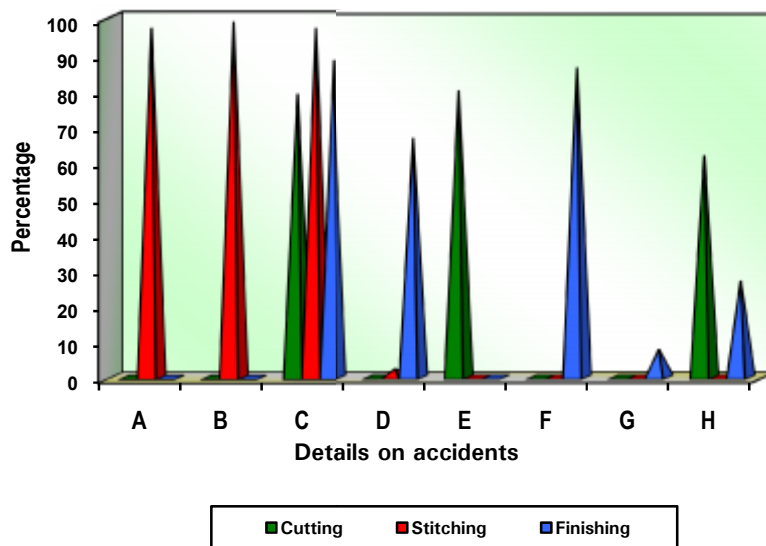
The most frequent sources of workers' injuries in the garment industry are: insecure way of work, violation of the safe work regulations, keeping working places untidy, bad work organisation, machines with some defects,

tiredness caused by monotonous work and insufficiency or lack of personal or collective means. The details of occurrence of accidents reported by workers are presented in Table 16 and Figure 12.

Table 16: Details on accidents in garment industries

Particulars	Percentage of workers*		
	Cutting (N=66)	Stitching (N=245)	Finishing (N=203)
Needle piercing	-	97.1	-
Hands getting caught in the wheel	-	98.8	-
Electrical shock	78.8	97.1	88.2
Trimmer piercing the palm	-	2.4	67.0
Cutting the finger tips	80.3	-	-
Burns and scalds	-	-	86.7
Hand and wrist injury by ticketing guns	-	-	7.9
Cornification	62.1	-	27.1

*Multiple response



- A. Needle piercing
- B. Hands getting caught in the wheel
- C. Electrical shock
- D. Trimmer piercing the palm
- E. Cutting the finger tips
- F. Burns and scalds
- G. Hand and wrist injury by ticketing guns
- H. Cornification

Figure 12: Details on Accidents in Garment Industries

All the accidents found in the garment industries were mild in terms of severity. However, the most commonly reported accidents in cutting sections of garment industries were cutting the finger tips (80 per cent), electric shock (79 per cent) and cornifications in the fingers (62 per cent). The fast pace of cutting the fabric using machine with carelessness were the reasons for cutting the finger tips. Due to incorrect earthing and also due to careless handling of the machine during operation might led to electric shock. Frequent use of scissors by workers led to cornifications in the fingers. In almost all the garment industries, the scissors used in cutting sections were tied with fabric to reduce the incidence of cornifications.

The accidents observed in stitching sections of garment industries were hands getting caught in the wheel (99 per cent), needle piercing and electric shock (97 per cent) and trimmer piercing the palm (2 per cent). Lack of workers' concentration, fast pace stitching while seated in awkward posture, need for precise fabric stitching and insufficient lighting might be the causative factors of these accidents.

The accidents encountered in finishing sections of garment industries were electric shock (88 per cent), burns and scalds (87 per cent), trimmer piercing the palm (67 per cent), cornifications in the fingers (27 per cent) and hand and wrist injury by ticketing guns (8 per cent). Burns and scalds occurred mainly in ironing section, trimmer piercing the palm in checking section and hand and wrist injury by ticketing guns in packing section.

A study carried out by Mehta, 2012 in Indian garment industries among 35 workers from Jaipur revealed that workers in cutting section were more prone to accidents than the ones in stitching and finishing sheds. Fifty five per cent of the stitching workers opined that they suffered from severe musculoskeletal pain whereas vibration induced syndrome was only faced by workers employed in cutting section.

- **Types of hazards in garment industries**

Most workplaces have a number of different hazards, which can be divided into the following broad categories namely mechanical, physical, chemical, biological, ergonomic and psychosocial. These hazards are common

to many occupations and workers are often exposed to more than one at a time. Workers do not create hazards in many cases; the hazards are built into the workplace. It is essential that work is made safer and healthier by modifying the workplace and all unsafe work processes. Table 17 and Figure 13 represent the types of hazards prevalent in selected Tirupur garment industries.

Table 17: Types of hazards in Garment Industries

Particulars	Frequency (N=514)	Percentage
Mechanical hazards	129	25.0
Physical hazards	178	34.6
Chemical hazards	60	11.6
Ergonomic hazards	347	67.4
Psychosocial hazards	168	32.6

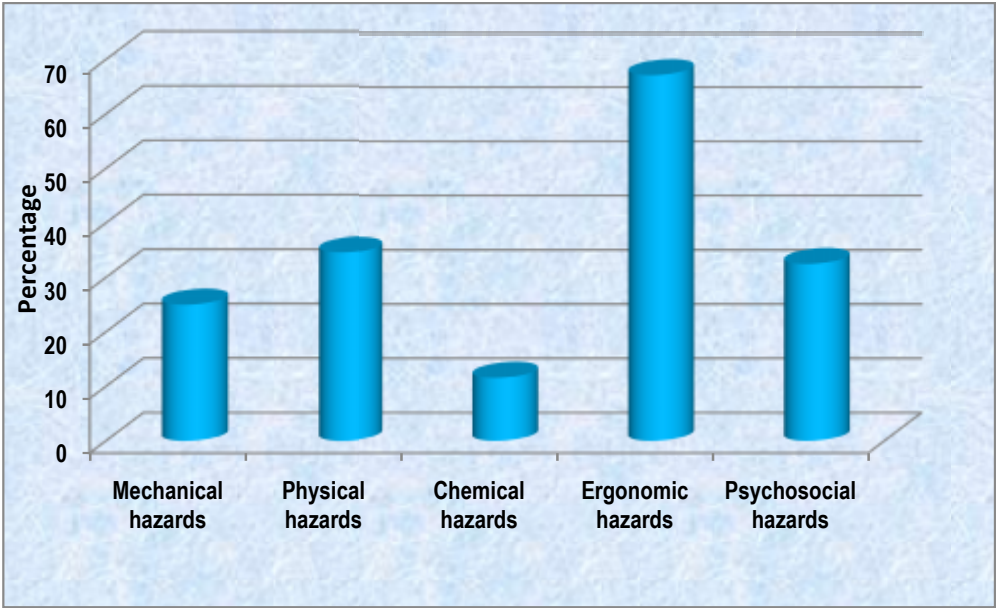


Figure 13: Types of Hazards in Garment Industries

The above Table indicates that one fourth of the workers responded to mechanical hazards in their workplaces. Compared to large and export garment industries in Tirupur, medium and small industries face more difficulties. It was very common to see guards missing from machines or sometimes because the machines were old and the guards have been escaped or were not present in the first place. Some industry managers indicated that they would replace the machines in the near future. Another most common finding was poor housekeeping i.e. untidiness, disorder and clutter, not only reduced productivity by blocking the smooth flow of materials through the industry, it trimmings and other combustible materials were left everywhere. It also could encourage vermin and their associated health hazards. The **mechanical hazards** included from cuts, bruises, wounds, sprains, fractures, loss of fingers and hands and sometimes death. Often workers complained about the lack of space and overcrowding in the industry. Garment industries which introduced regular cleaning programmes using industrial vacuum cleaners not only reduced maintenance costs as the machines remain cleaner for longer, there was less absenteeism through sickness and ultimately the factory had a competitive advantage through improved productivity.

Thirty five per cent of the garment workers reported **physical hazards** such as noise, vibration, electricity, temperature and lighting in their working places. High noise levels were found in some parts of garment industries. Burns, electric shock or sometimes death may be possible due to frayed wiring, broken plug sockets and wires dangling close to workers in many parts of a garment industry. Due to danger of electrocution there is possibility of fire. Many garment workers complained of hot, humid conditions in key sections of the garment industry such as ironing area. As a result, some owners provided ad-hoc solutions by placing fans in certain locations to try to increase the ventilation. A common problem found in many garment industries was either too much or too little light. For the industry as a whole, there must be good general lighting especially near steps, ramps and exits. So that workers can see where they are going and avoid trips and falls. In the cases of fluorescent lighting, they were often flickering which could be extremely stressful to workers. Months of dust cover the lamps and the windows and there appears to be no regular cleaning or

maintenance programme in place. Causes of fire accidents in garment industries might be due to unplanned work environment, disorganized workers, electric short circuit, faulty electrical wiring, smoking materials, boiler explosion, kitchen stove and carelessness, fire from existing structure and poor building design.

Twelve per cent of workers complained of **chemical hazards**. Almost all the occupations in industry have scope of exposure to some chemical substance or the other. The main chemical problem in garment industry come from the high dust levels in certain sections of the industry (e.g. the cutting section) and from the choice of chemicals used in the spot cleaning process. All garment industries had dust problems. Dust fibres mainly produced from cutting and sewing sections of garment industries could be seen on workbenches, lamps and even workers hair. The smallest of these fibres were breathed in by the workers and, over the long term, cause a variety of respiratory problems. The problems were made worse as many industries used brooms and dusters to clean the workplace rather than industrial vacuum cleaners which simply spread the dust and dust control was often made worse as workers did not wear their dust masks. Other chemical problems related to the use of various spot cleaning agents in the garment industry. Whilst some industries were switching to the safer option of using soap or water mixtures for the cleaning process, others used various solvents which had serious health and safety problems if not used correctly. Workers and owners often had little awareness of the dangers of such chemicals as they were not provided with the requisite Material Safety Data Sheet (MSDS) by the manufacturers.

Sixty seven per cent of the workers reported to have **ergonomical problems**. Such problems are common throughout the garment industry. Obsolete machinery, inadequate seating and standing arrangements for workers and the improper lifting or movement of heavy loads all led to stress and strain on the body. Due to awkward postures adopted by workers while working ended up in Work related Musculoskeletal Disorders (MSDs), lower back problems and fatigue. Common MSDs are Tendonitis, Epicondylitis (Tennis or Golfer's Elbow), bursitis, trigger finger, carpal tunnel syndrome and back strain. Work - related MSDs are also known as Repetitive Strain or Stress Injury (RSI), Repetitive

Motion Injury (RMI), Cumulative Trauma Disorder (CTD), Overuse Syndrome or activity related pain syndrome.

Thirty three per cent of the workers of garment industries felt **psychosocial hazards**. Factors responsible for psychosocial illness were frustration due to type of work, risks involved in work, monotony, long working hours, lack of recognition, lack of job satisfaction, poor man/woman management, lack of welfare activities and tensions at home and place of work. Work-related stress is not an illness but it could lead to physical effects such as heart disease and gastrointestinal disturbances leading to ulcers and psychological effects such as anxiety and depression. The indicators for psychosocial group are chronic absenteeism, mass leave, lock outs, strikes and unexplained reduction in production.

The study conducted by Akhter et al., (2010) was on par with the results of the present study. It was found that very few garment industries had legal requirement of proper cleanliness, disposal of wastes and effluents, ventilation and temperature, dust and fumes, artificial humidification, lighting, drinking water, latrines and urinals, spittoons and but prevalence of overcrowding, sexual harassment, discrimination in wage fixation, not enough maternity leave and no baby care center.

According to Tania and Sultana, (2014), in Bangladesh, industrial incidents happen in garments sector and maximum are fire and structure related. The garments sector contains many hazards and risks to workers, ranging from exposure to noise and dangerous substances, to manual handling and working with dangerous machinery. Each processing stage from the production of materials to the manufacturing, finishing, colouring and packaging pose risks for workers, and some of these are particularly dangerous for women's health. Since 1990, over 350 workers have died and some 1500 injuries in the fire related incidents in garments industries in Bangladesh. Till 2000, there were more than hundred fires in industries in Bangladesh.

Saramon, (2014) reported workers of Pragati Textile Industry located at industrial corridor of eastern Nepal. High intensity of noise was noticed in the textile industry. Eye problem was the most common problem followed by ear

problem, respiratory problem and skin problems. Hypertension and under-nutrition was also present. Hearing problems of the workers could be due the presence of high noise in the industry. Use of personal protective equipment in the textile industry was not satisfactory.

Chandra and Parvez, (2011) studied occupational hazards of Ghaziabad garment manufacturing units workers. The average level of illumination in the stitching sections of both male and female units was of 411.1 and 331.1Lx which was lower than recommended levels. The level of noise in male industry was more than female industry. Some unions have set a noise level of 80 dB as safe standard to work. The level of noise in male manufacturing units was more than 93.8 dB and in women manufacturing units 87.01 dB which was more than the standard level of noise. The majority of 49.0 per cent men and 36.3 per cent women got injured with machine needles. Whereas 21.8 per cent male and 29.0 per cent female got injured by scissors during cutting operations and some minor accidents 5.4 per cent each in both male and female workers. The study revealed lack of ventilation, inappropriate lighting, excessive noise and lack of personal protective equipment were the main causes of occupational hazards.

- **Knowledge, attitude and practice**

Medical surveillance is a valuable tool for assuring and maintaining a healthy workplace environment. It is the periodic testing of employees exposed to potentially hazardous materials or other risks in the workplace. It helps to detect early signs of work-related illness so that appropriate action can be taken to eliminate the underlying exposures. Knowledge, attitude and practice (KAP) regarding occupational health problems among garment workers are important to be healthy in their workplaces. Table 18 shows the knowledge of garment workers on occupational health problems.

Table 18: Knowledge of garment workers

Particulars	Frequency (N=514)	Percentage
Working in garment industry leads to health problem(s) such as:		
a. Respiratory problem		
i. Breathing problem	514	100.0
ii. Asthma	452	87.9
iii. Tuberculosis	47	9.1
b. Neural		
i. Headache	514	100.0
c. Dermatological problems		
i. Contact dermatitis	348	67.7
ii. Eczema	349	67.9
d. Cornification	403	78.4
e. Hearing disability	493	95.9
f. Eye problems	488	94.9
g. Gynaecological problems		
i. Irregular menstruation	281	54.7
ii. Miscarriage	260	50.6
iii. Uterus cancer	16	3.1
h. Urinary infections		
i. Burning sensation with micturition	215	41.8
ii. Bladder cancer	22	4.3
i. Musculoskeletal discomforts	514	100.0
Awareness of Personal Protective Equipments (PPE) such as:		
a. Eye protective equipment	35	6.8
b. Mask	514	100.0
c. Gloves	514	100.0
d. Gum boots	19	3.7
e. Ear muffs/Ear plugs	400	77.8
f. Thimbles	382	74.3
g. Dust protectors	153	29.8
h. Awareness of Occupational Health and Safety Policy	50	9.7

Mean: 23.5856 Standard deviation : 2.626426

The above Table shows the knowledge of the workers about the causative factors of occupational health problem(s) due to working in garment industry. Majority of the workers agreed that working in garment industry could lead to health problem(s) such as respiratory problems, neural problem, musculoskeletal discomforts, hearing disability and eye problems. More than half of the workers opined that possibilities of dermatological problems and gynaecological problems exceptional case for uterus cancer (3 per cent) also might occur. Knowledge on urinary infections were found to be 42 per cent for

burning sensation with micturition and only 4 per cent for bladder cancer. As regards the awareness of personal protective equipments, all the workers were aware of mask and gloves and two third of them knew ear muffs/plugs and thimbles. It was heartening to know that only 10 per cent of the workers were aware of occupational health and safety policy.

Table 19 shows the attitude of garment workers on occupational health problems.

Table 19: Attitude of garment workers

Particulars	Frequency (N=514)	Percentage
Use of personal protective equipment by workers while working reduce occupational related health problems	514	100.0
Use of ergonomically designed tool, equipment, furniture and workstation reduce workers' Musculoskeletal Discomforts (MSDs)	240	46.7
Good work environment in terms of lighting, noise temperature, humidity, ventilation and space improve workers' safety, comfort and also reduce worker fatigue	514	100.0
Periodic medical check-up of workers improve their health status	514	100.0
Administrative controls such as worker rotation, more task variety and increased rest breaks during work hours reduce work-related stress	514	100.0
Good relationship with management fellow workers and supervisors reduce bullying and sexual harassment in the workspot	514	100.0
Work practices such as proper lighting techniques, proper body postures and keeping both workers' body and their work areas clean improve quality of work	514	100.0
Maintenance of Material Safety Data Sheet (MSDS) is necessary at workplace	79	15.4
Electrical hazards such as shocks and fire explosion can be avoided by maintaining and installing properly designed electrical wiring	514	100.0

Mean: 7.620623; Standard deviation: 0.625983

The Table clearly indicates that all the workers strongly felt that use of PPE, good work environment, periodic medical check-up of workers, good relationship with management fellow workers and supervisors and good work practices should be followed in the garment industries in order to have a safe

work environment. Forty seven per cent of the workers opined that use of ergonomically designed tool, equipment, furniture and workstation would reduce workers' MSDs because many of them did not know the benefits of ergonomical principles to be followed in the workspot. Only 15 per cent of the workers felt the need of MSDS at workplace to enable the user to know the chemical composition, its safe method of handling and disposing, thereby to prevent health effects.

The practice of safety measures by garment workers is presented in Table 20.

Table 20: Practice of safety measures

Particulars	Frequency (N=514)	Percentage
Do you use Personal Protective Equipment such as:		
Mask	96	18.7
Hand gloves		
a. Flexible metallic gloves	26	5.1
Ear muffs/Ear plugs	17	3.3
Thimbles	8	1.6
Are you using comfortable and safe tools and equipments?	21	4.1
Are you adopting several healthy seating and standing postures while working?	55	10.7
Are you taking frequent short breaks to reduce the soreness and stiffness related to fixed and static work postures?	105	20.4
Are you working for excessively long working hours?	437	85
Are you following job rotation or rotate tasks in order to avoid boring and repeating work?	11	2.1
Are you maintaining factory clean and tidy?	514	100
Do you remove dirt and rubbish on a regular basis?	514	100
Are you keeping all aisles, stairs and passageways, etc. clear of stock items as well as rubbish?	514	100
Are you stacking all materials, supplies, stock, etc. safely?	514	100
Are you using facilities provided in the factory such as:		
a. Wholesome drinking water	514	100
b. Washing	514	100
c. Toilet for men and women separately	477	92.8
d. Spittoons	51	9.9
e. Lunch room	371	72.2
f. Canteen	91	17.7
g. Fire extinguisher	484	94.2
h. Alarm	416	80.9
Are you given periodic training for safe operation of new tools and equipments?	401	78.0

Mean: 11.86576 Standard deviation : 2.074508

It is evident from the Table that all the workers had the practice of keeping their surrounding work environment clean and stacking all kinds of garment products safely. In order to meet the ends, workers (85 per cent) had to work for excessively long working hours. When enquired about the use of PPE by workers, 20 per cent had a positive attitude. This might be one of the reasons for high levels of minor/major accidents and injuries prevailing in the industry among the workers. Moreover unaware of ergonomics led only 11 per cent to adopt several healthy seating and standing postures while working. The unavailability of proper furniture, tools and equipment created postural stress.

The mean and standard deviation of the total score of knowledge, attitude and practice were obtained to find the level of knowledge, attitude and practice among garment workers. Table 21 and Figure 14 represent the level of knowledge, attitude and practice (KAP) of garment workers.

Table 21: Level of KAP of garment workers

Particulars	Frequency (N=514)	Percentage
Knowledge		
Low level knowledge	71	13.8
Medium level knowledge	371	72.2
High level knowledge	72	14.0
Attitude		
Medium level attitude	476	92.6
High level attitude	38	7.4
Practice		
Low level practice	59	11.5
Medium level practice	359	69.8
High level practice	96	18.7

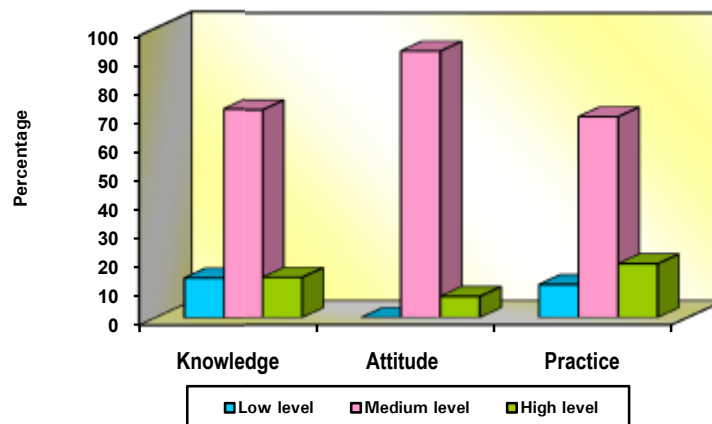


Figure 14: Level of KAP of garment workers

The above Table implies that workers had medium level for all the particulars namely knowledge (72 per cent), attitude (93 per cent) and practice (70 per cent). This necessitated the workers to undergo education or training programme to acquire knowledge, positive approach and ultimately implementing good practice in the workplace.

Pearson Correlation Co-efficient was computed to know the association among knowledge, attitude and practice of the garment workers. Table 22 shows the correlation co-efficient of KAP of garment workers.

Table 22: Correlation co-efficient of KAP of garment workers

	Knowledge	Attitude	Practice
Knowledge	1		
Attitude	0.25**	1	
Practice	0.35**	0.32**	1

** Correlation is significant at the 0.01 level (2-tailed).

When variables are significantly correlated, then there exist good relationships. The variables namely knowledge, attitude and practice of workers employed in garment industries were found to be significant at one per cent indicating a good relationship among them. **Hence hypothesis 1 is rejected** since there is relationship between knowledge, regarding the hazards and the attitude of the workers and the practices followed by them.

A similar study by Parimalam et al. (2007) related to KAP among 216 garment workers revealed that workers performed stereo-type operations in three sections namely cutting, stitching and finishing. More than one half of the workers in all the sections were aware of the benefits of personal protective equipments but only a few workers in the cutting section were using PPE. There was a wide gap between their knowledge level and practice with protective devices.

Again a study by Parimalam et al. (2010) among 142 fabric dyers and printers indicated that workers had knowledge regarding the occupational hazards, and their attitudinal approach toward the betterment of the work environment was positive.

- **Health problems of garment workers**

Garment industry involves activities which are repetitive and monotonous, involving long hours sitting or standing in one position. Health problems among garment workers range from discomfort and minor aches and pains, to more serious medical conditions requiring time off work and even medical treatment. In more chronic cases, treatment and recovery are often unsatisfactory – the result could be permanent disability and loss of employment (Lighten The Load, 2008). The health problems of the workers were categorised into neural problems, respiratory problems, Problems with sense organs, gynaecological problems and other health problems. The workers reported the periodicity of the occurrence of their health problems and are presented in Table 23.

Table 23: Health problems of garment workers

Health problems	Percentage of workers			
	Zero day	One to seven days	Eight days to fifteen days	More than 30 days but not everyday
Neural				
Headache	3.3	51.0	0.2	45.5
Respiratory				
Breathing difficulty	58.4	16.9	0.2	24.5
Asthma	85.6	0.2	0.2	14.0
Tuberculosis	97.7	1.9	-	0.4
Problems with sense organs				
Cornification	89.9		0.4	9.7
Hearing disability	60.9	31.5	-	7.6
Eye problem	58.4	35.8	-	5.8
Gynaecological				
Irregular menstruation	80.5	0.2	-	19.3
Others				
Generalised weakness	0.4	2.3	-	97.3
Swelling of feet	57.8	39.5	-	2.7
Acidity and heart burn	71.0	28.6	-	0.4
Insomnia	53.5	46.1	0.2	0.2
Poor oral health	37.4	24.3	-	38.3
Palpitation	83.5	16.3	-	0.2
Chest pain	81.7	18.3	-	-
Stomach spasms	99.4	0.6	-	-
Constipation	66.7	33.3	-	-
Piles	93.8	0.2	-	6.0
Ulcer	76.1	-	0.2	23.7

From the Table, it is evident that the workers reported generalized weakness by 97 per cent while headache by 45 per cent more than 30 days but not every day. The repetitive task performed by the workers without adequate rest breaks might be the causative factor for such health problems. Exposure of the workers to excessive cotton dust might lead to breathing difficulty (24 per cent) and asthma (14 per cent) for the same periodicity. Irregular menstruation was reported by 19 per cent of the female workers which was another health problem observed among female workers in garment industries. The results are on par with the study conducted by Deshingkar (2009).

The other health problems reported by garment workers are given in Table 24 and Figure 15.

Table 24: Other health problems of garment workers

Particulars	Frequency (N=514)	Percentage
Anaemia	97	18.9
Blood pressure	74	14.4
Diabetes	27	5.3
Hernia	5	1.0
Thyroid	30	5.8

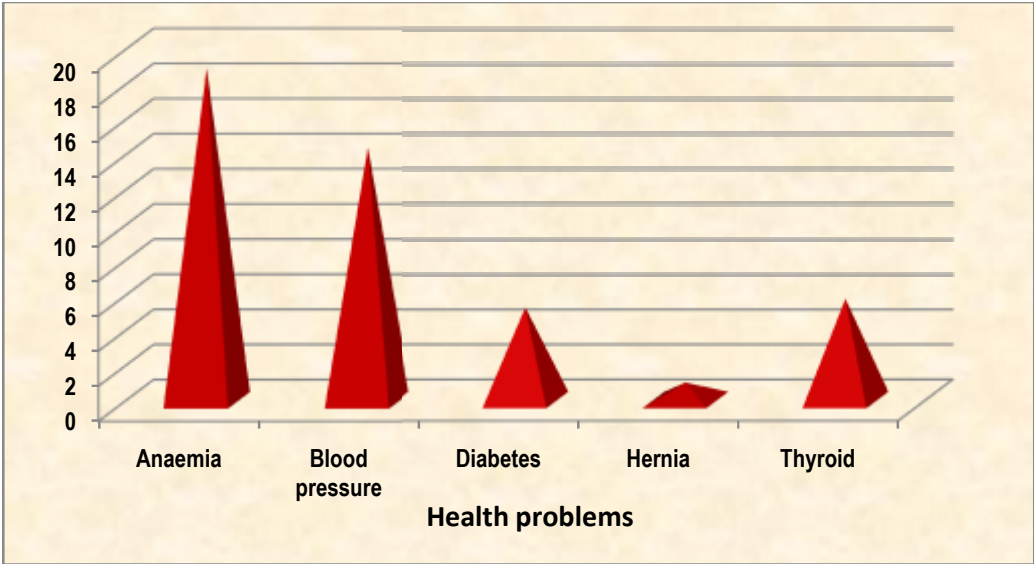


Figure 15: Other health problems of garment workers

The above Table indicates the other health problems as anaemia (19 per cent), blood pressure (14 per cent), thyroid (5.8 per cent), diabetes (5.3 per cent) and hernia (1 per cent).

- **Problems in garment industries**

The problems faced by workers in the garment industry are shown in Table 25.

Table 25: Problems faced in garment industry

Particulars	Frequency (N=514)	Percentage
Work		
Lack of personal protective equipment	428	83.3
Lack of furniture	234	45.5
Improper furniture	101	19.6
Others	71	13.8
Worker		
Inconvenience	227	44.2
Work overload	514	100.0
Frequent twisting	512	99.6
Lack of relaxation	189	36.8
Intolerant boss	2	0.4

The problems prevailing in the garment industries were observed in work, worker and work environment. Among problems regarding work, the workers reported lack of personal protective equipment (83 per cent), lack of furniture (45 per cent) mainly in cutting and finishing sections and improper furniture (20 per cent) in stitching section. Fourteen per cent of the workers reported other problems faced by the cluster were shortage of manpower, rising yarn prices, power cuts and rising transportation cost. All the workers strongly agreed to have work overload and frequent twisting. Less than half of the workers reported inconvenience and lack of relaxation in the workplace. Workers reported work environment as unhealthy in general. Lighting in all the sections of garment industry were of fluorescent tubelights and there were no specific task lighting for doing fine work. All the sections had higher range of noise mainly seen in ironing section. Temperature and humidity were hot and high leading the worker perspire profusely during working hours. Ventilation in the form of windows were observed in medium and large export garment industries but small scale had a closed one. There was no exhaust fan seen especially in ironing section where lot of steam was released. Colour in garment industries was mainly white which

was quite soothing and pleasant to the workers. All the garment industries had dust problem mainly cotton dust seen highly in cutting section and fairly in stitching section.

- **Rating of work**

The workers rated the activities involved in the garment industry which is presented in Table 26.

Table 26: Rating of work by workers

Rating of work	Frequency (N=514)	Percentage
Light	3	0.6
Moderate	392	76.3
Heavy	119	23.2

The above Table gives clear picture of garment manufacturing activities as reported by the workers. Seventy six per cent of the workers rated the garment manufacturing activities as moderate while 23 per cent as heavy. Less than one per cent rated as light work. In spite of being heavy work, workers continued in this profession in order to earn livelihood.

- **Types of fatigue**

The workers experience fatigue due to muscle exertion, repetitive and monotonous activities involved in garment industries. Table 27 shows the type of fatigue experienced by the workers during work hours.

Table 27: Type of fatigue

Rating of work	Frequency (N=514)	Percentage
Physiological fatigue	514	100.0
Psychological		
Boredom	237	46.1
Frustration	506	98.4

It is evident from the above Table that all the workers experienced physiological fatigue due to either prolonged standing or sitting in awkward posture throughout the working time. Ninety eight per cent of the workers felt frustration which might be due to inability to complete the task in the said target time while 46 per cent felt boredom fatigue due to monotonous activities. The workers were taxed both physically and psychologically.

B. Impact of Awareness Programme on Occupational Safety and Health

Awareness on ergonomics has a substantial impact on the industry, organization, management, employees and overall well-being of the system (Gungor, 2009 and Sundstorm, 2000). According to Musonda and Smallwood (2008), awareness is not only based on knowledge but also on the display of behaviour. Ergonomics awareness helps in application of ergonomical principles and contributes significantly to human well-being and safety due to a comfortable work environment and ergonomically designed tools, man-machine interface design and suitable work method to human anatomy (Kroemer and Grandjean, 1997). Thus, the awareness on ergonomic principles is important to occupational safety and health.

In the present study, awareness on the need to implement, maintain and improve a system of occupational health and safety (OHS) management has been initiated among workers employed in garment industries.

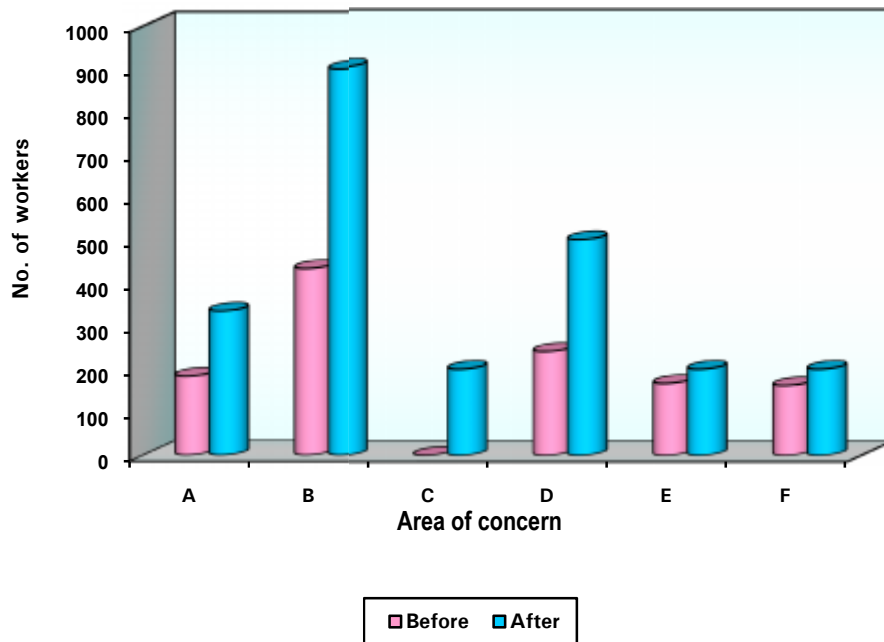
Altogether two hundred garment workers and public participated in the public meetings. Since the awareness programme was a general awareness so no evaluation in the improvements of knowledge gained by the participants were assessed.

The improvement in knowledge on occupational safety and health and ergonomic principles in the specific awareness programmes conducted for selected workers in garment industries was assessed using a checklist consisting of 29 statements / questions and the results are grouped under major areas and given in Table 28 and Figure 16.

Table 28: Improvements in knowledge

Area of concern	No. of workers* (N = 300)	
	Before	After
Labour laws related to textile workers	184	336
Occupational health hazards and its prevention	435	900
Meaning and importance of ergonomics in textile industry	–	200
Importance of nutritious diet	241	500
Causes and remedial measures of mental stress	167	200
Need for personal protective equipment	122	200

* Multiple responses



- A. Labour laws related to textile workers**
B. Occupational health hazards and its prevention
C. Meaning and importance of ergonomics in
D. Importance of nutritious diet
E. Causes and remedial measures of mental stress
F. Need for personal protective equipment

Figure 16: Improvements in knowledge

The above Table reveals that on an average 80 per cent of the participants gained knowledge from awareness programme when compared to 40 per cent before awareness programme. Hence, there was a significant improvement in the knowledge of the workers after the awareness programme.

The similar studies by Hu et al. (1998), Milczarek and Szczecinska (2006) and Pun et al. (2004) highlighted the promotion of employers' awareness on OHS in small sized industries to enhance better compliance, changes in work organisation and decrease in occupational risk. Furthermore, ergonomic training programme also presents positive results in creating awareness, increasing ergonomic knowledge to prevent work related musculoskeletal disorders and motivates employees to utilize their creative problem solving capacity (Munck-Ulf salt et al., 2003 and Shahnava z, 2000). The workers were thus benefitted in gaining knowledge. However, it is very important that the knowledge and experience acquired by the workers who took part in the awareness programme should be disseminated among other employees of the industry. Also learning

followed by practice is the best way to confirm and reinforce the occupational health and safety practices and ergonomic knowledge.

C. Assessment of workplace hazards and medical screening of the workers

The global strategy on “Occupational Health for All” will yield an immense impact on the health and safety of workers in the long run. The leading principle of this strategy is that “Every citizen in the world has the right to a “Healthy and safe work environment and to one that enable socially and environmentally productive lives” (WHO, 1995). It means that for healthy life of every citizen, safe, comfortable and clean work environment is a necessity. Practice of occupational hygiene and industrial safety can bring safe and comfortable work environment in industry.

1. Workplace hazards

The workplace hazards were assessed in the following ways:

a. Work environment

The details of work environment in garment industries are presented in Table 29.

Table 29: Details of work environment of garment industries

Parameters	Range	Mean	Recommended
Lighting (lux)	176 - 918	410	500-1000
Noise (dBA)	74 - 102	91.7	
Temperature (^o C)	28 - 37	34.8	
Humidity (%)	25 - 59	44.5	

The lighting levels ranged from 176 - 918 lx with a mean of 410 lx. According to Gandotra et al., (2005), the lighting between 500 lx and 1000 lx gives satisfaction to workers. The noise level ranged from 74 dBA to 102 dBA with a mean of 91.7 dBA. Regulations limiting noise exposures of industrial workers have been instituted in many countries. In Estonia, the current threshold level value for eight hour noise exposure is 85 dBA (Resolution of the Estonian Government, 2007). Hence in the present study, the noise level in the garment industries was found to be above the recommended levels. The temperature in

the industries ranged from 28⁰C to 37⁰C with a mean of 34.8⁰C. This high temperature may be due to the climatic conditions.

Workplace heat exposure, in addition to causing heat-related illness (such as heat stress, heat syncope, heat exhaustion and heat stroke) has been found to decrease productivity and to increase job - related accidents (Saari et al., 2006). According to Reinhold and Tint (2009), the minimum permitted temperature in workrooms is 12⁰C (in cold season the mean temperature of ambient air is below 10⁰C), hard physical work (energy consumption exceeds 1050 kJ/h). The maximum permitted temperature is 28⁰C (in warm season the mean temperature of ambient air exceeds 10⁰C), light physical work (mainly performed in a sitting position, energy consumption is below 500 kJ/h). Humidity in the industries ranged from 25 per cent to 59 per cent with a mean of 44.5 per cent. By the norms, the optimum humidity of the air is 40 per cent to 60 per cent, while permitted humidity is up to 70 per cent. The humidity of the air may influence the health and comfort of the worker as too dry air can cause local irritation of mucosa, eyes and skin. The overall symptoms are dizziness and headache. In the case of too humid air, the sensitiveness to the odours (gases, vapour) from the finishing materials will increase.

b. Work posture

The working posture and task should be designed to avoid strain and damage to any part of the body such as the tendons, muscles, ligaments and especially the back (Dahalan, 2005). Knowledge of the context and type of postures is necessary in order to examine their associations with health related outcomes (Taylor et al., 2005). During work, employees subconsciously tend to accept and adapt to unsatisfactory working conditions. They may not realize that their body is under strain until they feel actual pain and even then they may not understand the causes.

If work tasks and equipment do not include ergonomic principles in their design, workers may have exposure to undue physical stress, strain and overexertion, including vibration, awkward postures, forceful exertions, repetitive motion and heavy lifting. Recognizing ergonomic risk factors in the workplace is an essential first step in correcting hazards and improving worker protection. Ergonomists, industrial engineers, occupational safety and health professionals

and other trained individuals believe that reducing physical stress in the workplace could eliminate up to half of the serious injuries each year. Employers can learn to anticipate what might go wrong and alter tools and the work environment to make tasks safer for their workers (US Department of Labor, 2000).

i. Assessment using RULA

The results of the posture analysis among garment workers using RULA are shown in Table 30.

Table 30: Overall distribution of RULA score

Risk Level	Action Level	Ergonomic Intervention	Number (180)	Percentage
Negligible	1	Acceptable	-	-
Low	2	Investigate further	-	-
Medium	3	Investigate further and change soon	115	63.9
High	4	Investigate and change immediately	65	36.1

These results reveal that all categories of the risk levels exist in jobs postures. None of the worker was at negligible and low risk level. In 63.9 per cent of the workers studied, RULA Grand Score was between 5 and 6 indicating that the level of exposure to musculoskeletal risks was high and ergonomics intervention to decrease exposure level seemed essential (action level 3). In 36.1 per cent of the workers studied, RULA Grand Score was 7 indicating that the level of exposure to musculoskeletal risks was very high and immediate ergonomics intervention to decrease exposure level seemed essential (action level 4).

The study was done on workers working in different sections of the garment industry and their activities were divided in different categories like pattern making, cutting, stitching, checking, ironing and packing of garments. Thirty workers' RULA score from each activity of the garment production in detail is presented in Table 31.

Table 31: Process wise distribution of RULA score among garment workers

Activity	Score	Number (180)	Percentage
Pattern making (N=30)	5	13	43.3
	6	15	50.0
	7	2	6.7
Cutting (N=30)	5	14	46.7
	6	12	40.0
	7	4	13.3
Stitching (N=30)	5	5	16.7
	6	7	23.3
	7	18	60.0
Checking (N=30)	5	6	20.0
	6	8	26.7
	7	16	53.3
Ironing (N=30)	5	7	23.3
	6	10	33.3
	7	13	43.4
Packing (N=30)	5	9	30.0
	6	9	30.0
	7	12	40.0

ii. Assessment using postural discomfort

Ergonomic problems in the production process in the garment industry are often influenced by the working postures and repetitive movements of the operator when using a machine in long period of time. Workers, who perform repetitive action along with unnatural body position, are highly vulnerable to experience the musculoskeletal injury that related to their works. Work Related Musculoskeletal Disorder (WMSD) is an injury that attack parts of the body such as muscle, nerve, tendon, ligament, joints, and the human spine (Purnomo, 2006). Beside the unnatural postures and repetitive movements, WMSD can also be triggered by excessive energy expenditure and duration of working time. In addition, environmental factors and design workstations that are not appropriate can also contribute to the emergence of the injury musculoskeletal in the workers.

Table 32, 33, 34, 35, 36, 37 and Figure 17, 18 and 19 present the body discomfort among workers employed in pattern making, cutting, stitching, checking, ironing and packing of garments. The procedure of assessment of

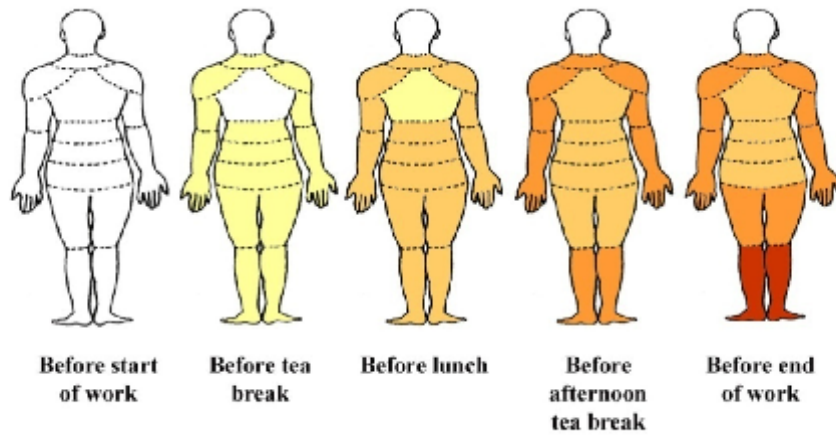
postural discomfort was carried out using a body map at regular intervals, namely, before the starting of work (BSF), before mid morning (MM), before lunch (L), before afternoon tea (MA) and before the end of work (BEW) throughout the day.

Table 32: Mean scores of body part discomforts of workers employed in pattern making

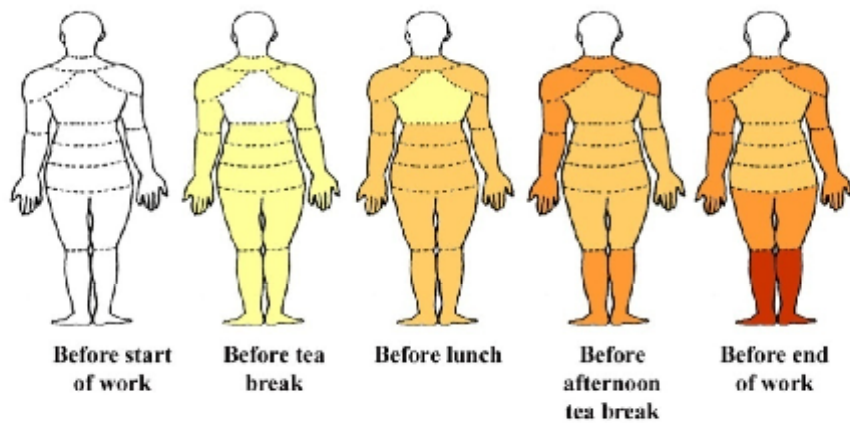
Body Parts	Number of workers (N=30)				
	BSF	MM	L	MA	BEW
Neck	1.0	1.2	2.3	3.4	3.6
Left shoulder	1.0	1.2	2.3	3.4	3.7
Right shoulder	1.0	1.2	2.3	3.4	3.7
Left upper arm	1.0	1.5	2.4	3.6	3.9
Right upper arm	1.0	1.5	2.4	3.6	3.9
Left lower arm	1.0	1.5	2.4	3.7	3.9
Right lower arm	1.0	1.5	2.4	3.7	3.9
Left palm	1.0	1.5	2.4	3.7	3.9
Right palm	1.0	1.5	2.4	3.7	3.9
Left fingers	1.0	1.5	2.4	3.7	3.9
Right fingers	1.0	1.5	2.4	3.7	3.9
Upper back	1.0	1.0	2.0	2.6	3.0
Mid back	1.0	1.3	2.2	2.8	3.0
Lower back	1.0	1.3	2.3	2.8	3.0
Buttocks	1.0	1.4	2.3	2.8	3.0
Left thigh	1.0	1.6	2.5	3.0	4.0
Right thigh	1.0	1.6	2.5	3.0	4.0
Left leg	1.0	1.6	2.7	3.3	4.2
Right leg	1.0	1.6	2.7	3.3	4.2
Feet	1.0	1.6	2.7	3.3	4.2

Table 33: Mean scores of body part discomforts of workers employed in cutting

Body Parts	Number of workers (N=30)				
	BSF	MM	L	MA	BEW
Neck	1.0	2.0	2.4	3.5	4.0
Left shoulder	1.0	2.0	2.4	3.5	4.0
Right shoulder	1.0	2.0	2.4	3.5	4.0
Left upper arm	1.0	2.0	2.6	2.8	3.4
Right upper arm	1.0	2.0	2.7	3.7	4.0
Left lower arm	1.0	1.7	2.5	2.6	3.2
Right lower arm	1.0	2.0	2.8	3.7	4.0
Left palm	1.0	1.7	2.5	2.6	3.2
Right palm	1.0	2.0	2.8	3.7	4.0
Left fingers	1.0	1.5	2.5	2.6	3.2
Right fingers	1.0	2.0	2.8	3.7	4.0
Upper back	1.0	1.0	2.0	2.2	2.7
Mid back	1.0	1.5	2.5	2.6	3.0
Lower back	1.0	1.5	2.7	2.9	3.0
Buttocks	1.0	1.5	2.7	2.9	3.0
Left thigh	1.0	2.0	2.6	3.0	3.6
Right thigh	1.0	2.0	2.6	3.0	3.6
Left leg	1.0	2.0	2.9	3.5	4.1
Right leg	1.0	2.0	2.9	3.5	4.1
Feet	1.0	2.0	2.9	3.5	4.1



a. Pattern Making



b. Cutting

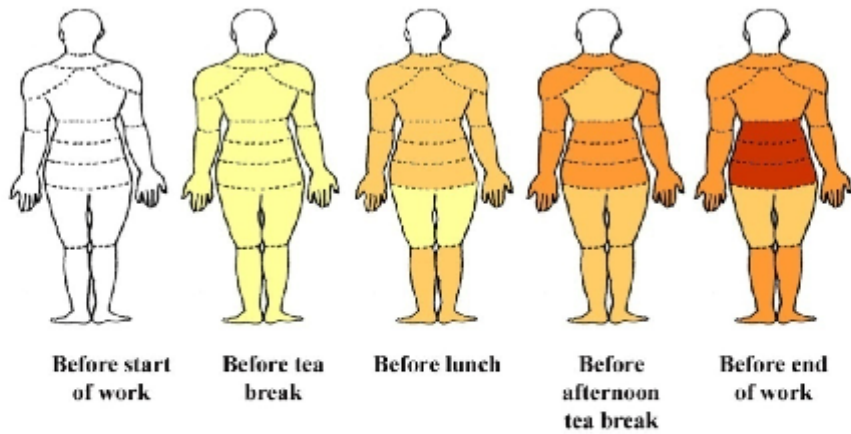
Figure 17: Body part discomfort of workers in pattern making and cutting section

Table 34: Mean scores of body part discomforts of workers employed in stitching

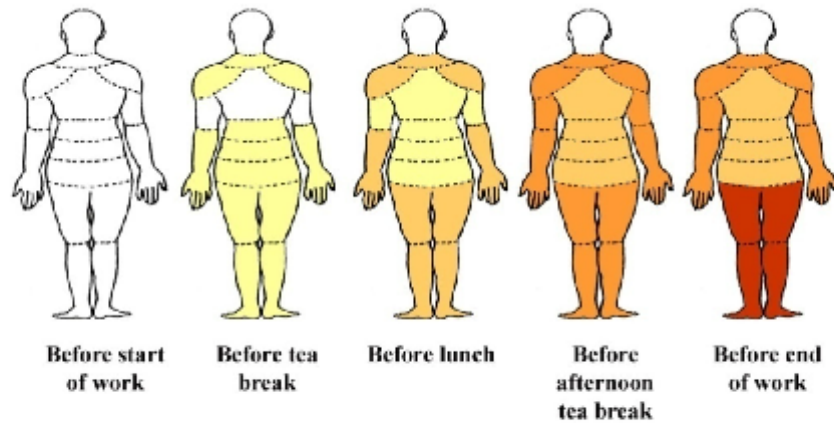
Body Parts	Number of workers (N=30)				
	BSF	MM	L	MA	BEW
Neck	1.0	1.5	2.6	3.4	4.0
Left shoulder	1.0	1.4	2.7	3.4	4.0
Right shoulder	1.0	1.4	2.7	3.4	4.0
Left upper arm	1.0	1.3	2.4	3.2	3.4
Right upper arm	1.0	1.3	2.4	3.2	3.4
Left lower arm	1.0	1.2	2.5	3.1	3.1
Right lower arm	1.0	1.2	2.5	3.1	3.1
Left palm	1.0	1.2	2.5	3.1	3.1
Right palm	1.0	1.2	2.5	3.1	3.1
Left fingers	1.0	1.2	2.5	3.1	3.1
Right fingers	1.0	1.2	2.5	3.1	3.1
Upper back	1.0	1.7	2.5	3.0	4.0
Mid back	1.0	2.0	2.6	3.2	4.4
Lower back	1.0	2.0	2.7	3.5	4.5
Buttocks	1.0	2.0	2.7	3.5	4.5
Left thigh	1.0	1.1	2.0	2.6	3.0
Right thigh	1.0	1.1	2.0	2.6	3.0
Left leg	1.0	1.2	2.5	3.0	3.7
Right leg	1.0	1.2	2.5	3.0	3.7
Feet	1.0	1.2	2.5	3.0	3.7

Table 35: Mean scores of body part discomforts of workers employed in checking

Body Parts	Number of workers (N=30)				
	BSF	MM	L	MA	BEW
Neck	1.0	1.7	2.7	3.7	3.8
Left shoulder	1.0	1.6	2.7	3.1	3.7
Right shoulder	1.0	1.6	2.7	3.1	3.7
Left upper arm	1.0	1.0	2.0	3.3	3.4
Right upper arm	1.0	1.0	2.0	3.3	3.4
Left lower arm	1.0	1.6	3.0	4.0	3.3
Right lower arm	1.0	1.6	3.0	4.0	3.3
Left palm	1.0	1.6	3.0	4.0	3.3
Right palm	1.0	1.6	3.0	4.0	3.3
Left fingers	1.0	1.6	3.0	4.0	3.3
Right fingers	1.0	1.6	3.0	4.0	3.3
Upper back	1.0	1.5	1.5	2.1	3.0
Mid back	1.0	1.8	1.8	2.4	2.6
Lower back	1.0	1.8	1.9	2.5	2.8
Buttocks	1.0	1.8	1.9	2.5	2.8
Left thigh	1.0	1.9	2.6	3.7	4.1
Right thigh	1.0	1.9	2.6	3.9	4.1
Left leg	1.0	1.9	2.8	3.9	4.3
Right leg	1.0	1.9	2.8	3.9	4.3
Feet	1.0	1.9	2.8	3.9	4.3



c. Stitching



d. Checking

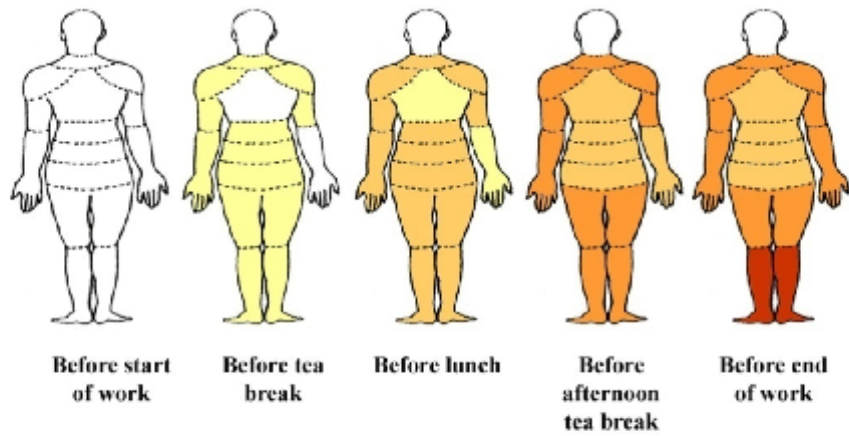
Figure 18: Body part discomfort of workers in stitching and checking section

Table 36: Mean scores of body part discomforts of workers employed in ironing

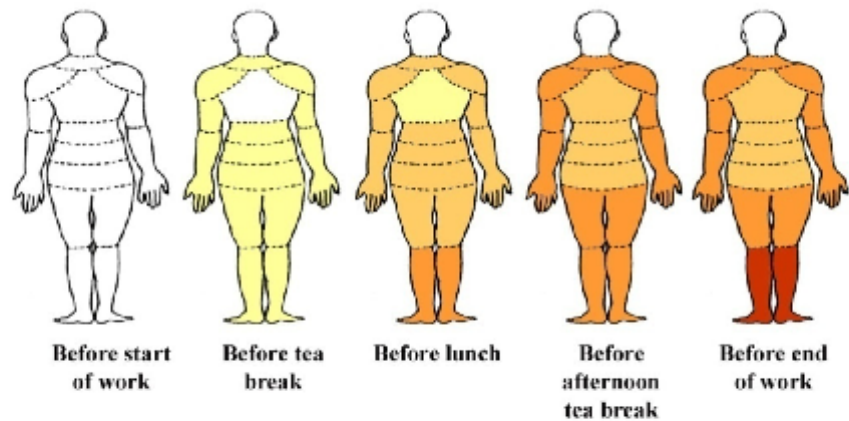
Body Parts	Number of workers (N=30)				
	BSF	MM	L	MA	BEW
Neck	1.0	2.0	3.0	3.4	4.0
Left shoulder	1.0	2.0	2.6	3.4	4.0
Right shoulder	1.0	2.0	2.6	3.4	4.0
Left upper arm	1.0	1.3	2.5	3.1	3.8
Right upper arm	1.0	1.3	2.5	3.1	3.9
Left lower arm	1.0	1.0	2.0	2.6	3.8
Right lower arm	1.0	1.3	2.5	3.1	3.9
Left palm	1.0	1.0	2.0	2.6	3.8
Right palm	1.0	1.3	2.5	3.1	3.9
Left fingers	1.0	1.0	2.0	2.6	3.8
Right fingers	1.0	1.3	2.5	3.1	3.9
Upper back	1.0	1.0	2.0	2.3	2.9
Mid back	1.0	1.1	2.1	2.5	2.9
Lower back	1.0	1.4	2.4	2.8	3.0
Buttocks	1.0	1.4	2.4	2.8	3.0
Left thigh	1.0	1.6	2.3	3.4	3.6
Right thigh	1.0	1.6	2.3	3.4	3.6
Left leg	1.0	1.7	2.5	3.6	4.1
Right leg	1.0	1.7	2.5	3.6	4.1
Feet	1.0	1.7	2.5	3.6	4.1

Table 37: Mean scores of body part discomforts of workers employed in packing

Body Parts	Number of workers (N=30)				
	BSF	MM	L	MA	BEW
Neck	1.0	1.2	2.4	3.3	3.5
Left shoulder	1.0	1.2	2.4	3.2	3.5
Right shoulder	1.0	1.2	2.4	3.2	3.5
Left upper arm	1.0	1.1	2.1	3.2	3.5
Right upper arm	1.0	1.1	2.1	3.2	3.5
Left lower arm	1.0	1.1	2.1	3.1	3.4
Right lower arm	1.0	1.1	2.1	3.1	3.4
Left palm	1.0	1.1	2.1	3.1	3.4
Right palm	1.0	1.1	2.1	3.1	3.4
Left fingers	1.0	1.1	2.1	3.1	3.4
Right fingers	1.0	1.1	2.1	3.1	3.4
Upper back	1.0	1.0	2.0	3.0	3.2
Mid back	1.0	1.2	2.3	3.0	3.2
Lower back	1.0	1.3	2.7	3.1	3.5
Buttocks	1.0	1.3	2.7	3.1	3.5
Left thigh	1.0	1.5	3.0	3.3	3.9
Right thigh	1.0	1.5	3.0	3.3	3.9
Left leg	1.0	1.7	3.2	3.5	4.2
Right leg	1.0	1.7	3.2	3.5	4.2
Feet	1.0	1.7	3.2	3.5	4.2



e. Ironing



f. Packing

Figure 19: Body part discomfort of workers in ironing and packing section

From the Table 32 and Table 33, it is evident that workers involved in pattern making and cutting of fabrics experienced extreme discomforts in both the legs and feet. They also reported severe discomforts in neck, shoulders, upper and lower arms. This may be due to prolonged standing and bending forward to complete the task. Moderate discomfort was felt in the back region due to frequent twisting of the trunk. However workers engaged in stitching of fabrics presented in Table 34 indicates extreme discomforts in the back region which may be due to forward inclined posture of the head and trunk. Moreover the condition of workers becomes worse due to lack of back rest. The stitching operators also experienced severe discomforts in their neck, shoulders, legs, feet, upper and lower arms. Table 35 showed the mean scores of workers involved in checking stitched garments. This task is done mainly by women workers in a prolonged standing posture. This resulted in extreme discomforts in both their thighs, legs and feet. They also reported severe discomfort in the neck region, shoulders, upper and lower arms, palms and fingers. Table 36 and 37 represents workers engaged in ironing and packing of garments. The discomforts experienced by them were similar to the workers involved in pattern making and cutting of fabrics.

c. Hazard identification and risk analysis

Healthy and safety issues are becoming increasingly important in the modern industrial world. Risk assessment is a core element of health and safety management. Hazard identification and risk assessment is a continual process. It is done in order to identify whatever could cause injury, damage, ill-health, financial loss and reputational loss to the organization. Table 38 presents the hazard identification and risk analysis of garment workers.

Table 38: Details of hazard identification and risk analysis of garment workers

Section	Activity	Consequence	Risk Score
Cutting	Laying the fabric	Dust exposure	10
	Pattern laying	Dust exposure	9
	Cutting manually i.e. using different types of scissors	Dust exposure and hand injuries	9
	Cutting mechanically using different types of knives	Dust exposure and hand injuries	9
Stitching	Stitching	Dust exposure	9
	Stitching	Work with bent back	10
	Stitching	Injuries of fingers and hands	8
	Stitching	Excessive noise exposure	8
	Stitching	Insufficient lighting	8
Finishing	Checking the stitched garments	Insufficient lighting	8
	Checking the stitched garments	Burns while removing stain using solvents	8
	Ironing the checked garments	Heat	8
	Ironing the checked garments	Excessive noise	9
	Ironing the checked garments	Burns of hands	8
	Prolonged standing while working	Postural stress	10

The most important process in the phase of making cloths is cutting of textile material. Cutting is performed under the affect of physical and in some cases chemical affects. For cutting of textile materials, the following energy forms are used namely mechanical, electrical, chemical and thermal respectively. The usage of different energies, various machines, devices and instruments, makes

human work more productive, rational and releases the man of needless efforts; it also contributes to the humanization of work. However, on the other hand, it causes the appearance of different gases, dusts, in some quantities that can in some cases, change the normal air content. Besides, these machines are the causes of mechanical injuries, noise, vibration, different radiations etc. In the present study, dust exposure was found to be a significant problem. Exposure to cotton dust has long been associated with adverse respiratory effects and diminished lung function, which is most evident as byssinosis, a chest tightness experienced by workers on the first day back after a weekend or vacation break and therefore called as 'Monday Fever' (Schilling, 1956, Roach and Schilling, 1960 and Berry et al., 1973). Workers should be encouraged to use protective devices such as face masks. Since heavy smoking is a risk factor for respiratory problems, measures should be taken to reduce smoking among garment workers. Rotating workers from dusty to non-dusty sections on a regular basis might reduce the length of exposure to higher dust levels, thereby reducing the risk.

The risk score of 10 was obtained for postural discomfort in the stitching section. The sewing operator is characterized by a static sitting posture, a forward inclined posture of the head and trunk and relatively uncomfortable ankle and knee angles. The sewing task includes simultaneous hand and arm movements, and the continuous operation of foot pedals. Therefore, the working posture is constrained by the eyes for visual control of the work, the hands for directing the sewing material, and the feet for speedy control of the work. Poor posture of the trunk, neck and upper extremities, and the monotonous repetitive movements result in a high prevalence of musculoskeletal complaints affecting the backs, necks and upper extremities among sewing machine operators (Haslegrave and Corlett, 1995, Vimha, 1982 and Punnett et al., 1985). In most cases, injuries of fingers and hands happen because of incorrect movements performed by a worker during a technological procedure. A common problem found in many Tirupur garment industries was either too much or too little light. The lighting between 500 lux and 1000 lux gives satisfaction to workers. It is recommended that workers undertaking fine work need adequate lighting (in the order of 1000 lux) but what they do not need is for the bright light to be shining

directly into their eyes. They need the light to shine directly onto the exact area where the fine work is being carried out. Often there were no shades on the lights or they were poorly positioned. In the cases of fluorescent lighting, they were often “flickering” which could be extremely stressful to workers. For the industry as a whole, there must be good general lighting especially near steps, ramps and exits so that workers can see where they are going and avoid trips and falls.

The main risk in the finishing section was postural stress. It might be due to prolonged standing. Various spot cleaning agents are used in the checking section. While some industries changed to the safer option of using soap or water mixtures for the cleaning process, others used various solvents which could have serious health and safety problems if not used in the correct manner. Workers and owners often had little awareness of the dangers of such chemicals as they were not provided with the requisite Material Safety Data Sheet (MSDS) by the manufacturers. Burns, electric shock or sometimes death might be possible due to frayed wiring, broken plug sockets and wires dangling close to workers in many parts of a garment industry. Not only was there the danger of electrocution, there is possibility of starting a fire. Many garment workers complained of hot, humid conditions in key sections of the garment industry such as ironing area. The health effects reported were irritability, heat cramps, exhaustion and stroke (dehydration). Occupational exposures to heat and noise are unavoidable in the garment industries, but these exposures could be minimized through efficient control measures at the worksite and/or the proper use of appropriate personal protective equipment and exposure control measures are rarely used at many worksites, and are given little importance and preference by many employers. This neglect might be due to the fact that the workers in rapidly developing countries were economic migrants from other states of the country, who accepted occupational exposures as part of the job. The hot and humid climatic conditions further dissuade the workers from using personal protective equipment, even when provided.

2. Medical screening

The findings of the medical screening of the selected garment workers are discussed under:

a. Body Mass Index (BMI)

BMI is a measure of body fat based on height and weight of adult men and women. Table 39 shows the BMI of garment workers.

Table 39: Body Mass Index of garment Workers

Body Mass Index (BMI)	Frequency (N=514)	Percentage
<18.5 (underweight)	102	19.8
18.6 – 24.9 (Normal)	289	56.3
25 – 29.9 (Overweight)	105	20.4
Above 30 (Obese)	18	3.5

More than one half (56 per cent) of the garment workers had normal BMI.

b. Blood pressure and Blood glucose

Blood pressure (BP) is the lateral pressure exerted by the blood on the walls of the vessels during its flow. Table 40 and 41 shows the blood pressure and blood glucose level.

Table 40: Blood pressure level of garment Workers

Blood pressure (mmHg)	Systolic		Diastolic	
	Frequency (N=514)	Percentage	Frequency (N=514)	Percentage
Low (90/60)	97	18.9	88	17.1
Normal (120/80)	341	66.3	336	65.4
High (160/100)	76	14.8	90	17.5

Sixty five per cent of the garment workers had normal blood pressure.

Table 41: Blood glucose level of garment Workers

Blood glucose (mg/dl)	Frequency (N=514)	Percentage
Low / hypoglycemia (Below 80)	41	8.0
Random (80/140)	440	85.6
High / hyperglycemia (Above 140)	33	6.4

Eighty six per cent of the garment workers had normal blood glucose.

c. Spirometry Test

Pulmonary function tests are performed to assess lung function, to determine the degree of damage to the lungs, diagnosis of certain types of lung disease and to analyze whether exposure to contaminants at work affects lung function. In occupational respiratory diseases, spirometry is one of the most important diagnostic tools, most widely used, most basic and effort dependent pulmonary function test. It plays a significant role in the diagnosis and prognosis of these diseases and describes the effect of restriction or obstruction on the lung function (Johncy et al., 2011). No earlier study among garment workers employed in Tirupur garment industries, India, in terms of pulmonary function tests has been reported. Hence, the present study was undertaken. The results are discussed below:

i. Demographic characteristics of garment workers

The results of the demographic characteristics of experimental group and control group are given in Table 42 and Table 43 respectively.

Table 42: The demographic characteristics of experimental group

Particulars	Frequency (N=200)	Percentage
Sex		
Male	114	57.0
Female	86	43.0
Marital status		
Married	141	70.5
Unmarried	43	21.5
Widow	16	8.0
Sections		
Cutting	26	13.0
Stitching	76	38.0
Checking	41	20.5
Ironing	27	13.5
Packing	30	15.0
Worksite		
Dusty section	200	100.0
Overcrowding	102	51.0
Smoking history		
Passive smoker	51	25.5
Non smoker	77	38.5
Ex smoker	21	10.5
Current smoker	51	25.5
Drinking history		
Non drinker	122	61.0
Ex drinker	24	12.0
Current drinker	54	27.0
Drug addiction habit		
Non drug consumption	102	51.0
Ex drug consumption	6	3.0
Current drug consumption	92	46.0
Fuel used for cooking		
Kerosene	59	29.5
Wood and kerosene	78	39.0
Gas (LPG)	194	97.0

One hundred and fourteen male and 86 female garment workers totaling 200 workers with a mean age 42.7 (± 15.81) years and work experience 19.2 (± 12.07) years employed in the garment industries were enrolled in the study. Seventy per cent of workers were married. Nearly half of the workers (49 per cent) were engaged in finishing section which was a combination of sections of checking, ironing and packing of garments. Thirty eight per cent of the workers were involved in stitching of garments while 13 per cent in cutting of fabrics. All the workers reported that the garment sections were dusty and half (51 per cent) of them felt overcrowding. The latter was classified according to the number of persons per room. Some of the personal habits were developed by the workers probably due to job stress or due to the influence of their peer groups. The habits were such as smoking of cigarettes or bidis (25 per cent), consuming alcohol (27 per cent) and chewing tobacco (46 per cent). Majority of workers used LPG gas (97 per cent) as cooking fuel while nearly equal number of workers (29 per cent and 39 per cent) used wood and kerosene.

Table 43: The demographic characteristics of control group

Particulars	Frequency (N=50)	Percentage
Sex		
Male	32	64.0
Female	18	36.0
Marital status		
Married	35	70.0
Unmarried	15	30.0
Smoking history		
Passive smoker	5	10.0
Non smoker	40	80.0
Ex smoker	3	6.0
Current smoker	2	4.0
Drinking history		
Non drinker	47	94.0
Ex drinker	2	4.0
Current drinker	1	2.0
Drug addiction habit		
Non drug consumption	72.0	36
Current drug consumption	28.0	14
Fuel used for cooking		
Kerosene	17	34.0
Wood and kerosene	3	6.0
Gas (LPG)	50	100.0

From the above Table, it is clear that 32 male and 18 female garment workers totaling 50 workers with a mean age 36.4 (± 11.66) years and work experience 11.9 (± 9.32) years were enrolled in the study. Seventy per cent of workers were married. Personal habits were also found among control group but in very less percentage. Fourteen per cent were tobacco chewers and only four per cent were smokers and two per cent were drinkers. All the subjects used LPG gas for cooking.

The height and weight of experimental and control groups were measured to obtain body mass index. Body mass index of experimental and control group is presented in Table 44.

Table 44: Body mass index of experimental and control group

Particulars	Frequency (N=200)	Percentage
BMI of workers		
Under weight	25	12.5
Normal	97	48.5
Over Weight	56	28.0
Obese	22	11.0
BMI of control group		
Under weight	4	8.0
Normal	27	54.0
Over Weight	15	30.0
Obese	4	8.0

From the above Table, it can be inferred that The mean of Body Mass Index (BMI) of the workers were found to be 23.6 (± 4.66) while The mean of Body Mass Index (BMI) of the workers were found to be 23.9 (± 4.32).

ii. Occupational and clinical history

Table 45 presents the details of occupational and clinical history of the experimental group.

Table 45: Details of occupational and clinical history of experimental group

Particulars	Frequency (N=200)	Percentage
Exposing/handling of toxic materials at worksite		
Cotton dust	198	99.0
Solvents	35	17.5
Wearing of protective device	41	20.5
Prevalence of respiratory symptoms		
Cold	35	17.5
Phlegm	120	60.0
Wheezing	33	16.5
Shortness of breath	115	57.5
Chest tightness	83	41.5
Past history of respiratory disease	75	37.5
History of atopy	75	37.5

The above Table clearly shows that almost all the workers (99 per cent) were exposed to cotton dust and solvents (17 per cent) during their working hours. Only 20 per cent of the workers wore protective devices during working hours. The prevalence of respiratory symptoms was 60 per cent of the total for phlegm, 57 per cent for shortness of breath, 41 per cent for chest tightness and more or less similar per cent for cold (17 per cent) and wheezing (16 per cent). History of respiratory disease and history of atopy were reported by equal number of workers (37 per cent).

Table 46 presents the clinical history of control group

Table 46: Clinical history of control group

Particulars	Frequency (N=50)	Percentage
Prevalence of respiratory symptoms		
Cold	2	4.0
Phlegm	24	48.0
Wheezing	2	4.0
Shortness of breath	12	24.0
Chest tightness	8	16.0
Past history of respiratory disease	12	24.0
History of atopy	12	24.0

From the above Table it can be inferred that subjects considered under control group had minimal prevalence of respiratory symptoms. Nearly half of the

subjects (48 per cent) reported to have phlegm followed by one fourth of them shortness of breath (24 per cent) and four per cent for both cold and chest tightness. Nearly one fourth (24 per cent) had past history of respiratory disease and history of atopy.

iii. Severity of COPD

Table 47 depicts the categorization of severity of COPD as per GOLD guidelines among garment workers.

Table 47: Severity of COPD as per GOLD guidelines of experimental group

Particulars	Frequency (N=200)	Percentage
Mild	-	-
Moderate	163	81.5
Severe	35	17.5
Very severe	2	1.0

More than three fourth of the garment workers (81 per cent) had moderate COPD followed by severe COPD (17 per cent) and very severe COPD (1 per cent). This implies that none of the subject under study was normal. Kamat et al. (1981) at Mumbai observed that prevalence of chronic bronchitis among cotton textile workers was 11-33 per cent. A study conducted at Tirupur by Jannet and Jeyanthi (2006) showed the same result that 23.07 per cent were chronic bronchitic symptomatics and 10.53 per cent were occupational asthmatic symptomatic.

The severity of COPD as per GOLD guidelines among control group was mild.

iv. Levels of COPD Vs risk factors

Identifying occupational risk factors on the individual level is important for prevention of disease before it is advanced and for modifying disability risk once disease is established. The association between levels of COPD (FEV_1) with its risk factors of 200 garment workers is presented in Table 48 and 49.

Table 48: Association between levels of COPD with its risk factors of experimental group

Particulars	χ^2 values
Sex	5.18 ^{NS}
Age	9.36 ^{NS}
BMI of the subject	20.62 ^{**}
Marital status	2.67 ^{NS}
Smoking habit	9.45 ^{NS}
Drinking habit	4.92 ^{NS}
Drug addiction habit	3.00 ^{NS}
Kerosene as cooking fuel	2.81 ^{NS}
Wood and kerosene as cooking fuel	2.91 ^{NS}
Gas as cooking fuel	1.11 ^{NS}
Overcrowding in worksite	2.25 ^{NS}
Sections in which employed	8.22 ^{NS}
Duration of exposing/handling toxic materials	5.72 ^{NS}
Wearing of protective device	0.53 ^{NS}
Prevalence of respiratory symptom - Cold	2.87 ^{NS}
Prevalence of respiratory symptom - Phlegm	3.75 ^{NS}
Prevalence of respiratory symptom -Wheezing	2.10 ^{NS}
Prevalence of respiratory symptom - Shortness of breath	8.79 ^{**}
Prevalence of respiratory symptom - Chest tightness	8.79 ^{**}
Number of years of work experience	8.79 ^{**}
Past history of respiratory disease	0.31 ^{NS}
History of atopy	0.78 ^{NS}

* $p < 0.05$, ** $p < 0.01$, NS: Non-Significant

Chi-square (χ^2) test was used to find the association between levels of COPD with its risk factors of experimental group. A significant association was found at one per cent level among garment workers who had respiratory symptoms namely shortness of breath and chest tightness and also number of years of work experience. **Hence Hypothesis 2 is rejected** as there is relationship between the years of experience and development of COPD and respiratory symptoms in the experimental group.

According to Boschetto (2006), Cigarette smoking is the major risk factor for COPD. However, relevant information from the literature published within the last few years, either on general population samples or on workplaces, indicates that about 15 per cent of all cases of COPD are work-related.

Table 49: Association between levels of COPD with its risk factors of control group

Particulars	χ^2 values
Sex	1.17 ^{NS}
Age	3.78 ^{NS}
BMI of the subject	5.32 ^{NS}
Marital status	3.06 ^{NS}
Smoking habit	2.78 ^{NS}
Drinking habit	2.51 ^{NS}
Drug addiction habit	2.76 ^{NS}
Kerosene as cooking fuel	2.47 ^{NS}
Wood and kerosene as cooking fuel	0.19 ^{NS}
Prevalence of respiratory symptom - Cold	0.09 ^{NS}
Prevalence of respiratory symptom - Phlegm	1.11 ^{NS}
Prevalence of respiratory symptom -Wheezing	0.09 ^{NS}
Prevalence of respiratory symptom - Shortness of breath	3.46 ^{NS}
Prevalence of respiratory symptom - Chest tightness	1.46 ^{NS}
Number of years of work experience	49.85 ^{NS}
Past history of respiratory disease	33.37 ^{NS}
History of atopy	33.37 ^{NS}

* $p < 0.05$, ** $p < 0.01$, NS: Non-Significant

When Chi-square (χ^2) test was used to find the association between levels of COPD with its risk factors of control group, all the particulars were found to be non-significant. **Hypothesis 3 is accepted as all cases of COPD are work-related.**

v. Effect of bronchodilator inhalation

Table 50 presents the effect of bronchodilator inhalation between experimental group and control group.

Table 50: Effect of bronchodilator inhalation between experimental group and control group

Group	Mean	Std. Deviation	t value
Experimental	64.64	9.38	16.57**
Control	91.58	13.31	

* $p < 0.05$, ** $p < 0.01$, NS: Non-Significant

't' test was used to find the effect of bronchodilator inhalation between experimental group and control group. FEV1 increased by 65 per cent in experimental group while 91 per cent in control group after bronchodilator test. A high significant difference at one per cent level was found between experimental group and control group when bronchodilator was administered to them.

Bronchodilators work through their direct relaxation effect on airway smooth muscle cells. Donohue (2004) and Calverley (2003) reported that 73 per cent of 813 patients with COPD increased their FEV1 by at least 12 per cent, or 200 ml, after long-term salmeterol treatment. However, 11 per cent of patients showed a similar increase in FEV1 after acute administration of ipratropium, 27 per cent after albuterol, and 35 per cent with both drugs combined.

A study conducted by Aliverti et al. (2005) showed that Salbutamol increased FEV1, forced vital capacity (FVC) and inspiratory capacity and reduced functional residual capacity (FRC) and residual volume significantly among in 18 patients with COPD. After the bronchodilator these patients tried to reduce the end expiratory lung volume when exercising, while those exercising longer continued to allow end expiratory abdominal wall volume to rise.

d. Heart rate of garment workers

Thirty workers from each of the three sections namely cutting, stitching and finishing were selected for recording the heart rate. The heart rate was recorded for 8 hours for all selected workers in all the sections. The heart rate data of the garment workers is given in Table 51.

Table 51: Heart rate of garment workers

Parameters	Section		
	Cutting (N=30)	Stitching (N=30)	Finishing (N=30)
Minimum heart rate (beats/min)	85	82	86
Maximum heart rate (beats/min)	97	103	110
Average heart rate (beats/min)	96	91	98

The analysis of heart rate indicates that cutting and stitching section workers had average heart rate of 96 beats/min and 91 beats/min as against 98

beats/min of workers in finishing section. This implies that finishing activity is moderately heavy activity involving lifting, checking, ironing and packing.

Fluctuations in heart rate among the workers were observed by Vuori (1998) in his study which was due to working postures, environmental influences and health status.

D. Evaluation of Ergonomic Furniture

An ergonomic table for workers in checking section was modified and an ergonomic chair was stitching section was designed. These were introduced to the workers and were evaluated the findings are discussed below:

1. Ergonomic table for workers in checking section

The ergonomic table (having adjustable and adequate worktable) and ergonomic stool for checking workers of garment industry developed by Ganguli et al. (2009) were adopted for the present study and modified based on the suggestions given by the workers. The modified ergonomically designed table could be used as a sit-stand workstation. The major changes made in the original workstation are as follows: (Plate 14).

- Two white fluorescent tube lights above the table top were fixed for proper vision while at work. Eighteen volts tube lights were used to generate less heat.
- A wooden drawer was provided for keeping worker's work tools and personal protective equipment such as trimmer, cotton thread, sticker of arrow shape, plastic glass, toothbrush, cotton hand gloves and face masks.



Plate 14 : Modified Ergonomic Table

- The sides of the table were closed with plywood so as to prevent accumulation of cotton dust.
- Two wooden racks underneath the tabletop were fixed where the centre rack is three-fourth of the bottommost rack in order to enable the worker to have sufficient thigh clearance while working on a seated position. The bottommost rack is used for storing the stitched garments to be checked while the centre rack for keeping the completed checked garments. The bottommost rack is sometimes used as footrest as well.

The improved ergonomic table was evaluated RULA, BPD, Heart rate studies and production rate for a period of two months.

a. Comparison of RULA using conventional and ergonomic tables

The results of the posture analysis among workers using conventional and ergonomic tables in checking section using RULA are given below:

- **Overall distribution of RULA score**

Table 52 shows the overall distribution of RULA score.

Table 52: Overall Distribution of RULA Score

Risk level	Action level	Ergonomic intervention	Conventional table		Ergonomically designed table	
			No.(10)	%	No.(10)	%
Negligible	1	Acceptable	-	-	-	-
Low	2	Investigate further	-	-	1	10.0
Medium	3	Investigate further and change soon	6	60.0	9	90.0
High	4	Investigate and change immediately	4	40.0	-	-

The above Table reveals that all categories of the risk levels exist in job postures. None of the worker is at negligible and low risk level among checking workers using conventional table. In 60 per cent of the workers studied, RULA Grand Score was between 5 and 6 indicating that the level of exposure to musculoskeletal risks was high and ergonomics intervention to decrease exposure level seemed essential (action level 3). In 40 per cent of the workers studied, RULA Grand Score was 7 indicating that the level of exposure to

musculoskeletal risks was very high and immediate ergonomics intervention to decrease exposure level seemed essential (action level 4).

The findings of workers using ergonomically designed table show that none of the worker is at negligible and high risk level. In 10 per cent of the workers studied, RULA Grand Score was between 3 and 4 indicating that the level of exposure to musculoskeletal risks was high and ergonomics intervention to decrease exposure level is needed (action level 2). In 90 per cent of the workers studied, RULA Grand Score was between 5 and 6 indicating that the level of exposure to musculoskeletal risks was high and ergonomics intervention to decrease exposure level seemed essential (action level 3). The finding thus shows that there is risk level in low and medium because the new workstation has the provision of height adjustable table with tilting facility.

- **Process wise distribution of RULA score**

Table 53 shows the process wise distribution of RULA score for using conventional and ergonomic tables.

Table 53: Process wise Distribution of RULA Score

Conventional table			Ergonomic table		
No.(10)	Score	%	No.(10)	Score	%
-	4	-	1	4	10.0
2	5	20.0	6	5	60.0
4	6	40.0	3	6	30.0
4	7	40.0	-	7	-

't' test was used to compare conventional table with ergonomically designed table in terms of RULA scores and it is presented in Table 54.

Table 54: Comparison of total RULA Scores of checking workers

Variables	Conventional Table	Ergonomically Designed Table	t - Value
Mean	6.2	5.2	6.71**
Standard Deviation	0.789	0.632	

* $p < 0.05$, ** $p < 0.01$, NS: Non-Significant

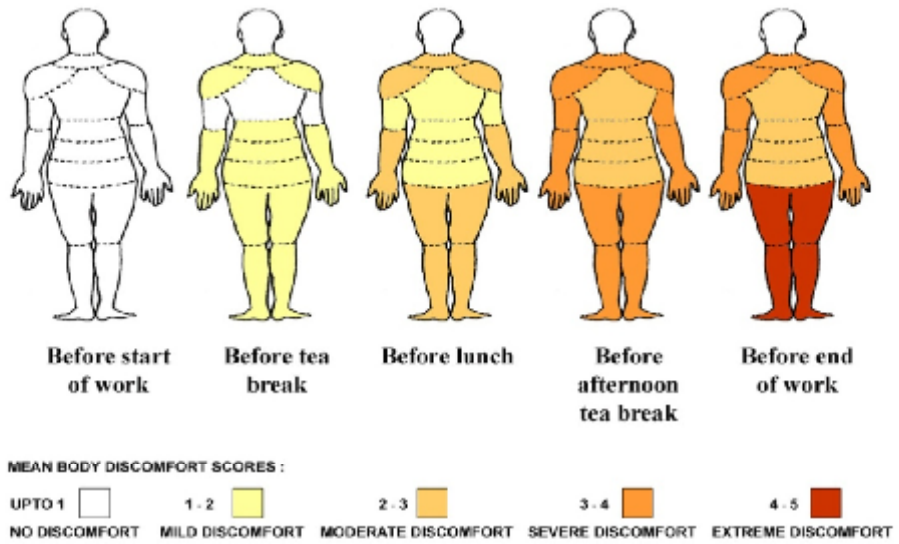
A high significant difference at one per cent level was found between conventional table and ergonomic table.

b. Comparison of BPD using conventional and ergonomic table

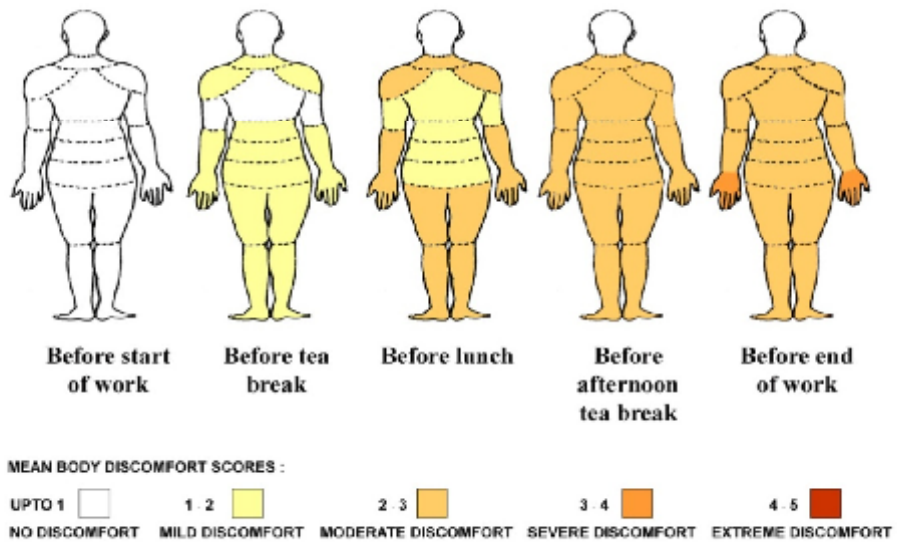
Table 55 and Figure 20 present the mean scores of the body part discomfort of ten workers (by end of day's work) using conventional table and ergonomic table.

Table 55: Comparison of body part discomfort of workers using conventional and ergonomic table

Body Parts	Mean scores of body part discomfort		t - Value
	Conventional Table	Ergonomic Table	
Neck	3.40	2.30	6.13 ^{**}
Left shoulder	3.60	2.50	6.13 ^{**}
Right shoulder	3.60	2.50	6.13 ^{**}
Left upper arm	3.10	2.20	3.86 ^{**}
Right upper arm	3.40	2.50	5.01 ^{**}
Left lower arm	3.50	2.70	6.0 ^{**}
Right lower arm	3.60	3.10	2.24 [*]
Left palm	3.50	3.40	NS
Right palm	3.60	3.50	NS
Left fingers	3.70	3.60	NS
Right fingers	3.70	3.60	NS
Upper back	2.90	2.70	NS
Mid back	2.70	2.50	NS
Lower back	2.40	2.20	NS
Buttocks	2.30	2.20	NS
Left thigh	4.10	3.00	6.13 ^{**}
Right thigh	4.10	3.00	6.13 ^{**}
Left leg	4.10	3.00	6.13 ^{**}
Right leg	4.10	3.00	6.13 ^{**}
Feet	4.10	3.00	6.13 ^{**}



a. Conventional table



b. Ergonomic table

Figure 20: Body part discomfort of workers using conventional and ergonomic table

From the above table, it is evident that workers experienced extreme discomfort (mean score of 4.10) in the thighs, legs and feet while using conventional table. It might be due to prolonged standing posture mainly by female workers. They also reported severe discomfort in the neck region, shoulders, arms, palms and fingers. While using ergonomic table, workers experienced moderate discomforts in the thighs, legs and feet followed by upper back, mid back, lower back, lower arm, upper arm, shoulders and neck except palms and fingers where they felt severe discomforts. High significant difference at one per cent level were observed in discomforts in the thighs, legs, feet, neck, shoulders and arms while using the two tables. There was no reduction of discomfort in the palms, fingers and back regions. The results are on par with the study conducted by Ghosh et al. (2010) in which MSDs were reported in different occupations due to improper body posture and work load. Poor designs of workstation are causes of improper postures which increases the discomfort and pain at different parts of the body such as back, neck and shoulders.

c. Comparison of heart rate using conventional and ergonomic table

Table 56 presents the details of heart rate of ten selected workers using conventional table and ergonomic table.

Table 56: Comparison of Heart rate of workers using conventional table and ergonomic table

Age (yrs)	Work experience	Conventional Table			Ergonomic Table		
		Minimum (bpm)	Maximum (bpm)	Average (bpm)	Minimum (bpm)	Maximum (bpm)	Average (bpm)
34	10	89	110	100	77	105	92
38	20	91	114	102	86	109	97
30	5	80	112	95	75	110	92
33	9	85	115	99	79	105	91
36	22	89	116	102	83	106	95
37	20	90	119	104	85	114	100
23	6	84	111	96	78	108	92
31	11	88	110	99	79	102	90
22	4	83	115	98	73	105	87
17	1	80	111	95	71	99	85

The minimum heart rate of workers using conventional table ranged from 80 to 91 beats/min and maximum heart rate from 110 to 119 beats/min. There was a slight decrease in the heart rate of workers using ergonomic table. The minimum heart rate of workers using ergonomic table ranged from 71 to 86

beats/min and maximum heart rate from 99 to 114 beats/min. The reduced heart rate observed while using modified table which might be due to less mobility as racks are provided to store the garments for a limited time period.

't' test was used to compare heart rate of checking workers using conventional table and ergonomic table and presented in Table 57.

Table 57: Comparison of heart rate of checking workers

Variables	Conventional table	Ergonomic table	t-Value
Mean	99	92.1	7.89**
Standard Deviation	3.091206	4.433459	

* $p < 0.05$, ** $p < 0.01$, NS: Non-Significant

There was a high significant difference at one per cent level indicating that the new workstation was user friendly and much better than the conventional workstation.

d. Change in production of workers using conventional and ergonomic tables

The percentage increase in production of the ten selected workers using conventional table and ergonomic table is presented in Table 58.

Table 58: Change in production of checking workers

Age (years)	Number of pieces checked per day		Change in production (%)
	Conventional table	Ergonomic table	
34	901	982	8.9
38	919	957	4.1
30	812	907	11.7
33	847	923	8.9
36	912	945	3.6
37	923	1009	9.3
23	801	893	11.5
31	820	882	7.6
22	795	868	9.2
17	727	834	14.7

The percentage of increase in production ranged from 4 to 15. Their increase in the productivity pattern could be attributed to other factors such as nature of work, the physical fitness and the ability to adapt to the new table. It

could be confirmed that the production could be improved by using the ergonomic table which has proved to have a reduction in their discomfort level and also the heart rate level.

Many studies showed that ergonomics and quality are closely related in the manufacturing context. In a study among apparel manufacturers in the US, the majority of participating companies reported that investing in ergonomic equipment (e.g. ergonomic chairs or tilted tables) resulted in less human errors and improved quality (Dillard and Schwager, 1997).

2. Ergonomic chair for stitching workers

The stitching adopted awkward postures while using conventional chair. Such awkward posture adopted for long period of time resulted in musculoskeletal discomforts. Hence an ergonomic chair was designed based on the workers' anthropometry measurements. Twelve anthropometric dimensions of human body in the sitting posture of 50 male and 50 female stitching workers were measured for the requirement of designing ergonomic chair. Table 59 shows the anthropometric measurements for sitting position of male and female stitching workers.

Table 59: Anthropometric measurements for sitting male and female garment workers

mm	Male (N=50)									Female (N=50)									P value
	Mean	Median	Mode	SD	Min	Max	5 th	50 th	95 th	Mean	Median	Mode	SD	Min	Max	5 th	50 th	95 th	
1	849.64	852	875	48.68	749	953	761.5	852.0	926.8	793	780	764	42.06	734	911	745.45	780	871.3	≤ 0.01
2	757.1	754	853	53.51	662	884	686.4	754.0	859.1	683.76	676.5	684	38.22	604	823	642.9	676.5	754.2	≤ 0.01
3	562.48	566.5	564	41.56	454	656	501.9	566.5	628.0	523.54	527	544	34.51	451	596	475.25	527	586.2	≤ 0.01
4	250.9	248	244	29.16	201	318	204.0	248.0	297.9	227.82	230	214	25.37	181	283	192.45	230	265.1	≤ 0.01
5	336.94	333	383	42.33	261	453	276.0	333.0	404.5	305.26	303	294	37.08	222	383	244	303	371.35	≤ 0.01
6	231.54	235.5	164	47.05	143	338	162.4	235.5	302.7	204.56	215	224	36.90	114	258	130.7	215	251.3	≤ 0.01
7	169.5	169	174	35.20	119	249	126.9	169.0	221.3	171.06	173	174	24.88	116	234	129.9	173	206.55	NS
8	436.44	432.5	421	32.02	344	528	391.5	432.5	482.7	413.28	409	404	24.48	356	463	383.45	409	452	≤ 0.01
9	441.82	443.5	454	30.86	369	514	397.5	443.5	489.3	442.42	443.5	449	30.32	391	533	396	443.5	487.95	NS
10	539.16	535	546	28.30	465	606	504.9	535.0	587.5	536.98	542	552	32.07	471	606	479.15	542	584.1	NS
11	423.58	408.5	494	50.59	352	528	360.8	408.5	509.5	426.9	444	434	60.21	316	524	331.25	444	506.2	NS
12	455	443	541	51.35	379	559	389.5	443.0	541.0	459.28	472	469	60.62	343	555	362.95	472	543.55	NS

Dimension (mm):

1: Sitting height, 2: Sitting eye height, 3: Sitting shoulder height, 4: Elbow rest height, 5: Upper lumbar, 6: Lower lumbar, 7: Thigh clearance, 8: Sitting popliteal height, 9: Sitting buttock popliteal height, 10: Buttock knee length, 11: Thigh to thigh length, 12: Hip breadth

If $P \leq 0.05$, significant at 5%

If $P \leq 0.01$, significant at 1%

If $P > 0.05$, Non significant

When 12 anthropometric dimensions of human body in the sitting posture of 50 male stitching workers were compared with 50 female, a high significant difference at one per cent level were found for sitting height, sitting eye height, sitting shoulder height, elbow rest height, upper lumbar, lower lumbar, and sitting popliteal height.

The present mean values of anthropometric data were compared with Gite et al. (2009), Parimalam et al. (2007) and Kabir and Ahmed (2003). Table 60 presents the comparison of anthropometric data with earlier research studies.

Table 60: Comparison of anthropometric data with earlier research studies

Anthropometric measurements	Present study				Gite et al. (2009)				Parimalam et al. (2007)				Kabir and Ahmed (2003)			
	Male (N=50)		Female (N=50)		Male (N=1000)		Female (N=587)		Male (N=)		Female (N=216)		Male		Female	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
<i>Sitting height</i>	849.64	48.68	793	42.06	781	83	754	63	-	-	738	30	834.8	98.72	770.1	90.90
Sitting eye height	757.1	53.51	683.76	38.22	670	79	638	58	-	-	675	30	-	-	-	-
Sitting shoulder height	562.48	41.56	523.54	34.51	561	79	521	67	-	-	522	28	-	-	-	-
<i>Elbow rest height</i>	250.9	29.16	227.82	25.37	201	25	187	21	-	-	172	23	247.1	27.89	222.9	24.54
Upper lumbar	336.94	42.33	305.26	37.08	-	-	-	-	-	-	-	-	-	-	-	-
Lower lumbar	231.54	47.05	204.56	36.90	-	-	-	-	-	-	111	13	-	-	-	-
<i>Thigh clearance</i>	169.5	35.20	171.06	24.88	117	17	110	16	-	-	141	23	115.5	12.60	134.0	14.98
<i>Sitting popliteal height</i>	436.44	32.02	413.28	24.48	422	24	394	28	-	-	363	21	438.8	51.44	412.2	48.38
<i>Sitting buttock popliteal length</i>	441.82	30.86	442.42	30.32	-	-	-	-	-	-	441	25	419.1	48.42	397.2	45.51
<i>Buttock knee length</i>	539.16	28.30	536.98	32.07	540	26	525	27	-	-	534	27	517.3	60.29	474.6	55.02
Thigh to thigh length	423.58	50.59	426.9	60.21	-	-	-	-	-	-	-	-	-	-	-	-
Hip breadth	455.88	51.35	459.28	60.62	300	31	286	24	-	-	230	41	-	-	-	-

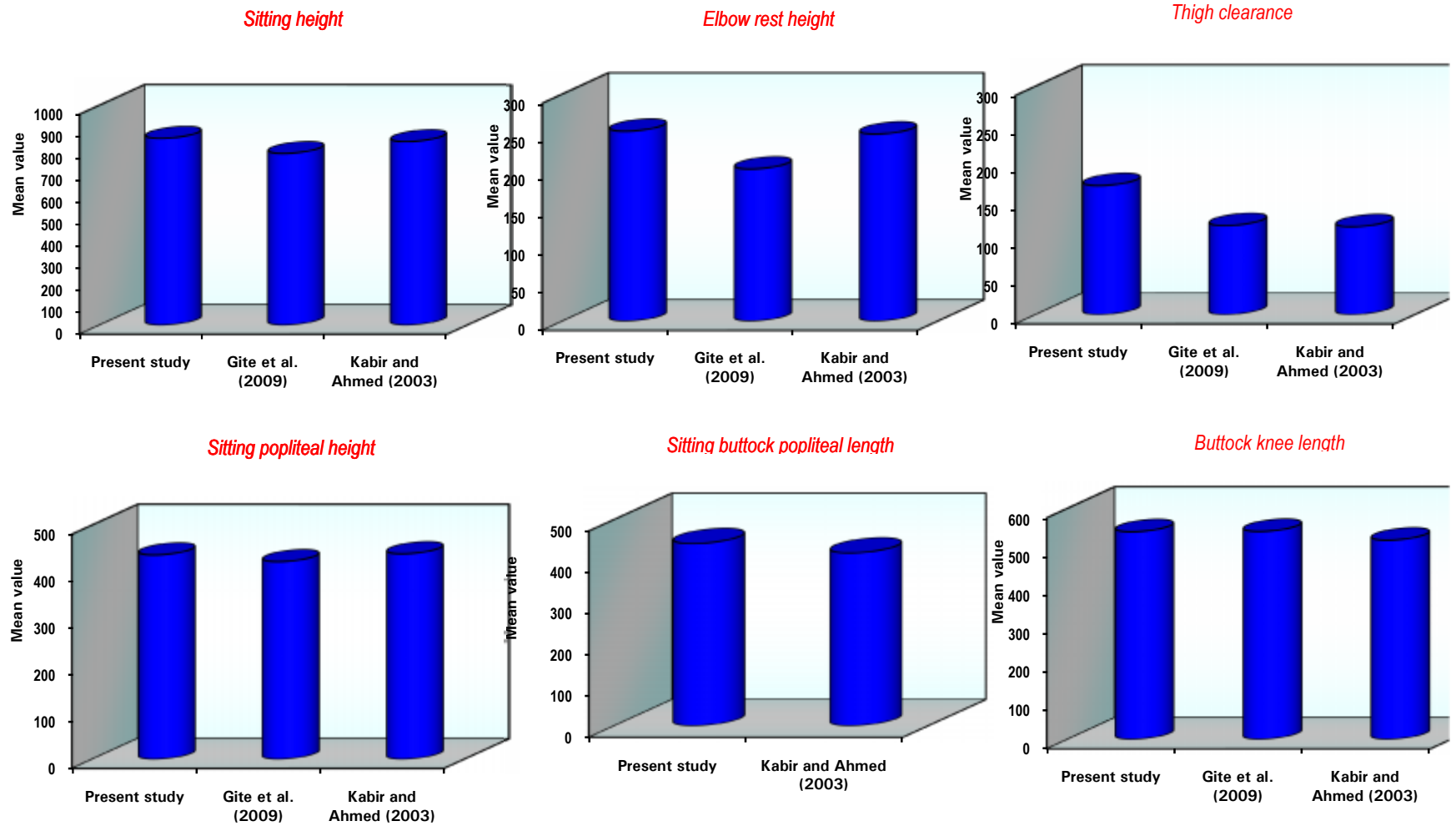


Figure 21a: Comparison of anthropometric data with earlier research studies for males

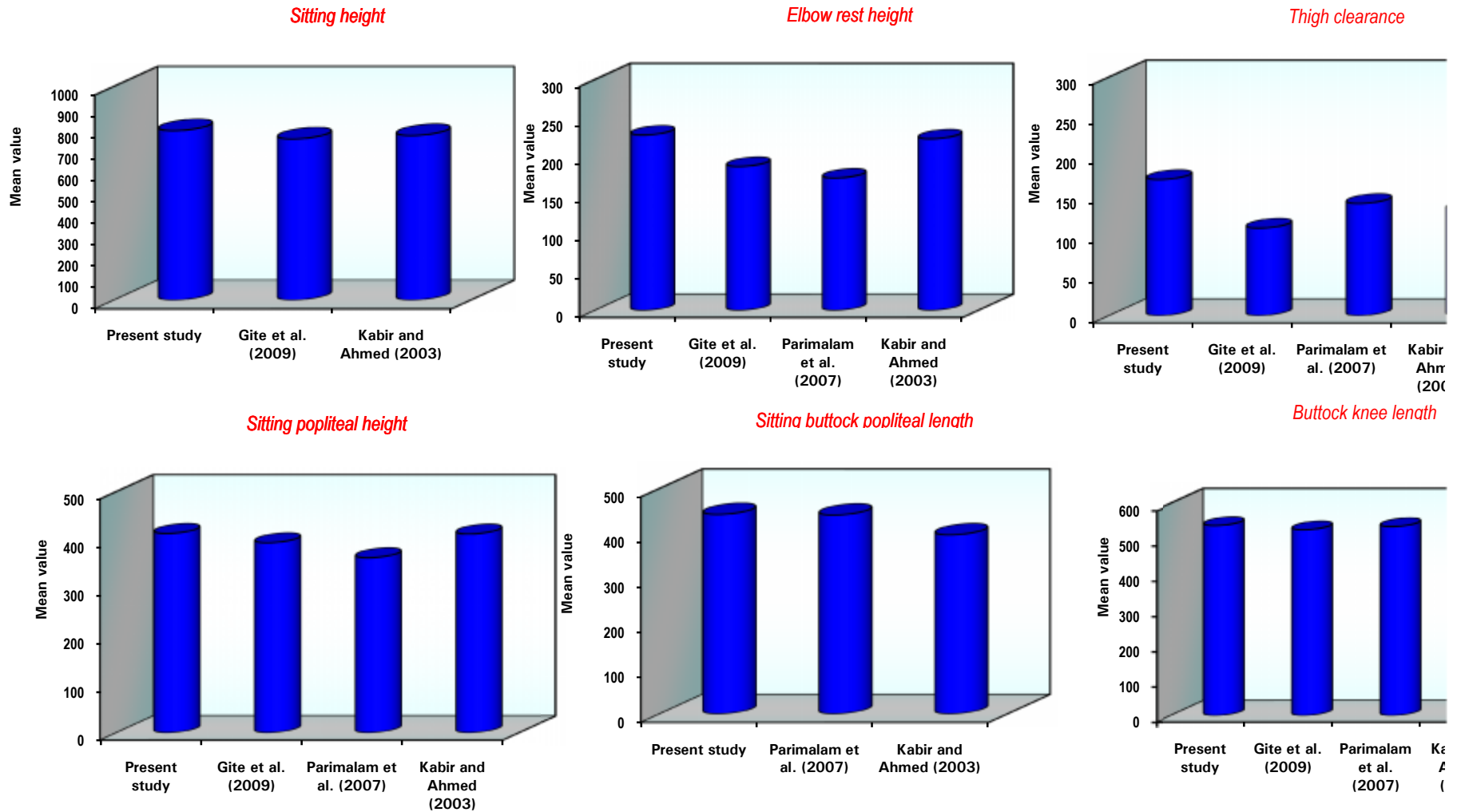


Figure 21b: Comparison of anthropometric data with earlier research studies for females

Most dimensions were significantly higher in males than females, but this difference was not significant in thigh clearance, sitting buttock popliteal height, buttock knee length, thigh to thigh length and hip breadth. This difference might be properly due to higher fat tissue in females.

Evaluation of the ergonomic chair for 10 stitching workers were carried out using the following headings namely RULA, BPD, Heart rate studies and worker productivity for a period of two months (Plate 15).



Plate 15: Ergonomic Chairs in Use

a. Comparison of RULA using conventional and ergonomic chair

The results of the posture analysis among workers employed in stitching section using RULA are given below:

- **Overall distribution of RULA score**

Table 61 shows the overall distribution of RULA score.

Table 61: Overall distribution of RULA score

Risk Level	Action Level	Ergonomic Intervention	Conventional chair		Ergonomic chair	
			No.(10)	%	No.(10)	%
Negligible	1	Acceptable	-	-	-	-
Low	2	Investigate further	-	-	2	20.0
Medium	3	Investigate further and change soon	5	50.0	8	80.0
High	4	Investigate and change immediately	5	50.0	-	-

The above Table reveals that none of the worker was at negligible and low risk level among stitching workers using conventional chair. In half of the workers studied (50 per cent), RULA Grand Score was between 5, 6 and 7 indicating that the level of exposure to musculoskeletal risks was high and ergonomics intervention to decrease exposure level seemed essential (action level 3 and 4).

The findings of workers using ergonomically designed chair showed that none of the worker was at negligible and high risk level. In 20 per cent of the workers studied, RULA Grand Score was between 3 and 4 indicating that the level of exposure to musculoskeletal risks was high and ergonomics intervention to decrease exposure level is needed (action level 2). In 80 per cent of the workers studied, RULA Grand Score was between 5 and 6 indicating that the level of exposure to musculoskeletal risks was high and ergonomics intervention to decrease exposure level seemed essential (action level 3). The finding thus showed that there was low and medium risk level because the new workstation had the provision of backrest with cushion facility.

- **Process wise distribution of RULA score**

Table 62 shows the process wise distribution of RULA score using ergonomic chair.

Table 62: Process wise Distribution of RULA Score

Conventional chair			Ergonomic chair		
No.(10)	Score	%	No.(10)	Score	%
-	4	-	2	4	20.0
2	5	20.0	6	5	60.0
3	6	30.0	2	6	20.0
5	7	50.0	-	7	-

‘t’ test was used to compare conventional chair with ergonomic chair in terms of RULA scores and it is presented in Table 63.

Table 63: Comparison of total RULA Scores of stitching workers

Variables	Conventional chair	Ergonomic chair	t - Value
Mean	6.3	5.0	3.88**
Standard Deviation	0.823	0.667	

* $p < 0.05$, ** $p < 0.01$, NS: Non-Significant

A high significant difference at one per cent level was found between conventional chair with ergonomic chair.

b. Comparison of BPD using conventional and ergonomic chair

The sewing operation is characterized by a static sitting posture, a forward inclined posture of the head and trunk and relatively uncomfortable ankle and knee angles. The sewing task includes simultaneous hand and arm movement, and the continuous operation of foot pedals. Therefore, the working posture is constrained by the eyes for visual control of the work, the hands for directing the sewing material and the feet for speedy control of the work. Poor posture of the trunk, neck and upper extremities and the monotonous repetitive movements result in a high prevalence of musculoskeletal complaints affecting the backs, necks and upper extremities among sewing machine operators (Li et al., 1995, Vihma et al., 1982 and Punnett et al., 1985).

Table 64 and Figure 21 present the comparison of mean scores of the body part discomfort of workers using conventional and ergonomic chair.

Table 64: Comparison of mean scores of the body part discomfort of workers using conventional and ergonomic chair

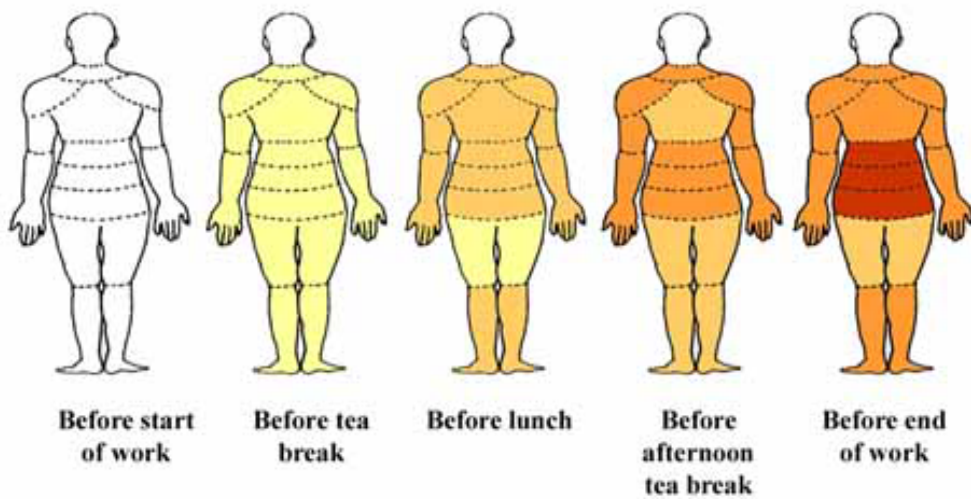
Body Parts	Mean scores of body part discomfort		t - Value
	Conventional chair	Ergonomic chair	
Neck	4.00	2.40	9.80**
Left shoulder	4.00	2.50	9.00**
Right shoulder	4.00	2.50	9.00**
Left upper arm	3.70	2.60	4.92**
Right upper arm	3.50	2.40	4.71**
Left lower arm	3.40	2.20	5.69**
Right lower arm	3.30	2.00	8.51**
Left palm	3.20	1.80	7.42**
Right palm	3.20	1.80	7.42**
Left fingers	3.20	1.80	7.42**
Right fingers	3.20	1.80	7.42**
Upper back	4.00	2.80	4.81**
Mid back	4.50	2.90	5.58**
Lower back	4.50	2.90	5.58**
Buttocks	4.40	2.70	5.53**
Left thigh	3.00	1.80	9.00**
Right thigh	3.00	1.80	9.00**
Left leg	3.40	2.60	3.86**
Right leg	3.50	2.10	7.20**
Feet	3.40	2.50	3.86**

* $p < 0.05$, ** $p < 0.01$, NS: Non-Significant

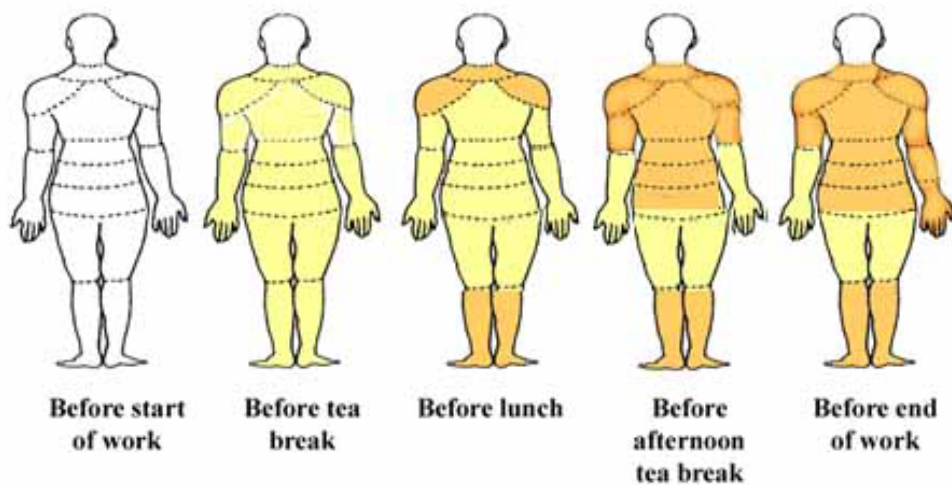
From the above Table it is clear that workers experienced extreme discomfort (mean score of 4.50, 4.40 and 4.00) in the back, buttocks, neck and shoulders while using conventional chair. It might be due to prolonged sitting without backrest provided in the chair which ultimately results in awkward posture. They also reported severe discomfort in the upper and lower arms, legs, palms and fingers.

While using ergonomic chair, workers experienced moderate discomforts in the mid back, lower back, upper back followed by arms, legs, shoulders and neck and mild discomfort in palms, fingers and thighs. When 't' test was computed between both the chairs, a high significant difference at one per cent level were observed in all the body parts.

The hypothesis 4 is rejected as there is relation between the conventional checking table and conventional stitching chair used in the garment industry and the incidence of Musculoskeletal Disorders.



a. Conventional chair



b. Ergonomic chair

Figure 22: Body part discomfort of workers using conventional and ergonomic chair

c. Comparison of heart rate using conventional and ergonomic chair

Table 65 presents the details of heart rate of ten selected workers using conventional chair and ergonomic chair.

Table 65: Comparison of heart rate workers using conventional chair and ergonomic chair

Age (yrs)	Work experience	Conventional chair			Ergonomic chair		
		Minimum (bpm)	Maximum (bpm)	Average (bpm)	Minimum (bpm)	Maximum (bpm)	Average (bpm)
28	7	91.0	105.0	96.0	80.0	106.0	92.0
24	7	86.0	111.0	94.0	81.0	99.0	90.0
37	17	88.0	117.0	101.0	83.0	111.0	97.0
18	2	79.0	104.0	90.0	75.0	97.0	86.0
27	9	82.0	99.0	91.0	77.0	101.0	88.0
21	5	93.0	103.0	98.0	86.0	103.0	95.0
20	3	82.0	99.0	90.0	79.0	99.0	87.0
31	14	80.0	109.0	96.0	76.0	101.0	88.0
16	1	75.0	91.0	82.0	73.0	84.0	79.0
36	18	89.0	119.0	102.0	82.0	107.0	93.0

It is clear from the above Table that the minimum heart rate of workers using conventional chair ranged from 75 to 93 beats/min and maximum heart rate from 91 to 119 beats/min. There was a slight decrease in the heart rate of workers using ergonomic chair. The minimum heart rate of workers using ergonomic chair ranged from 73 to 86 beats/min and maximum heart rate from 84 to 111 beats/min. The reduced heart rate observed in new workstation might be due to getting support of the upper extremities in terms of backrest with cushion facility. There was no significant impact of the two different chairs. It might be due to the adoption of sitting posture while at work which might lead to less postural stress and thereby normal heart beat.

Hence the Hypothesis 5 is rejected as there are changes in the physiological function of the heart with regards to the usage of the conventional checking table and conventional stitching chair.

d. Change in production of workers using conventional and ergonomic chair

The percentage increase in production of the ten selected stitching workers using conventional chair and ergonomic chair is presented in Table 66.

Table 66: Change in production of stitching workers

Worker	Age (years)	Number of pieces stitched per day		Change in production (%)
		Conventional chair	Ergonomic chair	
1	28	532	605	13.7
2	24	511	567	10.9
3	37	651	716	10.0
4	18	537	559	4.1
5	27	509	583	14.5
6	21	623	679	9.0
7	20	647	685	5.9
8	31	566	612	8.1
9	16	552	571	3.4
10	36	614	647	5.4

The percentage increase in production ranged from 3 to 14. Hence the productivity pattern was improved by using the ergonomic chair.

Ergonomic interventions for workers

a. Awareness programme

Two different awareness programmes were planned and conducted to create general awareness among public and special awareness for workers specially in their workplace. Participants gained knowledge in the area of concern such as labour laws related to textile workers, occupational health hazards and its prevention, meaning and importance of ergonomics in textile industry, importance of nutritious diet, causes and remedial measures of mental stress and need for personal protective equipment.

b. Promoting use of personal protective equipment (PPE)

From our earlier observation and assessment, it was found that the workers had lung problems, injuries such as cuts, needle piercing, cornification and hearing disability. All the workers employed in one government industry were promoted with PPE such as face masks, thimbles, cotton linear gloves and ear plugs. They were asked to use PPE continuously during working time. Plate 16 presents the workers using the personal protective equipment (PPE).



Non use of mask



Promoting use of mask



Non use of thimbles



Promoting use of thimbles



Non use of cotton liners (gloves)



Promoting use of cotton liners (gloves)

Plate 16: Garment Workers using Personal Protective Equipments

c. Introducing ergonomically designed furniture

1. Ergonomic table

The modified ergonomic table for checking workers was promoted to the same garment industry (Plate 17).

d. Ergonomic chair

Ten ergonomic chairs for stitching workers designed and evaluated were promoted to the same garment industry. The workers readily accepted both the ergonomic furniture due to its convenience.



Plate 17: Ergonomic Interventions