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Ergonomic assessment of the work environment of food processing enterprises in Punjab

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Abstract
A number of environmental factors like noise, temperature, light and relative humidity influence the work in the food processing enterprises. Workstation dimension also affect the health and well being of workers engaged in the enterprises. Present study was planned to assess the environmental factors of the food processing enterprises. Objectives of the present study were to study the location and dimension of workplace in food processing enterprises as well as to study the environmental conditions of the food processing enterprises. Six micro, three small and two medium scale food processing enterprises were selected for the study and from each type enterprises, 50 respondents were selected making a total of 150 respondents. Major finding of the study was that the light intensity in all type of enterprises was less than the recommended value. The workstation dimensions were also not in accordance with the recommendations. Therefore there was a great need of modification and improvement in the environment of food processing enterprises.

Keywords: Environment, ergonomic assessment, food processing enterprises, workstation dimension, workplace

Introduction
Food processing enterprises places the workers in varying temperature like excessive cold temperature for refrigeration and dealing with perishable foods in pack house and extreme hot for giving the heat treatments to the food products. Workforce engaged in various activities get occupational exposure of noise, vibration, heat stress, dust, fumes, gasses and other toxic chemicals, heavy load lifting, work posture etc. Wherever the poor working conditions exist, there are the potentials of hazards to worker's health as well as their safety. Work in industry plays a vital role in people's lives, since most workers spend at least eight hours a day in the workplace. Therefore, work environment should be safe and healthy. Unfortunately, a few employers realise and assume less accountability for the safeguard issues related to workers' health and safety. Indeed, a number of employers are still unaware that they have the moral as well as legal liability for protecting the workers (Singh 2016) [8]. Consequently, the job-related accident and diseases are recurrent throughout the globe. There is a strong need to recognize the association between workers' health and safety, the workplace, and the environment inside as well outside the workplace. In the light of above, present study was planned with the following objective:

1. To study the location and dimension of workplace in food processing enterprises
2. To study the environmental conditions of the food processing enterprises

Methodology
For conducting the ergonomic assessment, six micro, three small and two medium scale food processing enterprises were selected from Punjab. A well-structured interview schedule and worksheets were developed to record the data regarding workplace dimension and environmental conditions of the workplace. For recording temperature, humidity, light intensity and sound levels, thermometer, hygrometer, lux meter and sound level meter were used respectively. The data collection was done in the months of March to June.

Results and Discussion
The ergonomic assessment was done on the basis of physical parameters of the workplace. It includes workplace location, work counter and sitting stool's dimension and environmental conditions.

Location of workplace

Regarding location of workplace, it was observed that irrespective of type of enterprises, respondents were working in open area, shed, common hall or separate room. Table 1 shows that nearly half of the respondents were working in the common hall (51.33%) and less than half of them were working in the open area (42.66%). Shed and separate room were provided to 21.33 percent and 29.33 percent respondents respectively. In micro scale enterprises maximum number of respondents were working in shed (64.00%) and in small scale enterprises maximum number of respondents were working in open area (88.00%). Whereas, in medium scale enterprises majority of respondents were working in the common hall (90.00%). Due to difference in the work location of respondents, their environmental parameters also varied.

Table 1: Location of workplace

Location	f (%)			
	Micro Scale (n=50)	Small Scale (n=50)	Medium Scale (n=50)	Total (n=150)
Open area	20 (40.00)	44 (88.00)	0 (0.00)	64 (42.66)
Shed	32 (64.00)	0 (0.00)	0 (0.00)	32 (21.33)
Common Hall	22 (44.00)	10 (20.00)	45 (90.00)	77 (51.33)
Separate room	8 (16.00)	12 (24.00)	24 (48.00)	44 (29.33)

Dimensions of work counter

The appropriate height of workstation helps in maintaining the proper body posture and allows the work to flow effortlessly. According to Grandjean (1982) [5], for light work the work counter height for standing task should be just below the elbow level of respondents and its depth should not exceed 20 inches. According to the Punjab's anthropometric data, the standing elbow height of 5th percentile of females was 83.1 cm or 32.7 inches so the height of work counter should not exceed 83 cm (Gite and Majumder 2007) [3]. Kroemer (1989) [6] recommended that on the basis of 50th and 95th percentile of the female's/male's anthropometric data, the height of workstation should be around 27.6 inches which can vary upto 60 inches. All work counter dimensions were measured with the help of measuring tape. Satisfaction level of respondents about various dimensions was also assessed on three point scale in which 1 denoted not satisfied, 2 denoted satisfied and 3 denoted highly satisfied from the work counter. Table 2 depicts the height, width and depth of the work counter and perception of respondents about the dimension of work counter. The width and depth of work counter in micro scale enterprises were 68.20 inches and 30.20 inches respectively (no height due to working at floor level). In small scale enterprises height, width and depth were 36.66 inches, 96.34 inches and 39.67 inches respectively. In medium scale enterprises height, width and depth of the enterprises were 41.75 inches, 380.00 inches and 35.00 inches respectively. On the basis of Punjab's anthropometric data the height of workstation in small as well as medium scale enterprises was higher but in micro scale enterprises respondents were working on ground so there was no work counter height. Inappropriate height of work counter may cause discomfort in the spine and shoulders if left unattended.

On the basis of satisfaction of the respondents about height of the work counter, it was found that in micro scale enterprises, respondents were not satisfied (mean score-1.00) and in small (mean score-2.04) and medium scale (mean score-2.14) enterprises respondents were satisfied with the height of work counter. Regarding width of the work counter, respondents of micro (mean score-2.38) and medium scale (mean score-2.00) enterprises were satisfied with it but the satisfaction level of respondents of small scale enterprises (mean score-1.82) was on the lower side. Respondents of all the three type of enterprises were satisfied with the depth of work counter.

Grandjean (1982) [5] recommended the maximum counter depth as 20 inches but in all the enterprises it was much high than recommendation due to which workers had to extend their body to reach the materials which may cause discomfort. But on contrary, it was observed respondents of all the enterprises were satisfied with the depth of work counter which may be due to the habit formation by working in a difficult condition for long duration.

Table 2: Work counter dimensions in micro, small and medium scale enterprises

Parameters (Inches)	Recorded dimension, Mean ± SD			Respondent's satisfaction level about dimension*(1/2/3), Mean score		
	Micro Scale (n=6)	Small Scale (n=3)	Medium Scale (n=2)	Micro Scale (n=50)	Small Scale (n=50)	Medium Scale (n=50)
Height	0.00	36.66±4.19	41.75±0.35	1.00	2.04	2.14
Width	68.20±3.11	96.34±2.25	380.00±2.83	2.38	1.82	2.00
Depth	30.20±1.78	39.67±1.15	35.00 ± 0.71	2.26	2.14	2.36

*****Note: 1= Not satisfied, 2= Satisfied, 3=Highly satisfied

Dimension of sitting stools

Sitting stool was used in only micro and small scale enterprises and not in medium scale enterprises. Respondents in medium scale enterprises were working in standing posture. In small scale enterprises, respondents did not prefer to work on the work counter due to insufficient light and uncomfortable height of work counter. They used to take the materials outside the working area and worked in natural light by sitting on a low rise sitting stool. In medium scale enterprises all the respondents were working in standing position but sometimes they sit on storage cans to take rest. The dimensions of different type of sitting stools used by respondents in micro and small scale enterprises were measured with the help of measuring tape and are presented in table 3. Three type of sitting stool were observed in the micro and small scale enterprises viz. S1, S2 and S3 (Fig 1). S1 was the wooden rectangular sitting stool having the average dimension of 28.50 cm length, 15.34 cm breadth and 6.17 cm height. S2 was the square shaped plastic sitting stool with the average dimension of 28.00 cm length and breadth and 23.00 cm height. S3 was the circular shaped plastic sitting stool with the average height of 12.12 cm and average diameter of 30.75 cm.

Table 3: Dimension of the sitting stools used by the respondents in micro and small scale enterprises

Sitting stool Dimension (cm)	Mean ± SD		
	S1	S2	S3
Length, l	28.50 ± 0.5	28.00 ± 0.7	--
Breadth, b	15.34 ± 0.76	28.00 ± 0.7	--
Height, h	6.17 ± 0.58	23.00 ± 1.4	12.12 ± 0.63
Diameter, d	--	--	30.75 ± 0.95

Note: S1= Rectangular wooden sitting stool; S2= Square plastic sitting stool; S3= circular plastic sitting stool

Fig 1: Different types of sitting stools used by the workers in micro and small scale enterprises

Environmental conditions at workplace

Temperature, humidity, sound level and light intensity were the environmental components considered for the study. Table 4 portrays the details pertaining to environmental conditions of the food processing enterprises in the month of March to June. It was found that micro, small and medium scale enterprises were having the average light intensity of 117.60 lux, 164.00 lux and 295.50 lux respectively which was found less than the recommended value for food processing units which is 375 lux (Gandotra *et al.* 2013) [2]. Poor lighting produces stress on the eyesight and to get proper vision, workers automatically bend their neck forward which may lead to discomfort at the cervical region.

The comfortable sound level is 30 to 60 dB and it should not increase 90 dB as it may create hearing problems if continued for the duration of 8 hours or more (Aggarwal 2001) [1]. Results revealed that both micro (67.88 dB) and small scale (76.93 dB) enterprises were having the safe sound levels but medium scale enterprises were having higher sound level (95.00 dB). The main reason of which may be due to machines used in the enterprises like slitter, churner, conveyor and vehicle for transportation. According to Malagie *et al.* (2012) [7] the noise dose of 96 dB if left untreated may lead to noise induced hearing loss if continued for long period. Therefore high noise level in medium scale enterprises was a major issue which need to be addressed at the earliest.

According to Singh (2016) [8] the comfortable temperature range for workers in industries is 20 ^{0}C to 29 ^{0}C. Results in Table 4 further depicts that the temperature of micro scale enterprises (31.6 ^{0}C) was above the higher limit whereas of small (27.33 ^{0}C) and medium scale enterprises (20.50 ^{0}C) were within the recommended limit of comfortable temperature range. In micro scale enterprises, the work was generally done in shed so the temperature increased due to the presence of asbestos or metallic sheet used as shed. In small scale enterprises, the work was done in open area under the shade of either cemented roof or trees so the temperature was somewhat controlled. Whereas in medium scale enterprises, work was done in closed room with air conditioners on so the temperature was controlled according to requirement. Malagie *et al.* 2012 [7] also found that sometimes workers in food processing enterprises had to work in the big freezing rooms at a temperature of around -18 ^{0}C or even less so protective clothing is very much required to protect from freezing temperature.

According to Gandotra *et al.* (2013) [2], comfortable relative humidity level in summer for Indian climate is 40-60 per cent but all the enterprises except small scale were having the higher humidity levels. Table 4 depicts that highest humidity was recorded in medium scale enterprises (78.25%) followed by micro scale (67.80%) and small scale enterprises (56.27%). The reason for difference in humidity may be due to the difference in the type of work location and the difference of work being performed in all the three type of enterprises. Micro and small scale enterprises were dealing with preparation of preserved products like making jam, jellies, squashes, sauce and pickles using heat. Whereas, medium scale enterprises were dealing with the cold processing in which they had to deal with the frozen products only and they take raw materials from ice chilled conditions. Moreover, the storage of processed food was done in refrigerated rooms due to which temperature was very low and humidity was very high.

Gomes *et al.* (2002) [4] also measured the thermal stress, relative humidity, ventilation, illumination and noise levels at different foundry and soft drink bottling factory. They found that thermal stress and noise levels were high (exceeding 90 dB), while relative humidity, ventilation, illumination were low at foundry as compared to bottling plant.

Table 4: Environmental parameters at workplace

Environmental parameters	Mean ± SD			
	Micro Scale	Small Scale	Medium Scale	Recommended
Lighting (lux)	117.60 ± 33.74	164 ± 148.71	295.50 ± 72.83	375 *
Sound level (dB)	67.88 ± 3.23	76.93 ± 4.61	95 ± 35.36	30-60 and < 90 **
Temperature (^{0}C)	31.6 ± 1.67	27.33 ± 8.38	20.50 ± 0.71	20-29 ***
Humidity (%)	67.8 ± 3.70	56.27 ± 9.18	78.25 ± 0.35	40-60 ****

*&**** Gandotra *et al.* (2013) [2], ** Aggarwal (2001) [1], ***Singh (2016) [8]

Conclusions

Regarding location of workplace, it was observed that irrespective of type of enterprises, respondents were working in open area (42.66%), shed (21.33%), common hall (51.33%) or separate room (29.33%). On the basis of Punjab's anthropometric data, the height of workstation in small as well as medium scale enterprises was higher but in micro scale enterprises respondents were working on ground so there was no work counter height. It was found that micro, small and medium scale enterprises were having the average light intensity of 117.60 lux, 164.00 lux and 295.50 lux respectively which was found less than the recommended value. Both micro (67.88 dB) and small scale (76.93 dB) enterprises were having the safe sound levels but medium scale enterprises were having higher sound level (95.00 dB). The temperature of micro scale enterprises (31.6 ^{0}C) was above the higher limit whereas in small (27.33 ^{0}C) and medium scale enterprises, (20.50 ^{0}C) it was within the recommended limit. More humidity was recorded in medium scale enterprises (78.25%) followed by micro scale (67.80%) and small scale enterprises (56.27%).

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