Kaizen for the Flour Mill Workers

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ABSTRACT

Health status of flour mill workers indicated that majority of the workers had low average aerobic capacity and belonged to normal category of BMI. Respiratory symptoms and health problems related to the occupation were cough and cold, chest tightness, sputum production with flour dust, heat stress, skin itching and hearing impairment. As per the ambient temperature and relative humidity recorded in the flour mill premises, the humidex value ranged between 34 to 50 indicated that heat stress experienced by the workers was very high. Noise level recorded in the 93 per cent selected flour mills exceeded the PEL of 65 dB by 26 to 60 percent. Illumination level recorded in flour mills ranged between 80 to 90 Lux which was highly inadequate by 17 to 94 per cent in all the selected flour mills. These findings indicated a vital need to use personal protective aid for noise control and increasing illumination level in flour mill by increasing number of light source i.e. two bulb of 100 watt for 10'x 12' room. Concentration of Oxygen was adequate in all the flour mills and Carbon Monoxide and Sulphur Dioxide level was within the limit of IAQ standards (NIOSH). But Carbon Dioxide percentage (0.18%) in flour mill atmosphere exceeded the limit of IAQ standard i.e. 0.1 percent in 17 per cent flour mills. There was significant reduction in drudgery of flour mill workers (21 %) when work was performed by wearing newly developed personal protective noise and dust controlling mask and using flour presser. Dust controlling bag (DCB) was found significantly effective in reducing IFD level in flour mill by 79 percent.

Research findings revealed a vital need to increase adequate ventilation in flour mills with exhaust fan facility and use of personal protective noise and dust controlling mask by flour mill workers. Dust controlling measures such as dust controlling bag for flour outlet of mill and use of flour presser for reducing frequency of bending posture should be promoted.

Key words: BMI, humidex, drudgery, Illumination level, posture

INTRODUCTION

Indoor air pollution is a major problem in developing countries, and is increasing more and more due to rapid industrialization and ineffective pollution control measures. It has increased due to lack of public awareness of the impact of indoor air pollution on human health. Flour mills produce a large amount of flour dust. On an average flour mill workers are exposed to the workplace environment for 8-10 h a day and there are no provisions for minimization of the dust produced in the flour mills In India, Poor ventilation is a basic problem in flour mills throughout the country. Flour dust accumulates in the workplace environment because of poor ventilation; hence workers get exposed to excessive amount of flour dust. Long term continuous exposure of workers to fine dust leads to pulmonary and respiratory diseases [2]. The work environment seriously influences the organism of exposed humans. The workers of

agriculture industry are highly exposed to harmful factors in their work environment, such as dust, unfavorable microclimatic condition, excessive noise and insufficient light. Dust is treated as the most influential agent, and perceived as a frequent cause of the respiratory system illnesses. Occupational respiratory diseases are usually caused by extended exposure to irritating or toxic substances that may cause acute or chronic respiratory ailments, although severe single exposures can cause chronic lung disease as well. The occupationally related lung diseases are most likely due to the deposition of dust in the lung and air influenced by the sort of dusts, the period of exposure, the concentration and size of airborne dust in the breathing zone.

Many industries, including flour mills, generate dust, which is released into the air and later inhaled during industrial processes, such as cleaning, crumbling of the product, packaging and shipping. Flour dust has a varied composition, including particles of husk, cuticular hairs, pollen, starch grains, bacteria, mucous spore, and particles of mineral origin (free silica). It may also contain a large number of contaminants, including fungi and their metabolites (aflatoxin), insects, mites, mammalian debris, and various chemical additives, e. g, pesticides and herbicides [1].

Considering flour mill workers work related environmental problems, it was felt that there is need to decrease the environmental problems of flour mill workers. Prior to this solution the existing condition also need to be studied and therefore this study has been planned with the objectives given below.

1. To study environmental problems faced by flour mill workers while working in flour mills.
2. To study prevalence of work related health hazards in workers exposed to organic dust in flour mill.
3. To estimate the physiological cost of workers while performing work in flour mill.

METHODOLOGY

Ergonomic evaluation of selected enterprise activity

Healthy, non smoking 30 flour mill workers working at flour mill for 4-8 hrs/ day and 6 days/ week and having minimum five years experience of work in flour mill were selected for the study.

Fig 1: **MKV Kaizen for Flour mill**

Mode of data collection

No. of women workers: 16

No. of men workers: 14

Field trials/Replications: 03

No. of activities: 01

No. of methods: 02

No. and name of technologies designed and developed:

1. Personal protective noise and dust controlling mask
2. Dust controlling bag (DCB)
3. Flour presser

A structured questionnaire was used to collect anthropometric data and information about health problems of workers and environmental data of flour mills. Pulmonary function test (PFT) of flour mill workers was carried out by trained technician at Dr. Shankarrao Chavan Government Medical College, Nanded by using electronic Spirometer. Heat stress reference chart was used for calculating humidex values.

Measurement of Parameters

Average working Heart Rates (b.m^{-1}) (AWHR): Working heart rate was recorded with the help of heart rate monitor, six times at every three minutes till the completion of activity.

Average peak heart rate (b.m^{-1}) (APHR): was noted down while performing the activity.

a) Average & peak energy expenditure (kj.m^{-1}) (AEE & APEE) was calculated by using following formula.

EE (kj.m^{-1}) = 0.159 X Heart rate (b.m-^{1}) -8.72

b) Total cardiac cost of work (TCCW) (b.m^{-1}) TCCW was calculated by using the following formula

TCCW = Cardiac cost of work + Cardiac cost of recovery

where,

Cardiac cost of work = (Average working heart rate – Average resting heart rate) X Duration

Cardiac cost of recovery = (Average recovery heart rate – Average resting heart rate) X duration

c) Physiological cost of work (PCW) (Beats) was calculated by following formula

PCW = TCCW / Total time of work.

d) RPE (Rated perceived exertion) was measured on five point scale viz. very light (1), light (2), moderately light (3), heavy (4), very heavy (5).

FINDINGS

Physical characteristics and health status of the flour mill workers

Table 1 indicates that total sample size of flour mill workers (n=30) comprised of 14 men (46.6 %) and 16 women (53.3%). Mean age of the male flour mill workers was 45 yrs and that of female flour mill workers was 39 yrs. Mean body weight of male workers was 60 kg and that of women was 52 kg. Body mass index (BMI) & VO_2 max of female workers was higher (24 BMI & 29 VO_2 max ml/kg/min) than male (23 BMI and 25 VO_2 max ml/kg/min). All the flour mill workers belonged to normal category of BMI and low average category of VO_2 max.

Table 1: Physical characteristics of selected flour mill worker

Physical characteristics	Flour mill workers	
	Male (n = 14) (Mean ± SD)	**Female** (n =16) (Mean ± SD)
Age (yrs)	45 ± 10	39 ± 8
Height (cm)	159 ± 8	148 ± 5
Weight(kg)	60 ± 10	52 ± 12
BMI	23 ± 3.45	25 ± 5.67
VO_2 Max (ml/kg/min)	25.08 ± 5.38	29.47 + 5.64

Prevalence of respiratory symptoms and health problems reported by flour mill workers

Majority of the flour mill workers reported prevalence of respiratory symptoms such as cough and cold (12 to 21%) followed by difficulty in breathing (12 to 14 %). Feeling of chest tightness was reported by 25 per cent women and 14 per cent men workers. Two women workers complained about sputum production with pellets of flour dust. The overall mean values of the lung function parameters were found to be decreased in comparison with predicted values. Out of total 12 flour mill workers, 4 (33.33 %) workers were advised to undergo further PFT test. It indicated that flour dust adversely affects pulmonary function parameters of the flour mill workers. Irrespective of gender, about 80 percent flour mill workers reported body pain after performing activities in flour mill; it was followed by feeling of heat stress (25 to 35 %). About 6 percent flour mill workers had difficulty with hearing. Eye irritation, hair dandruff, skin itching & headache were the occupational health problems reported by flour mill workers.

Assessment of environmental parameters in selected flour mills

As per the table 2, ambient temperature and relative humidity recorded in flour mill ranged

between 25° to 34°c and to 51-69 percent respectively. As per the heat stress reference chart highest humidex value recorded was 50 followed by 41 and 34. At the value 50, humidex is hazardous to continue physical activity. Extra water and adequate ventilation with exhaust fan facility is the action required for combat heat stress. Average noise level in 93 per cent selected flour mills ranged between 79 to 82 dB which was exceeding above PEL (26-60%). Illumination level recorded in flour mills ranged between 80 to 90 lux which was highly inadequate (17 to 94 %) in 100 per cent flour mills. These findings indicate a vital need to use personal protective aids for noise control and increasing illumination level in flour mill by increasing number of light fixtures i.e. two bulbs of 100 watt for 10x 12' room.

Measurement of O_2, CO_2, CO and SO_2 concentrations in selected flour mill workstations is depicted in table 6. Values showed that concentration of oxygen was adequate in all the flour mills and carbon monoxide and sulphur dioxide level was within the limit of IAQ standards (NIOSH). But carbon dioxide percentage (0.18%) in flour mill atmosphere was exceeding limit of IAQ standard i.e. 0.1 percent in 17 per cent flour mills.

Postural analysis of flour mill workers while performing flour pressing activity

Postural analysis of flour mill workers is revealed that when newly designed flour presser was used for flour pressing, angle of deviation at elbow and lumbar joint was reduced significantly. There was no significant change at shoulder joint.

Inhalable Flour dust (IFD) measurement in workers' breathing zone

Table 3 indicates IFD level in workers breathing zone. It is clear that majority of flour mills (62%) exceeded PEL [10 mg/m^2 (8-h TWA)]. There was significant reduction in the IFD level (14-96%), when dust controlling bag (DCB) was used for outlet of flour mill.

Ergonomic evaluation of flour mill workers

Average working heart rate in traditional method was recorded as 98 $beats.min^{-1}$ which was reduced in case of improved method by 5 $beats.min^{-1}$. The trend was true in case of peak heart rate, energy expenditure and peak energy expenditure. Statistically significant reduction was found in average total cardiac cost of work (TCCW) and physiological cost of work (PCW) when work was performed by improved method. Rated perceived exertion (RPE) of flour mill worker was reduced by 24 per cent when work was performed by using developed technologies. Results indicate that improved method i.e. use of noise and dust controlling mask, flour presser and dust controlling bag were effective in reducing physiological cost of work of flour mill worker.

Table 3: Inhalable Flour dust (IFD) measurement in workers' breathing zone

IFD level in comparison with PEL		IFD level		't' Value	Reduction of IFD level due to newly developed technology DCB
Flour mills within PEL	**Flour mills exceeding PEL**	**Air Sample without DCB** (Mean ± SD)	**Air Sample with DCB** (Mean ± SD)		
10(37)	17(62)	13.75±8.71	6.77±4.92	3.63**	14-96%
					N = 27

DCB: Dust controlling bag for flour outlet, Figures in parenthesis indicates percentages

IFD: Inhalable Flour Dust PEL for IFD**:** 10 mg/m^3 (8- h TWA)

** Significant at 1% level

Table 2: Assessment of environmental parameters in selected flour mills

Sr. No.	Environmental parameters	Measurement time (Mean±SD)			Min.	Max.	Comparison with PEL	Action Required
		10-11 am	**2-3 pm**	**6-7 pm**				
1.	Temperature C^O	25±5.41	34±3.32	26+2.53	20	42		1. At value of 30 Humidex, warn for symptoms of heat stress and extra water 2. At value of 50 Humidex, it is hazardous to continue physical activity 3. Adequate ventilation and exhaust fan facility
2.	Relative Humidity (%)	58±8.42	51±11.83	69±11.38	41	89		
3.	Humidex*	30	41	34	30	50		
4.	Noise level (dB) PEL for noise = 65dB	82.33±1.52	82.4±5.68	79.21±11.44	48	104	26-60 % Excess level in 93 % flour mills	Use of personal protective aid for noise control
5.	Illumination level(lux) BOIS for illumination level = 200 lux for general lighting	80.5±41.7	90.50±40.46	82.08±52.65	11	165	17-94 % inadequacy in 100% flour mills	No. of lighting fixtures should be increased
								N= 27

* Heat stress reference chart

Table 4: Measurement of O_2, CO_2, CO and SO_2 concentrations in selected flour mill workstations

Sr. No.	Name of the gas analyzed	Concentration of Gas		Mean ±SD	NIOSH recommendations for IAQ	Comparison with recommendations for IAQ	Action Required
		Min.	**Max.**				
1.	Oxygen (%)	20.4	30.8	20.72±4.32	19.5	Adequate	--
2.	Carbon dioxide (%)	0.02	0.39	0.18 ± 0.11	0.1	Concentration exceeds limit of IAQ standards	Adequate Ventilation and exhaust fan facility
3.	Carbon monoxide (PPM)	1	22	0.5 ± 0.50	25	Within limit of IAQ standards	--
4.	Sulphur dioxide (PPM)	000	0.1	0.02 ± 0.20	3	Within limit of IAQ standards	--

IAQ: Indoor air quality

Table 5: Ergonomic evaluation of flour mill workers while performing flour mill activities

Sr. No.	Physiological parameters	Traditional method (mean ± SD)	Improved Method (mean ± SD)	Significant reduction in Improved over traditional	't' test
1.	Average working heart rate (beats.min^{-1})	98±10	93±10	5(5.10)	NS
2.	Average peak heart rate (beats.min^{-1}	111±14	104±10	7(6.30)	2.22*
3.	Average energy expenditure (kj.min^{-1})	6.78±1.67	6.10±1.54	0.68(10.02)	NS
4.	Average peak energy expenditure (kj.min^{-1})	8.97±2.18	7.78±1.64	1.19(13.26)	2.04*
5.	Average TCCW(beats)	989±417	778±336	211(21.33)	2.15*
6.	Average PCW (beats)	19±7	15±5	4(21.05)	2.54*
7.	Average RPE	2.73±1.48	2.06±1.33	0.67(24.54)	NS
					N=30

Improved Method= Use of noise and dust controlling mask, flour presser, dust controlling bag and handling lower load *Significant at 5% level, Figures in parenthesis indicates percentages

CONCLUSION

It can be concluded from the data that health status of selected flour mill workers in terms of BMI was normal but aerobic capacity was low average. More respiratory symptoms were reported by flour mill workers than other health problems. PFT test of flour mill workers revealed that values of lung function parameters were reduced in comparison with predicted values. About 26 to 60 per cent noise pollution was recorded in the selected flour mills and mean inadequacy level of light in flour mill was 59 per cent. Concentration of CO2 in air was exceeding PEL in 17 per cent mills. There was significant reduction in drudgery of flour mill workers when work was performed by wearing newly developed personal protective noise and dust controlling mask and using flour presser. Dust controlling bag (DCB) was found significantly effective in reducing IFD level in flour mill by 79 percent.

Research findings reveal that there is vital need to increase adequate ventilation in flour mills with exhaust fan facility and use of personal protective noise and dust controlling mask by flour mill workers. Dust controlling measures such as dust controlling bag for flour outlet of mill and use of flour presser for reducing frequency of bending posture should be promoted.

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