

Work-related musculoskeletal disorders: A case study among male molasses workers in Nadia district of West Bengal, India

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ABSTRACT


Background: Molasses making is one of the most agro-based sectors in India where about 4.50 core rural people are involved in the sugarcane cultivation and 5 lakh are directly engaged in the small-scale industries. The workers are prone to different health problems, but the effect has rarely been evaluated. **Objectives:** The aim of this study is to identify the musculoskeletal disorders of the molasses making workers and its association with age, experience, education, and addiction to smoking and alcohol. **Materials and Methods:** Working postures are analyzed by Ovako Working Posture Analysis System method. A modified Nordic questionnaire is used to survey the workers' work-related musculoskeletal disorders (WMSDs), job details, and socioeconomic status. Statistical tests, namely, mean, standard deviation, odds ratio (OR), and 95% confidence interval (95% CI) are computed to analyze the data. **Results:** Due to poor working postures, a large number of workers are suffering from lower back and shoulder pain. Strong associations are observed between upper back pain with the age group of 31-45 years (OR 2.03, 95% CI [0.84, 4.91]) and illiterate (OR 2.06, 95% CI [0.90, 4.71]) workers. High ORs for musculoskeletal disorders are found among experienced and non-addicted workers. **Conclusions:** Definite pattern of risk factors can be obtained by including workplace stress and strain in the study. Awareness and educational campaign about the wrong working postures and WMSDs will help to reduce the risk factors.

KEY WORDS: Work-related Musculoskeletal Disorders; Molasses Workers; Ovako Working Posture Analysis System, Odd Ratio

INTRODUCTION

India is placed at the 2nd position in the for sugar production. It is one of the most agro-based sectors which generate employment and income to the rural areas of the country. About 28 million tonnes of sugar are produced per year by 530 registered sugar factories, and hence, India emerges as a 2nd largest agricultural-based industry.^[1] More than

4.50 core rural farmers are involved in the sugarcane cultivation and 5 lakh local village people are directly engaged in this industry.^[2] In India, 65-70% sugarcane is used to manufacturing sugar, whereas 30-35% are used to producing molasses and Khandsari. Sugar industry produces nearly 65,000 tones molasses as a by-product which is used for alcohol and ethanol production. In addition to these organized sugar factories, thousands of rural people are engaged in the molasses-making activities through unorganized small cottage-based factories. Most of these locally molasses making factories are in private hands and to combat with the cost of production, they use workforce from rural areas. Locally, molasses-making process has different steps, namely, carrying of sugarcanes, grinding, taking out impurities, boiling of juice, mixing and stirring, and carrying

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to the storerooms. The whole processes are done manually by the workers and so most of them are suffering from different types of occupational health problems mainly work-related musculoskeletal disorders (WMSDs).^[3,4]

WMSDs are one of the most important causes for occupational hazards which not only affects the workers' efficiency and health conditions but also at the same time it decreases the production rates and waste millions of working hours.^[5-8] Many researchers have reported about the strong association between awkward working postures and WMSDs^[9-15] Several studies have also shown that some others factors such as age, education level, working experience, smoking, and alcohol consumption can also affect the musculoskeletal system of the workers.^[16-23] Lack of preventive measures for risk factors, prolonged working hours, poor working environment, and socioeconomic status are responsible for the poor health conditions of the workers which in turn increases the psychological stresses and leads to workplace injuries.^[24] In this study, an attempt is made to identify the occupational health hazards particularly WMSDs among rural molasses-making workers.

MATERIALS AND METHODS

Subject Selection

In West Bengal, India, all molasses-making small-scale factories are running by private hands. Only 167 male molasses workers having at least 1 year working experience are randomly selected from such 16 small-scale factories for the present study. The aims and objectives of the study are clearly explained (Layman terms) to all the participants, and written consents of the workers are also obtained.

Physical and Physiological Parameters

Anthropometric scale and weighing machine are used to measure the height and weight of the workers, respectively. Body mass index (BMI) of the molasses workers is calculated using the standard equation.^[25]

Blood pressures (systolic blood pressure or SBP and diastolic blood pressure or DBP) of the workers at resting state are taken twice by Srishti stethoscope (India) and Heine sphygmomanometer (Germany). The heart rate of the workers at resting state is also measured from the carotid artery by beats per minute count method.

Questionnaire Preparation

A slightly modified Nordic questionnaire is used in this study to survey the workers' WMSDs and job details.^[26] The survey sheet had objective type questions with multiple choice answers, and communication is made through local language.

Analysis of Working Postures

Different working cycles of the molasses-making process are observed and recorded by video recording process (Canon SX110IS, Japan). Most frequently maintained working postures are analyzed by Ovako Working Posture Analysis System (OWAS) method.^[27]

Statistical Analysis

Software MATLAB 7.0.4.365(R14) Service Pack 2 and SPSS version 3.5 are used for data analysis including mean value, standard deviation, odds ratio (OR), and 95% confidence interval (95% CI).

RESULTS

Physical characteristics with job details of molasses workers are presented in Table 1. The age of the workers ranges from 15 to 75 years. Most of the workers have normal BMI, blood pressures, and heart rate. The working experience of these workers is ranges from 1 to 55 years with the average working duration of 11 h/day with almost an hour break. Most of these molasses workers have meet accidents during their working life and felt very tired after day long hard work.

Most common molasses working posture codes for carrying of sugar canes (P1), grinding (P2), filtering the juice (P3), boiling (P4), mixing of ingredients (P5), and storing (P6), respectively, are shown in Table 2. It is found that all frequently maintained working postures are harmful for the musculoskeletal system according to the OWAS.













Workers are suffering from WMSDs in different body parts after day long hard work. Percent distribution of affected

Table 1: Physical parameters and job details of the molasses workers

Parameters	Results (n=167)
Age (year)	36.5±14.1
Weight (kg)	54.9±10.3
Height (m)	1.62±0.07
BMI	20.9±3.5
<18.5	43 (25.7)
18.5-24.9	106 (63.5)
>24.9	18 (10.8)
Working experience (year)	17.9±13.9
Working hours/day	10.9±2.6
Feeling tired	146 (87.4%)
Blood pressure (mm/Hg)	
SBP	130.7±18.3
DBP	81.1±10.6
Heart rate (bpm)	80.7±11.4

BMI: Body mass index

Table 2: Frequently maintain working postures with OWAS action category of molasses making workers

Picture	Stick diagram and OWAS AC	Picture	Stick diagram and OWAS AC
 P1	 4273=4	 P4	 4142=4
 P2	 3151=4	 P5	 4152=4
 P3	 4141=4	 P6	 2173=3

OWAS: Ovako Working Posture Analysis System

body parts of the workers is illustrated in Figure 1. It is seen that the most affected body parts of the molasses workers are lower back and shoulder.

Illiteracy rate (34.7%) is found very high among these workers, and only 11.4% of workers have completed their secondary level of education. Almost all these molasses workers are non-vegetarian, and 72.5% are addicted to smoking, whereas 55.1% are found alcoholic. The association between WMSDs with various factors such as age, education, experience, and addictions is observed and presented in the Tables 3 and 4. It is seen that most affected body part of the molasses workers is lower back irrespective of age, educational, experience, and addiction factors. It is observed that workers of 15-30 years of age group are found less affected from WMSDs compared to age group of 31-45 and >45 years. Strong associations are observed between the age group of 31 and 45 with upper back pain (OR 2.03, 95% CI [0.84, 4.91]) and also between the age group >45 years with ankle pain (OR 2.38, 95% CI [0.64, 8.81]). It is interesting to note that workers above primary level of education (others) have almost no WMSD risks.

Molasses workers with 6-15 years working experience comparatively show lower risk to WMSDs, whereas workers with >25 years of working experience have the highest risks of WMSDs. High risk for ankle (OR 2.61, 95% CI [0.70, 9.71]), elbow (OR 1.95, 95% CI [0.94, 4.03]), and wrists (OR 1.77, 95% CI [0.58, 5.39]) are also found among the most experienced workers (>25 years). Workers, who are not

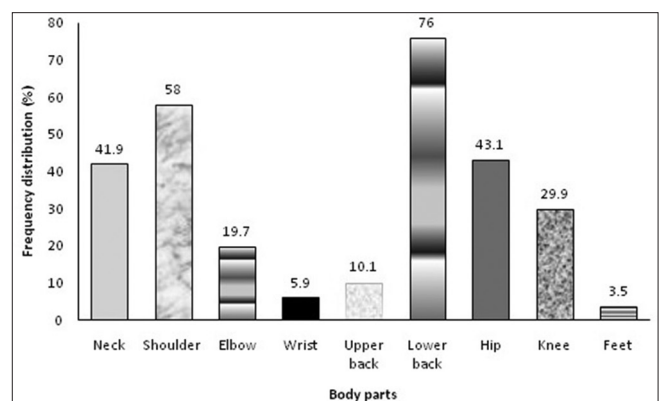


Figure 1: Frequency distribution of different body parts discomfortability

addicted to smoking and alcohol, are reported to have a more WMSD risk.

DISCUSSION

Lower socioeconomic class people of the local areas are directly engaged in molasses-making activity and exposed various types of hazardous working conditions every day. Instead of about 11 h of strenuous work which is more than the recommended working hours (The Factories Act, 1948).^[28] They do not get sufficient calories to fulfill their nutritional budget, and hence, 25.7% of workers are suffering from underweight or malnutrition problems. In this study, we have found that more than 72% of workers are smoker

Table 3: Association of WMSDs with age and education among molasses workers

Body parts	n (%)	OR	95% CI	n (%)	OR	95% CI
Age group 15-30 (n=70)				Illiterate (n=58)		
Neck	22 (31.4)	0.63	0.35, 1.14	26 (44.8)	1.12	0.61, 2.05
Shoulder	40 (57.1)	0.93	0.53, 1.65	38 (65.5)	1.33	0.71, 2.49
Elbow	10 (11.4)	0.50	0.22, 1.15	17 (29.3)	1.62	0.82, 3.19
Wrists/ hands	02 (02.8)	0.41	0.09, 1.93	05 (08.6)	1.33	0.44, 4.02
Upper back	02 (02.8)	0.25	0.05, 1.15	11 (18.9)	2.06	0.90, 4.71
Lower back	46 (65.7)	0.64	0.35, 1.17	48 (82.7)	1.61	0.74, 3.46
Hips/thighs	27 (38.5)	0.82	0.46, 1.46	22 (37.9)	0.80	0.43, 1.48
Knees	15 (21.4)	0.65	0.33, 1.20	20 (34.4)	1.26	0.67, 2.39
Ankle/feet	02 (02.8)	0.78	0.15, 4.00	03 (05.1)	1.46	0.35, 6.05
Age group 31-45 (n=48)				Primary (n=27)		
Neck	27 (56.2)	1.78	0.93, 3.40	16 (59.2)	2.01	0.88, 4.60
Shoulder	31 (64.5)	1.28	0.65, 2.50	18 (66.6)	1.40	0.59, 3.31
Elbow	08 (20.8)	1.02	0.46, 2.27	08 (29.6)	1.64	0.66, 4.08
Wrists/ hands	05 (10.4)	1.64	0.54, 5.00	02 (07.4)	1.13	0.23, 5.42
Upper back	09 (18.7)	2.03	0.84, 4.91	02 (07.4)	0.70	0.15, 3.24
Lower back	41 (85.4)	1.96	0.82, 4.71	19 (70.3)	0.79	0.32, 1.95
Hips/thighs	27 (56.2)	1.78	0.92, 3.42	13 (48.1)	1.22	0.54, 2.76
Knees	15 (31.2)	1.09	0.54, 2.19	07 (25.9)	0.84	0.33, 2.12
Ankle/feet	0	-	-	02 (07.4)	2.14	0.41, 11.23
Age group >45 (n=49)				Others (n=82)		
Neck	21 (42.8)	1.03	0.54, 1.97	28 (34.1)	0.72	0.41, 1.25
Shoulder	27 (55.1)	0.86	0.45, 1.64	42 (51.2)	0.74	0.43, 1.26
Elbow	16 (32.6)	1.89	0.93, 3.84	09 (10.9)	0.48	0.22, 1.06
Wrists/ hands	04 (08.1)	1.26	0.38, 4.14	04 (4.88)	0.73	0.22, 2.36
Upper back	06 (12.2)	1.23	0.45, 3.31	04 (4.88)	0.45	0.15, 1.39
Lower back	38 (77.5)	1.16	0.54, 2.47	58 (70.7)	0.81	0.45, 1.46
Hips/thighs	18 (36.7)	0.76	0.39, 1.47	37 (45.12)	1.08	0.64, 1.84
Knees	19 (38.7)	1.52	0.78, 2.96	22 (26.83)	0.88	0.49, 1.59
Ankle/feet	04 (08.1)	2.38	0.64, 8.81	01 (1.22)	0.33	0.04, 2.79

WMSDs: Work-related musculoskeletal disorders, CI: Confidence interval, OR: Odds ratio

and 55% are alcoholic to get relief from excessive workload, heavy physical, and psychological stresses of day-long work. Azagba and Sharaf have reported that the job stress has significant positive impact on smoking and alcohol consumption among the workers.^[29]

Molasses-making workers maintain different types of awkward working postures during their prolonged working hours. Due to bent and twisted back position, squatting with knees bent leg postures and load handled more than 20 kg make most of the postures hazardous to the musculoskeletal system. All frequently maintained molasses-making postures have an extreme harmful effect on the musculoskeletal system of the workers, and corrective measures should be taken immediately.

Several studies have reported that wrong working postures during prolonged work can cause WMSDs among the

workers.^[30-32] Lower back pain can be occurred due to repetitive forward bending and twisting of the back position which exerts compressive pressures on the lower vertebra and its surrounding back muscles.^[33-36] The present study is also shown that 76% of workers are suffering from lower back pain due to prolong maintain of bent and twisted back postures. It is also observed that, due to prolonged maintain of poor working postures, a large number of workers are suffering from shoulder and hips or thighs pain, followed by neck, knees, elbow, upper back, wrist, and feet or ankle discomfortability.

Many researchers have shown that the risk of WMSDs increases with age of the workers.^[37,38] In this study, it is observed that workers among 15-30 years age group are found less affected from WMSDs compared to higher age groups of workers. It is interesting to observe that workers with higher education levels (secondary and tertiary) are

Table 4: Association of WMSDs with experience and addiction among the workers

Body parts	n (%)	OR	95% CI	n (%)	OR	95% CI
1-5 years (n=38)				Smokers (n=121)		
Neck	15 (39.4)	0.90	0.44, 1.85	49 (40.4)	0.94	0.58, 1.51
Shoulder	27 (71.0)	1.72	0.80, 3.71	71 (58.6)	0.99	0.62, 1.60
Elbow	04 (10.5)	0.46	0.15, 1.38	24 (19.8)	0.97	0.54, 1.7
Wrists/hands	01 (02.6)	0.38	0.04, 3.06	10 (08.2)	1.27	0.52, 3.11
Upper back	02 (05.2)	0.49	0.10, 2.21	10 (08.2)	0.79	0.35, 1.80
Lower back	30 (78.9)	1.26	0.53, 2.96	92 (76.0)	1.06	0.61, 1.83
Hips/thighs	22 (57.8)	1.81	0.88, 3.70	51 (42.1)	0.96	0.59, 1.54
Knees	11 (28.9)	0.98	0.45, 2.13	37 (30.5)	1.06	0.63, 1.76
Ankle/feet	02 (05.2)	1.49	0.28, 7.68	04 (03.3)	0.91	0.25, 3.32
6-15 years (n=54)				Non-smokers (n=46)		
Neck	18 (33.3)	0.69	0.36, 1.31	21 (45.6)	1.16	0.60, 2.24
Shoulder	27 (50.0)	0.70	0.38, 1.30	27 (58.6)	1.00	0.51, 1.94
Elbow	10 (18.5)	0.88	0.40, 1.94	10 (21.7)	1.09	0.49, 2.40
Wrists/hands	02 (03.7)	0.54	0.11, 2.54	01 (02.1)	0.31	0.03, 2.50
Upper back	07 (12.9)	1.31	0.51, 3.36	07 (15.2)	1.58	0.61, 4.08
Lower back	37 (68.5)	0.73	0.37, 1.43	33 (71.7)	0.85	0.41, 1.77
Hips/thighs	20 (37.0)	0.77	0.41, 1.45	21 (45.6)	1.10	0.57, 2.13
Knees	12 (22.2)	0.68	0.33, 1.41	12 (26.0)	0.84	0.40, 1.77
Ankle/feet	0	-	-	02 (04.3)	1.21	0.23, 6.25
16-25 years (n=30)				Alcoholic (n=92)		
Neck	15 (50.0)	1.38	0.63, 3.01	36 (39.1)	0.89	0.52, 1.49
Shoulder	16 (53.3)	0.80	0.36, 1.75	57 (61.9)	1.14	0.68, 1.93
Elbow	05 (16.6)	0.78	0.27, 2.19	16 (17.3)	0.82	0.42, 1.58
Wrists/hands	03 (10.0)	1.57	0.41, 6.02	02 (02.1)	0.31	0.06, 1.45
Upper back	01 (03.3)	0.30	0.03, 2.37	08 (08.6)	0.84	0.34, 2.02
Lower back	23 (76.6)	1.10	0.44, 2.75	74 (80.4)	1.38	0.74, 2.57
Hips/thighs	11 (36.6)	0.76	0.34, 1.70	43 (46.7)	1.15	0.69, 1.93
Knees	08 (26.6)	0.87	0.36, 2.10	25 (27.1)	0.89	0.50, 1.58
Ankle/feet	0	-	-	01 (01.1)	0.29	0.03, 2.48
>25 years (n=45)				Non-alcoholic (n=75)		
Neck	22 (48.8)	1.32	0.68, 2.56	34 (45.3)	1.14	0.66, 1.98
Shoulder	28 (62.2)	1.15	0.58, 2.28	41 (54.6)	0.84	0.49, 1.47
Elbow	15 (33.3)	1.95	0.94, 4.03	18 (24.0)	1.23	0.64, 2.36
Wrists/hands	05 (11.1)	1.77	0.58, 5.39	09 (12.0)	1.93	0.76, 4.88
Upper back	07 (15.5)	1.62	0.62, 4.20	09 (12.0)	1.20	0.51, 2.83
Lower back	35 (77.7)	1.17	0.53, 2.57	51 (68.0)	0.71	0.39, 1.29
Hips/thighs	19 (42.2)	0.96	0.49, 1.87	29 (38.6)	0.83	0.47, 1.45
Knees	18 (40.0)	1.60	0.81, 3.17	24 (32.0)	1.13	0.62, 2.04
Ankle/feet	04 (08.8)	2.61	0.70, 9.71	05 (06.6)	1.91	0.56, 6.48

WMSDs: Work-related musculoskeletal disorders, CI: Confidence interval, OR: Odds ratio

less affected from musculoskeletal problems as this result is also supported by the previous works^[39,40] which may be due to some knowledge and awareness about the risk factors presented in the working places.

Häkkinen *et al.*^[17] have reported that new workers are more susceptible to upper limb musculoskeletal disorders,

whereas Noroozi *et al.*^[22] have shown that workers more than 10 years of working experience have a higher risk of neck and back pain. In our study, high risks of the shoulder, lower back, hips, and ankles pain are observed among the beginners, whereas the lower risk of WMSDs is also found among the workers between 6 and 15 years of working experience. Workers with >25 years working experience

have the highest risk for musculoskeletal symptoms. It may be due to the age of the workers of this group (above 40 years), and they are engaged particularly in boiling (P4) and mixing of ingredients (P5) work which requires prolonged maintain of awkward back and leg postures. Association between smoking and musculoskeletal disorders has been reported in earlier studies.^[18,19] Association between smoking and wrists, lower back, and knees is observed in our study. It is interesting to observe that alcohol addicted molasses workers have reported less musculoskeletal pain in different body parts. However, the effects of alcohol consumption on health are complex, and it is multidimensional, whereas Nelson *et al.* have reported that moderate drinkers perform better than the non-drinkers.^[41,42] Due to prolonged and heavy work with poor working conditions and awkward working postures, 87.4% of workers are reported heavy tiredness after the work. The present investigation has pointed the occupational hazard present in the molasses-making workers despite some limitations. Lack of a large number of subjects from the study area imposes limits of the data interpretation. Another limitation of the survey is that health-related data were obtained from face-to-face interview of the workers as there was no health register.

CONCLUSIONS

The present study shows that, due to prolong maintain of bent and twisted back posture and squatting with keens bent leg posture, most of the molasses workers are suffering from WMSDs. The most affected body part of the workers is lower back irrespective of age, educational, experience, and addiction factors. Higher risks for WMSDs are found among the most experienced, illiterate, non-addicted, and 31-45 years of age group workers.

Proper awareness programs and educational campaigns can reduce the workplace risk factors. A recommended work-rest scheduled^[43] with the correction of hazardous working postures should be considered to lower the risk of WMSDs. The molasses workers are prone to different health problems, but it has been rarely assessed. The result of the present work may help the policymakers to take control measures for improving the workers' health, quality of life, efficiency, and working environment.

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