

## Evaluation of the musculoskeletal problems related to Occupational health of sweet makers of West Bengal

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**Abstract:** *Objective:* The objective of the study was to evaluate work related musculoskeletal problems of the sweet-makers and to identify causative working postures leads to stress. *Background:* Informal sweet making sectors spread over the entire country. Many people are involved in the industry. However, no reports so far, as per our knowledge, are available concerning the assessment of work related musculoskeletal disorders (WMSDs) of the sweet-makers of India. *Methods:* The working postures were captured by still photography and were evaluated using Rapid Entire Body Assessment (REBA) and Rapid Upper Limb Assessment (RULA). Modified Nordic musculoskeletal disorder questionnaire was used to get information about discomfort of the workers and BPD scale was used to evaluate the degree of discomfort. *Result:* The results indicated that the working postures of the sweet-makers were very strenuous. The regions of maximum discomfort were head, neck, shoulder, wrists, upper and lower back and mild discomforts were felt at waist, knees and ankles. Although intensity of discomfort varies in workers based on their predominant working postures. *Conclusion:* The strenuous postures were associated with WMSDs of the sweet-makes, which could lead to physiological hazards and ultimately the productivity. Implementation of proper workstation is recommended for the betterment of the workers.

**Keywords:** REBA, RULA, Sweet-makers, Musculoskeletal disorder.

### Introduction

Sweet is the cuisine that is found in almost all the countries of the world, though the style of production as well as the taste varies from country to country. In Asian countries sweet dishes are very special. Indian sweets are different from other confectionery products and do not have similarities with the bakery products manufactured in other parts of the world. Sweet making sectors represent a part of the most popular works of the unorganized sector in the various states of India and other Asian countries and manufacture delicious sweet dishes and deserts. Every ethnic group has many kinds of traditional sweets made of different ingredients and those are specific to various occasions and festivals as well. A large number of workers are engaged in those unorganized sectors in India as well as in different Asian countries [1].

The workers have always to compromise with improper working postures, hazardous working environment and heavy workload. It has been documented that Indian economy is characterized

by the existence of high level of informal or unorganized labour employment. The workers in the organized sector constitute about 7% of the country's total workforce and the rest (93%) comprises of subsistence farmers, agricultural workers, fisher folk, dairy workers and those working in traditional manufacturing sectors like handlooms belong to the unorganized counterpart [2]. For the perspective of study, there is a growing interest in the subject of MSDs related to the workplace owing to increasing number of workers suffering from these disorders. It was reported by Kondo et al. (1985) that musculoskeletal pains were frequent in the various body parts of the workers engaged in bakery industries because of the postures they adopted [3]. Repetitive use of arms and hands, static posture during work and sustained standing position exerted excess load to the nervous system and somato-sensory system. These all were attributed to the manifestations of MSDs amongst the workers.

It has been reported by Windau et al. (1999) that nearly 2 millions workers are injured each year because of ergonomic hazards on the job [4]. In many countries the prevention of MSDs among the work force is considered a national priority [5]. It was reported by the National Institute for Occupational Safety and Health (NIOSH) that the low back pain is mainly induced by the inappropriate workplace [6]. It also has been observed that the discomfort increases with the advancement of age because of increasing rigidity in body parts [7]. Recent studies have demonstrated that low back disorder rates vary substantially between industries, occupations, and by job within given industries according to facilities [8]. According to Colombini and Occhipinti (2006), work-related upper limb musculoskeletal disorders (UL-WMSDs) have alarmingly increased now a days and this is the commonest disorder in industrialized world [9]. This report is limited to low back pain and injuries although some of the findings may be applicable to other types of work related back disorders [10-13]. So far we studied the literatures; very few reports are present, which could describe the possible physiological hazards faced by the sweet-makers in India. Present study is aimed at evaluating the working postures and musculoskeletal problems amongst the workers engaged in sweet making industries. The predominant working postures taxing sweet makers also evaluated.

### Material and Methods

*Subjects:* Data were collected from 256 adult male sweet-makers. The subjects were randomly taken with minimum 5 years of experience in the present job from different sweet shops of the state of West Bengal. All the subjects were free from physical abnormalities and did not have suffered any of the life-threatening or infectious diseases ever. Consents were taken from the workers and their employer to conduct the study. STROBE guidelines were followed while conducting the study [14].

*Analysis of the working postures:* It was observed that the sweet making process required specific skill. After carefully observing the entire process of sweet making, the workers were categorized into three groups namely Category A, B and C according to the predominant postures the workers adopted during work. The postures were

standing (Category A), sitting on the desk or stool (Category B) and sitting on the ground or squatting (Category C) respectively. For more prominent information about the various postures, digital photography and video recording systems were undertaken and also undertake the frequency (per hour) and duration (hour/ day) of various works in between three categories. Rapid Entire Body Assessment (REBA) [15] and Rapid Upper Limb Assessment (RULA) [16] were performed to determine the postural stress of the workers. The video motions were frozen and stick diagrams were made. The most frequent postures were taken into consideration [17].

*Task analysis:* Work frequency/hour, work cycle time (min), range of duration (min) of specific task and total duration (in hour) in a day, etc. of sweet makers were analysis by HSE (Health and safety executive) and ART tool (Assessment of repetitive task) method (18-19).

*Questionnaire Study:* The postural stresses were evaluated based on the modified Nordic Musculoskeletal Disorder Questionnaire (MSQ) [20-22]. The questionnaire constituted a series of questions with multiple-choice answers. The questionnaire was divided into two parts - one part was associated with the various working manifestations and the other part consisted of the queries about human physiological health. The body parts with discomfort (head, neck, shoulder, wrist, upper back, lower back, waist, knee and ankle) were recorded according to the responses of the workers working in those three categories. The degrees of discomfort/pain of the workers working with different activity in between three categories were assessed using Body Parts Discomfort (BPD) [23] scale.

This scale consists of markings from 1 to 10. Marks were put according to the intensity of pain. '1' indicates the onset of discomfort/pain or just identifiable discomfort/pain in body parts, '5' indicates moderate discomfort/pain whereas '10' indicates maximum or intolerable discomfort/pain. The subjects were asked to assess their discomfort levels and the grade was accordingly given to the response of each individual.

**Data Analysis:** Chi-square tests [24] were performed to observe if there were significant differences in responses of the workers who felt or did not feel discomfort in different body parts for working in those three categories. Level of significance was taken as  $p < 0.05$ . Somers' d [25-26] was applied to observe the direction of the tendency of pain for each of the three categories.

The population value of Somers' *D* (Somers 1962) is defined as:

$$DYX = \frac{\tau_{XY}}{\tau_{XX}}$$

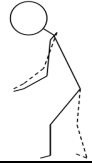



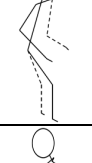

Where,  $\tau_{XY}$  is the difference between two probabilities, namely, the probability that the larger of the two *X* values is associated with the larger of the two *Y* values and the probability that the larger *X* value is associated with the smaller *Y* value. *DYX* is the difference between the two

corresponding conditional probabilities, given that the two *X* values are known to be unequal.

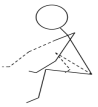
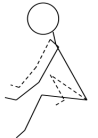
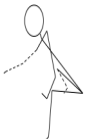
**Results**

The various working phase and working postures of the sweet-makers were analyzed by work cycle time (min), range of duration (min), frequency/hour, duration (hour/ day), BPD scale rating and by postural analyses tools (REBA and RULA) with their action category, that were presented in the Tables 1, 2 and 3. It was clear from the tables 1, 2 & 3 that sitting on stool and sitting on ground (Category B and C respectively) were more harmful than standing (Category A) and could cause severe MSDs. The average REBA and RULA scores and the action categories of those postures indicated that the body parts were more likely to be affected for awkward bending.

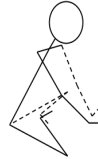
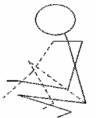
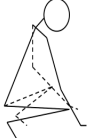
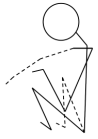

**Table-1:Preparation of food products in standing posture [Category-A]**

Type of Work	Posture	Cycle Time [Min]	Range of Duration [Min]	Frequ-ency /hour	Duration (hour/ day)	REBA Score	Action Categ-ory	RULA Score	Action Categ-ory	BPD Scale [Mean ± SD]
1. Mixing sugar with posset		2.84 ± 0.45	15-25	22.34 ± 3.18	1.02 ± 0.121	11	11-15	7	7	5.59 ± 1.23
2. Boiling and condensing of milk		0.28 ± 0.01	35-45	209.08 ± 3.94	3.54 ± 0.343	9	8-10	6	6	4.25 ± 1.20
3. Making rasgulla		0.24 ± 0.01	35-45	236.45 ± 5.23	2.271 ± 0.310	5	4-7	6	6	3.66 ± 0.59
4 Shifting sugar syrup		3.50 ± 0.14	3-5	17.24 ± 1.02	0.69 ± 0.075	11	11-15	7	7	8.23 ± 2.12
5. Putting rasgulla into sugar syrup		1.20 ± 0.02	15-20	49.84 ± 2.41	1.59 ± 0.071	5	4-7	6	6	2.12 ± 0.46
6. Placing the container on the oven		2.32 ± 0.01	2-5	25.62 ± 2.66	0.387 ± 0.067	8	8-10	7	7	8.80 ± 1.52

**Table-2: Preparation of food products in sitting on high desk or stool [Category B]**

Type of work	Posture	Cycle Time [Min]	Range of Duration [Min]	Frequency/ hour	Duration (hour/ day)	REBA Score	Action Category	RULA Score	Action Category	BPD Scale [Mean ± SD]
1. Making flour pulp for <i>Kachouri</i>		0.08 ± 0.00	120-150	752.07 ± 5.03	3.659 ± 0.156	10	8-10	7	7	8.54 ± 2.30
2. Pressing the pulp		0.08 ± 0.00	90-120	747.24 ± 5.92	3.146 ± 0.109	11	11-15	7	7	8.14 ± 1.82
3. Frying <i>Kachouri</i>		0.09 ± 0.00	120-150	663.72 ± 7.75	3.74 ± 0.078	11	11-15	7	7	9.04 ± 2.52

**Table-3: Preparation of food products in sitting on the ground with the legs bent or squatting posture [Category C]**

Type of Work	Posture	Cycle Time [Min]	Range of Duration [Min]	Frequency/ hour	Duration (hour/ day)	REBA Score	Action Category	RULA Score	Action Category	BPD Scale [Mean ± SD]
1. Mixing wheat with flour		1.56 ± 0.09	25-30	38.54 ± 1.80	2.597 ± 0.080	11	11-15	7	7	7.25 ± 1.75
2. Putting spices inside the posset balls		0.13 ± 0.01	35-45	461.71 ± 4.99	2.283 ± 0.192	8	8-10	7	7	6.66 ± 1.70
3. Making <i>Sandesh</i>		0.09 ± 0.00	60-90	663.99 ± 11.29	3.169 ± 0.432	9	8-10	7	7	6.95 ± 2.45
4. Pouring cream on <i>Sandesh</i>		0.08 ± 0.00	15-25	751.8 ± 10.68	1.414 ± 0.342	10	8-10	7	7	7.19 ± 1.47
5. Garnishing <i>Sandesh</i>		0.05 ± 0.00	45-60	1216.56 ± 6.92	2.078 ± 0.223	10	8-10	7	7	8.41 ± 2.42

As the working postures were divided in three categories, the categorical observations of the feeling of discomfort in different body parts were presented in Table 4. There, it was destined to

observe how much the workers complained about feeling of pain in different body parts working in a specific posture for long time that represented in table 1, 2, 3.

In Table 4, assessment of response and tendency of discomfort according to the category of work was performed and it was found that in the areas like head, neck, shoulders, wrists, upper and lower back, the feeling and no feeling of discomfort were significantly altered than the areas like waist, knee and ankles. Considering a

particular area of discomfort, it was also observed that the feeling and no feeling also significantly altered according to the category of work. The tendency of discomfort as assessed by Somers'd been also observed according to the category of work for individual body part.

**Table-4: Association of pain/discomfort of the workers categorized according to predominant working posture.**

Category of Working Posture	Body Parts	Discomfort of Subjects		$\chi^2$ [p value]	Somers'd	Tendency of Discomfort
		Feeling	No Feeling			
Category-A Category-B Category-C	Head	4 27 28	71 97 29	35.235 [p=0.000]	0.25839	Increased from A to B and B to C
Category-A Category-C Category-B	Neck	31 64 57	38 60 6	34.332 [p=0.000]	0.26976	Increased from A to C and C to B
Category-A Category-C Category-B	Shoulders	22 68 63	38 42 23	20.015 [p=0.000]	0.21819	Increased from A to C and C to B
Category-A Category-B Category-C	Wrist	19 41 26	89 61 20	25.228 [p=0.000]	0.25102	Increased from A to B and B to C
Category-B Category-A Category-C	Upper back	57 36 52	71 20 20	16.093 [p=0.000]	0.21003	Increased from B to A and A to C
Category-A Category-B Category-C	Lower back	54 109 38	35 19 1	28.417 [p=0.000]	0.23561	Increased from A to B and B to C
Category-A Category-C Category-B	Waist	43 43 98	22 18 32	1.902 [p=0.386]	0.06586	Slightly increased from A to C and C to B
Category-A Category-B Category-C	Knee	12 18 20	89 68 49	7.792 [p=0.020]	0.11376	Slightly increased from A to B and B to C
Category-A Category-B Category-C	Ankles	13 21 45	38 59 80	2.813 [p=0.245]	0.08193	Slightly increased from A to C and C to B

**Discussion**

The sweet-makers used to work for more than twelve hours in a day. They had to adopt some awkward postures as per their job demand. Most of the sweet shop workers are engaged with specific work according to their experiences, but some sweet shop workers are engaged with different work in between three job categories according to their job demand. So, the regular work load for every worker is very excessive. The time study of every task were represented in the table 1, 2 , 3. The feelings of discomfort throughout the day were observed. The jobs

which require specific skill also imposed strains on the regions like head, neck, shoulders, wrists, upper and lower back, waist, knee and ankles as pressure and movement of these body parts are directly involved during static or dynamic types of activities.

It was noteworthy that the postures the workers had adopted merely had any beneficial impact. All of the postures were strenuous and the corresponding REBA and RULA scores were alarming. Mixing of wheat with flour, pressing the pulp for frying,

preparation of posset, mixing of sugar with posset, frying *Kachouri*, shifting of the sugar syrup- all of those postures belonged to the very high risk level with REBA and RULA scores of 11 and 7 respectively. Making flour pulp for *Kachouri*, putting of spices inside the posset balls, placing of container on the oven, boiling and condensing of milk, making of *rasgulla*, putting of *rasgulla* in the sugar syrup, making of *sandesh*, pouring of cream on *sandesh* and garnishing of *sandesh*- all of these postures are highly risky, because most of them are with continuous static work load. Such high scores and action categories of REBA and RULA indicate possible physical hazards of the body [22]. So modifications of those postures soon are highly recommended, i.e., should not work with continuous static awkward posture and required sufficient rest pauses between the work period. It was observed that extensive repetition of movement of limbs were needed for boiling of milk, making of *rasgulla*, preparation of *Kachouri* and preparation of *sandesh* and the average time for the purposes were also long, whereas, mixing of sugar with posset, shifting of sugar syrup, putting of *rasgulla* into sugar syrup, placing of the container on the oven and mixing of wheat with flour needed less cyclic repetition of the limbs and also the times needed for the purpose were less than the previously mentioned jobs. The impact of these strenuous postures on the workers led to produce MSDs symptoms soon and implied serious health injuries. It was noteworthy that all the postures they had adopted were hazardous and could impose problems in the areas like vertebral column, bone and joints, which might disturb their work efficiencies and could ultimately, reduce the productivity.

Analyses of the tendency of pain in body parts due to the predominant postures during different type of task were evaluated by Somers'd. It was evident from Table 4 that the pain in head was much more in men working with sitting posture on the ground than those working, sitting on a platform or standing. There might be another reason that workers sitting in this posture generally used to perform precise works like garnishing *sandesh*, and need constant attention to their work. So, pain in head might be due to excess strain on their eyes [27] and continuous tedious repetitive activity that led to headache. In case of neck and shoulder, the workers who used

to work sitting on a high platform, complained more pain in those areas. The possible reason could be due to the excess bending of neck and shoulder. As the oven remained far more than the reachable distance from the hands, there were excess leaning and excess bending of those regions, which could create extra load on those areas. Pain of neck and shoulder were less in the workers sitting on ground because they did not have to bend their extremities much, still, they were also prone to suffer from those problems because of the constant bending of their necks due to precision work and shoulders due to repetitive movements [9]. Tendency of pain in wrist increased from Category A to Category B and Category B to Category C. That was due to repetitive movements of the wrists for the precision works like making and garnishing of *sandesh* etc. Pain in upper back was felt more by the workers sitting on ground and slightly less by those standing. Conclusion could be made in those regards that repetitive movement of the upper and lower arms led to the generation of discomfort in the upper part of the body and also to the scapular parts [9].

The vertebral column of the ground-sitting workers looked like bow, as they had to bend their backs to get a closer proximity of the products to their eyes. That could have impact on the lower discs of the vertebral column [8]. Therefore, feeling of discomfort in lower back of the workers sitting on ground (Category C) was higher than other two categories (Category A and B). Having been bent forward and leaned constantly, extra pressure was imposed on the waist. That was also due to stiffness and least movement of waist region [10-11,28], which led to cause more pain in the workers sitting distantly from their area of operation (Category B). However, there was little deviation of feeling of pain between those three groups and pain was slightly more in Category B from the Categories C and A. The workers who used to sit on the ground had acquired specific type of postures, either squatting or kneeling or just sitting cross-legged. Movement of legs was not possible in those specific types of postures as well as in-sufficient work place layout. Therefore, circulation used to get interrupted by pressure and fluid could accumulate in

those regions leading to pain. Pain in the knees as well as ankles were reported to be slightly higher in the workers belonged to Category C. However, in case of feeling of discomfort in knee and ankle did not significantly differ between the three categories. Persons sitting on high platform or standing on ground for long time might also suffer from those problems, as there were also the possibilities to accumulate metabolites in those lower proximities.

It could be said from the assessments that for the sweet-makers, standing posture was more beneficial than the other two types. But, in the Indian perspective, it is not possible to imply only the standing condition due to job demand. Moreover, majority of the workers prefer working sitting on the ground irrespective of their job types. The reason behind is that more stable posture, more is the exert force, and in spite of probable hazards, they favor that kind of posture. Though, the study was intended to identify the predominant working postures of the sweet-makers and how those postures could be the causes of body parts discomfort, other assessment techniques should also be implied to conceptualize the exact cause and effect for the generation of MSDs. The assessment of working posture on this context is highly significant as many of the people live on these types of work in India and other Asian countries. The physical, physiological and economical status of their living remains in very constraint position. Any physical hazard could debar them from these jobs and ultimately could impose a fatal condition upon them. Implementation of new design of workplace, work environment, reduced multi-task activity of the workers, worker should be identified for specific activity according to their

work experience of present job, sufficient rest pauses in between their work period, concerning to the sweet makers about the possible hazards on their different body parts form this multi-task activity with different awkward posture, etc. at present should be considered with optimum priority. This attempt may increase the productivity as well as their standards of physical and physiological health.

### Conclusion

In this study, relationship between working posture and discomfort in various body parts was found. The clear view of musculoskeletal disorder due to hazardous working posture was significantly observed and it can be interpreted that inadequate guidelines for working posture is producing occupational health hazards among the workers. The musculoskeletal problems were observed to be associated with the category of posture in the relevant field. As the age increases, muscles tend to get rigid and continuous exposure to the physically stressful job inflicts an additional load on the bones and muscles. More investigations are needed to get information all about the working status of the sweet-makers. Moreover, Indian economy many a time depends on the unorganized sectors, so, implementation of proper working condition must be followed.

### Acknowledgement

The authors gratefully acknowledge all the sweet making workers for their co-operation and Mr. Biswajit Roy, Assistant Professor of Statistics, Presidency University, Kolkata for his kind help in statistical analyses.

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