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PREVALENCE OF WORK-RELATED MUSCULOSKELETAL DISORDERS AMONG PROFESSIONAL BREAD-MAKING WORKERS IN INDIA

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ABSTRACT

Background: The occurrence of work-related musculoskeletal disorders (WMSDs) due to workplace factors is not well described in bread making workers, an understudied population globally. However, the task is very repetitive and exhaustive in nature.

Objective: To evaluate the prevalence of work-related musculoskeletal disorders and its associated risk factors among bread making workers.

Methods: WMSD symptoms in past 12 months using a self-modified musculoskeletal questionnaire (Nordic Questionnaire), were assessed in 229 bread making workers from District Aligarh, Uttar Pradesh, India. Chi-square tests and binary logistic regression were performed to analyze associations of MSD related to task variables.

Results: The results showed 149 (65.1%) participants reported MSD symptoms with prevalence in shoulder (n = 107, 46.7%), buttock (n = 87, 37.9%) and lower arm (n = 69, 30.1%). Duration of heat exposure per day significantly affects lower arm region (p = 0.027), hand (p = 0.032) and lower back (p = 0.029). Types of equipment significantly affected hand, neck, and shoulder discomfort (p <0.05). Workers involved in making both dough and bread were at higher risk of discomfort in middle back (OR = 2.106) and thighs (OR = 2.022). Workers using tandoor (fire pits) were at higher risk of discomfort in shoulder (OR = 1.541) and upper arm (OR = 2.61).

Conclusion: The results showed a high prevalence of WMSD among bread making workers, with the shoulder, buttock and lower arm being the most affected body parts. Exposure of this workforce to ergonomic hazards and WMSDs increases the urgent need for public policy to address work strategies that protect workers and place this issue at the top of occupational health priorities.

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Bread, dough, musculoskeletal disorders, risk factors, Nordic questionnaire

INTRODUCTION

Musculoskeletal disorders (MSDs) are injuries that affect muscles, nerves, tendons, joints, cartilage, or intervertebral discs, while work-related musculoskeletal disorders (WMSDs) are disorders in which the work environment and the tasks performed play a major role in their pathogenesis[1]. MSDs are often overlooked by researchers due to their low mortality rate, but they have become a major contributor to the global disease burden, with the total number of cases increasing by 83.9% between 1990 and 2019 (Global Burden of Disease Study 2019)[2]. WMSD is usually caused by working long hours in highly repetitive jobs, and its prevalence and associated medical and compensation costs are increasing every year[3]. Internationally, an estimated 40% of workplace injury and illness-related costs are due to musculoskeletal disorders[4]. In high-income countries, approximately 30% of the workforce is exposed to work conditions that trigger or exacerbate musculoskeletal disorders, while in the global south this figure ranges between 50% and 70%[5]. Over the past two decades, researchers have studied the relationship between various risk factors and the incidence and severity of musculoskeletal disorders and categorized these factors into various occupational settings[6]. Research showed that WMSDs are prevalent in a wide range of occupational groups, including industrial workers, those involved in food and meat processing, and clerical workers[7]. Workers always compromise with improper working postures, dangerous working conditions and heavy job demand. As reported by Kondo et al.[8], workers in the bakery industry often experience musculoskeletal pain due to the awkward postures, the nature of the work, and the types of materials handled. The incidence of psychosocial aspects related to work and the work environment plays an important role in the development of WMSDs of the upper extremity and back discomfort.

Bakery workers are often subject to strenuous physical activity, including lifting, forceful exertions, and poor working posture. Several tasks performed by workers can lead to symptoms of WMSD in bakery workers, including handling dough, standing next to a hot oven for extended periods of time, bending over continuously to place and pick food in the oven, and working in confined and heated spaces[6]. Chen et al.[9] showed that manual dough handling is one of the main daily tasks of bakery workers and is also the cause of the prevalence of WMSDs among bakery workers. High temperature exposure has a decisive impact on the physical strength of unprotected personnel, especially those working in high temperature environments[10]. A few studies investigated the role of physical work demands, obesity and smoking in predicting the onset and risk factors of musculoskeletal discomfort in kitchen workers[11,12]. One study showed that kitchen staff had a higher prevalence of WMSDs (84%) compared with employees working in other jobs in hotel restaurants, mainly concentrated in the shoulders (58%), neck (54%), lower back (53%), and fingers (46.5%)[13].

A high prevalence of WMSD in the shoulder (41.1%), hand/wrist (38.2%), and lower back (40.1%) among food service workers in Taiwan[14] was also reported. Another study showed that the one-year prevalence of WMSDs among kitchen workers was 82.7%. Age between 30 and 39 years, job dissatisfaction, anxiety, prolonged standing, and excessive arm extension were identified as significant determinants of WMSDs among kitchen workers in the hospitality industries[15].

There is a notable lack of epidemiological information on work-related musculoskeletal disorders (WMSDs) in the food industry, especially among workers engaged in bread making. However, to the best of our knowledge, there are no reports evaluating work-related musculoskeletal disorders (WMSDs) among workers in bread making in India. Bread is a flat, round flat bread, also known as chapatti/roti/phulka/naan, usually baked in a hot wok[16] or tandoor[17]. The type of oven known as a tandoor is built by digging a large hole in the ground. It is commonly used in the Turkey, as well as in Afghanistan, Pakistan, India, and Tibet[17]. There are also areas where the oven is located on a ground plinth or at a certain height from the ground. The associations between various risk factors or postural assessments have been extensively studied in kitchen, restaurant, and bakery workers worldwide. However, WMSDs in bread-making workers in developing countries, especially India, are understudied. Therefore, there is a need to study the relationship between prevalence, risk factors, and types of WMSDs, especially the interactions between risk factors and psychosocial aspects in the food industry. The lack of adequate resources on WMSD for bread-making workers indicates a huge gap in the literature that needs to be filled. The importance of prioritizing the protection and promotion of safety, health, and well-being of workers in the bread-making industry must be emphasized. Occupational hazards must be regularly monitored and evaluated to identify potential risks and take necessary protective measures. Cross-sectional studies are an appropriate tool in this context, but only for examining the association between risk factors and musculoskeletal problems. This study aims to assess the prevalence of work-related musculoskeletal disorders and their associated risk factors among bakery workers. Therefore, the assumed

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Variables		N = 229	%	Mean
Smoking	Yes	145	63.3	
	No	84	36.7	
Alcohol	Yes	41	17.9	
	No	188	82.1	
Work duration per day	≤ 8 Hours	156	68.1	
	More than 8 Hours	73	31.9	
Type of bread	Roti/Chapatti	22	9.6	
	Naan	207	90.4	
Type of involvement	Bread and Dough making	162	70.7	
	Dough making	67	29.3	
Equipment used to make bread	Tandoor	177	77.3	
	Gas	52	22.7	
Posture used	Sitting	19	8.3	
	Standing	210	91.7	
History of MSD in past 12 months	Yes	149	65.1	
	No	80	34.9	
Discomfort in body region	Neck	52	22.7	
	Shoulder	107	46.7	
	Upper Back	63	27.5	
	Mid- back	54	23.6	
	Lower arm	69	30.1	
	Lower back	65	28.4	
	Buttock	87	37.9	
	Thigh	47	20.5	
	Leg	50	21.8	
	Hand/wrist	56	24.5	
	Upper Arm	34	14.8	
	Chest	35	15.3	
Age (years)				24.1 ± 4.5
Experience level (years)				5.8 ± 3.7
Heat exposure per day				6.35 ± 1.5
Numbers of hours worked per day				7.98 ± 1.9

Table 1. *Demographics characteristics of the participants.*

alternative hypothesis for the present investigation was: "Among bread making workers, associations exist between sociodemographic, work-related risk factors, and reported musculoskeletal disorders in different body regions".

METHODS

Study design

The study aims to investigate the factors affecting MSDs among bread making workers, and to assess the relationship between associated risk factors and workload-related factors in different body parts. The research protocol was designed based on the Code of human ethics of the World Medical Association (Declaration of Helsinki) and written informed consent to participate was obtained from the participants. The study was ethically approved with no PROD 340B/EC/04/21, dated 25/08/2021. In this cross-sectional study, data was collected from among bread making workers in Aligarh, Uttar Pradesh, India. In

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this survey, 252 participants meeting the inclusion criteria volunteered and 23 participants were disqualified from the study because they had not completed the questionnaire. Therefore, 229 participants with a response rate of 90.87% were finally selected for the study. The study period was from 27/11/2020 to 30/04/2021. Full-time bread making workers from different regions interviewed personally. In addition, participants should: (i) have not reported any injury, (ii) minimum one year of experience with bread making, (iii) >18 years of age, and (iv) ready to participate in the research. However, those who have prior peripheral nerve disease, trauma and fractured sprains, and other musculoskeletal injuries were excluded from the study. Observed individuals with any missing information was also excluded from the survey.

Questionnaires

A self-modified musculoskeletal questionnaire (Nordic questionnaire) was distributed among bread making workers and subsequently collected after the interview. The self-modified musculoskeletal questionnaire (Nordic questionnaire) lasted 30 to 45 minutes. The questionnaire is divided into background information, including age, experience, working hours per day, smoking habits, alcohol consumption. In addition, nature of work, including type of bread prepared, type of equipment used to bake bread, posture, exposure to heat, how long respondents used to work, work-related risk factors and their association with body parts. Respondents were asked to choose from 12 body parts (neck, shoulders, lower back, middle back, lower arm, buttock, thigh, leg, hand, upper back, upper arm and chest) the prevalence of MSD. The participants mark with a "√" (√ = yes) on a discomfort map (Corlett & Bishop) where they have observed any type of MSD symptoms, in the past 12 months. The Nordic questionnaire included whether they had felt discomfort in the past 12 months, which affected their ability to work (1 point for a "yes", 0 for a "no"). In the Nordic questionnaire, discomfort scores for each section range from 0 to 3, with 0 being the lowest and 3 the highest. However, in self-modified musculoskeletal questionnaire, due to the limited range of scores, the discomfort score for each section was further divided into "no" (0) and "yes" (1-3 points = 1). The self-modified musculoskeletal questionnaires can identify differences in discomfort caused by different work factors, thereby more clearly defining MSD problems. Several researchers have shown that the questionnaire has adequate consistency, reliability and validity[18,19].

Pilot survey

The questionnaires were translated into Hindi language, and the content, clarity and language were confirmed in a pilot study of 50 participants. The bread making workers were asked separately all the questions corresponded to the nature of the study to determine the occurrence of MSDs. Based on the feedback, a revision of the questionnaire was conducted. The content of the questionnaire obtained an acceptable index of reliability (Kappa coefficient = 0.92), demonstrating that it can give consistent results in repeated tests.

Statistical analysis

Statistical analysis (MANOVA) of demographic data *(Table 1)*, MSD discomfort, and work-related risk factors of 229 participants was performed on IBM SPSS version 25.0 *(Table 2)*. Univariate binary logistic regression was used to assess potential risk factors associated with the development of MSDs in different body regions among bread making workers *(Table 3)*. Chi-square tests were performed to assess associations with MSD symptoms among bread making workers. Regression models with odds ratios (OR) and 95% confidence intervals (CI) estimated risk factors influencing MSD symptoms *(Table 4)*.

RESULTS

Demographic characteristics

Results for demographic characteristics of all bread making workers are shown in *Table 1*. The mean age, experience of work and heat exposure duration were having mean and standard deviation as 24.1 ± 4.5 years, 5.8 ± 3.7 years, and 6.35 ± 1.5 hours, respectively. In total, 146 (63.7%) belonged to the 18-25 age group and 83 (36.3%) belonged to the >25 age group. The average years of experience of a bread making workers were found to be 5.8 ± 4.5 years, with daily working hours of 7.98± 1.9 hours and a daily heat exposure duration of 6.35 ± 1.5 hours. As per this study, 162 (70.7%) bread making workers were engage in both dough and bread making, while 67 (29.3%) of the participants only prepare the dough for bread making. Most of the bread making workers (n = 177, 77.3%) used tandoor, while 52 (22.7%) workers used gas. In addition, 210 (91.7%) participants reported that they make the bread in standing posture, white remaining used to make bread in sitting posture.

Factors causing MSDs

The survey as per questionnaire *(Table 1)* showed that 149 (65.1%) study participants reported MSD symptoms and 80 (34.9%) reported no symptoms of MSD in past 12 months. In this report of MSD prevalence in past 12 months, highest prevalence was in the shoulder (n = 107, 46.7%) followed by in the buttock (n = 87, 37.9%) and lower arm (n = 69, 30.1%). In addition, multivariate ANOVA *(Table 2)* indicated that workers involved in preparing different types of bread/naan had a significant effect on middle back (p = 0.031), lower back discomfort (p = 0.014), and a symptom of headache (p = 0.047). Workers used different types of equipment to bake different types of bread reported a significant effect on hand discomfort (p = 0.022) neck (p = 0.039) and shoulder (p = 0.028) discomfort. Age had a significant effect on discomfort in upper back (p = 0.048), lower arm (p = 0.017), upper arm (p = 0.028) and buttock

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Variables	Discomfort/ MSD reported	p values
Smoking	Buttock	0.044
Type of bread	Headache	0.047
	Mid back	0.031
	Lower back	0.014
Equipment used	Hand	0.022
	Neck	0.039
	Shoulder	0.028
Age	Lower arm	0.017
	Upper back	0.048
	Buttock	0.035
	Upper arm	0.028
Experience	Lower arm	0.001
	Thigh	0.039
	Chest	0.046
Type of involvement	Upper back	0.037
Duration of work hours per day	Shoulder	0.017
	Thigh	0.027
Heat exposure duration	Lower Arm	0.027
	Hand	0.032
	Lower back	0.029
Alcohol * type of bread	Headache	0.045
Smoking * equipment used	Mid back	0.019
	Leg	0.048
Smoking * heat exposure duration	Lower back	0.044
	Hand	0.045
Alcohol * duration of work hours per day	Shoulder	0.007
Duration of work hours per day * equipment used	Neck	0.019
	Upper back	0.043
	Buttock	0.048
Duration of work hours per day * heat exposure duration	Hand	0.019
Type of involvement * type of bread	Neck	0.042
	Headache	0.009
	Lower back	0.042
Type of bread * equipment used	Leg	0.035
Type of bread * heat exposure duration	Lower back	0.042
Type of involvement * Heat exposure duration	Shoulder	0.001
	Hand	0.047
Equipment used * heat exposure duration	Neck	0.037
	Upper back	0.034
Smoking * equipment used * heat exposure duration	Thigh	0.036

Table 2. *Summary of multivariate ANOVA for main effects and their interactions (p values).*

(p = 0.035). The duration of experience on work was significantly related to discomfort in the lower arm (p = 0.001), thigh (p = 0.039), hand/palm (p = 0.004) and chest (p = 0.046). Workers who were engaged in making both dough and bread had a significant effect on discomfort in the upper back (p = 0.037). Duration of heat exposure per day also played a critical role in MSD pain and discomfort in the lower arm region (p = 0.027), hand (p = 0.032), lower back (p = 0.029). Shoulder (p = 0.017) and thigh (p = 0.027) discomfort was largely significant due to working hours per day. In addition, there was a significant interaction between working hours per day and equipment used to bake bread for neck (p = 0.019), upper back (p = 0.043), and buttock (p = 0.048) discomfort. There was also a significant interaction between types of bread prepared and workers engaged in making both dough and bread leading to neck and lower back discomfort (p = 0.042) along with headache (p = 0.009). Furthermore, the interaction between types of equipment used to bake bread and heat exposure duration had a significant effect on neck (p = 0.037) and upper back (p = 0.034) discomfort.

Association between participants' demographics and work-related factors with neck, shoulder, and back discomfort

Chi-square tests were performed to determine associations between participant demographics, work-related factors, neck, shoulder, and back discomfort *(Table 3)*. The results showed that smoking habit and MSD history in past 12 months were significantly associated with neck and shoulder discomfort.

In addition, age (χ^2 = 3.222, p = 0.048), experience level (χ^2 = 14.598, p <0.001), type of involvement (χ^2 = 4.651, p = 0.031) and past 12-month MSD history (χ^2 = 5.198, p = 0.023) were significantly associated with those who experienced lower back discomfort. Middle back discomfort was significantly associated with type of involvement (χ^2 = 4.377, p = 0.036) and MSD history in the past 12 months (χ^2 = 17.66, p <0.001). Upper back (χ^2 = 64.741, p <0.001) and buttock (χ^2 = 3.606, p = 0.048) discomfort was significantly associated with those reported history of MSD in past 12 months.

Association between participants' demographics and work-related factors with upper extremity discomfort

Upper extremity disorders denoted to discomfort of lower and upper arm, hand and chest. Chi-square tests were accomplished to define the relationship between participants' demographics, work-related factors, and upper extremity discomfort *(Table 3)*.

The results showed that alcohol consumption (χ^2 = 8.863, p = 0.003) and types of equipment used to bake bread (χ^2 = 7.145, p = 0.008) was significantly associated with lower arm and upper arm discomfort respectively. Hand discomfort was significantly associated with type of

Variables	Neck	Shoulder	Upper back	Middle back	Lower arm	Lower back	Buttock	Thigh	Leg	Hand	Upper arm	Chest
Posture												
Sitting (19)	2 (10.5)	6 (31.5)	3 (15.7)	6 (3.1.5)	6 (31.5)	7 (36.8)	6 (31.5)	8 (42.1)	5 (26.3)	7 (36.8)	4 (21.0)	3 (15.7)
Standing (210)	50 (23.8)	75 (35.7)	60 (28.5)	48 (22.8)	63 (30.0)	58 (27.6)	81 (38.5)	39 (18.5)	45 (21.4)	49 (23.3)	30 (14.2)	32 (15.2)
χ^2	1.752	1.077	0.13	1.427	0.736	0.021	0.729	0.362	5.916	0.244	1.721	0.631
p value	0.186	0.299	0.718	0.232	0.391	0.886	0.393	0.548	0.015	0.621	0.190	0.427
Experience (years)												
≤5 (120)	32 (26.6)	49 (40.8)	38 (31.6)	31 (25.8)	45 (37.5)	35 (29.1)	41 (34.1)	37 (30.8)	32 (26.6)	36 (30.0)	25 (20.8)	23 (19.1)
5-10 (119)	20 (16.8)	32 (26.8)	25 (21.0)	23 (19.3)	24 (20.1)	30 (25.2)	46 (38.6)	10 (8.4)	18 (15.1)	20 (16.8)	9 (7.5)	12 (10.1)
χ^2	0.729	0.685	0.021	2.227	1.981	14.598	0.145	1.046	5.555	0.081	1.195	1.287
p value	0.393	0.313	0.884	0.136	0.159	0.000	0.703	0.306	0.018	0.775	0.274	0.257
Smoking												
Yes (145)	40 (27.5)	49 (33.7)	44 (30.3)	35 (24.1)	39 (26.8)	43 (29.6)	55 (37.9)	25 (17.2)	33 (22.7)	31 (21.3)	18 (12.4)	25 (17.2)
No (84)	12 (14.2)	32 (38.1)	19 (22.6)	19 (22.6)	28 (33.4)	22 (26.2)	32 (30.1)	22 (26.2)	17 (20.2)	15 (17.8)	16 (19.0)	10 (11.9)
χ^2	5.361	5.12	0.431	1.592	0.068	1.964	0.314	0.001	2.611	0.198	2.023	1.851
p value	0.021	0.018	0.512	0.207	0.794	0.161	0.575	0.980	0.106	0.656	0.155	0.174
Alcohol												
Yes (41)	10(24.3)	13(31.7)	16(39.0)	17(41.4)	17(41.4)	8(19.5)	12(29.2)	4(9.7)	10(24.3)	8 (19.5)	3 (7.3)	10 (24.3)
No (188)	42(22.3)	68(36.1)	47(25.0)	37(19.6)	52(27.6)	57(30.3)	75(39.8)	43(22.8)	40(21.2)	48 (25.5)	31(16.4)	25(13.2)
χ^2	0.081	0.127	0.293	3.320	8.863	3.047	1.934	1.613	3.550	0.191	0.660	2.240
p-value	0.777	0.568	0.588	0.068	0.003	0.081	0.164	0.204	0.060	0.662	0.416	0.134
Types of bread												
Naan (207)	49 (23.6)	75 (36.2)	60 (28.9)	48 (23.1)	67 (32.3)	59 (28.5)	78 (37.6)	45 (21.7)	50 (24.1)	51 (24.6)	31 (14.9)	34 (16.4)
Bread (22)	3 (13.6)	6 (27.2)	3 (13.6)	6 (27.2)	2 (9.1)	6 (27.2)	9 (40.9)	2 (9.1)	0 (0.0)	5 (22.7)	3 (13.6)	1 (4.5)
χ^2	0.005	0.012	0.010	0.297	2.207	1.651	0.762	1.490	0.082	2.316	0.714	1.195
p value	0.998	0.928	0.918	0.597	0.137	0.199	0.383	0.222	0.775	0.128	0.398	0.274
Age (Years)												
18-25 Years (146)	35(23.9)	52(35.6)	38(26.0)	34(23.2)	38(26.0)	46(31.5)	60(41.0)	36(24.6)	31(21.2)	39(26.7)	26(17.8)	26(17.8)
>25 Years (83)	17(20.4)	29(34.9)	25(30.1)	20(24.1)	31(37.3)	19(22.8)	27(32.5)	11(13.2)	19(22.8)	17(20.4)	8(9.6)	9(10.8)
χ^2	0.367	0.387	0.011	0.445	0.019	3.222	1.932	1.648	4.219	0.085	1.112	2.794
p-value	0.544	0.498	0.918	0.505	0.890	0.048	0.165	0.199	0.031	0.770	0.292	0.065
Equipment used to bake bread												
Tandoor (177)	43(24.2)	68(38.4)	53(29.9)	39(22.0)	57(32.2)	51(28.8)	67(37.8)	34(19.2)	42(23.7)	36(20.3)	24(13.5)	26(14.6)
Gas (52)	9(17.3)	13(25.0)	10(19.2)	15(28.8)	10(19.2)	14(26.9)	20(38.4)	13(25.0)	8(15.3)	20(38.4)	10(19.2)	9(17.3)
χ^2	1.118	1.213	3.166	2.313	1.035	1.590	0.071	0.006	0.826	1.640	7.145	1.023
p-value	0.290	0.312	0.075	0.128	0.309	0.207	0.790	0.937	0.363	0.200	0.008	0.312
Type of involvement												
Dough and bread (162)	39 (24.1)	54 (35.8)	51 (31.4)	40 (24.6)	42 (25.9)	46 (28.3)	69 (42.5)	30 (18.5)	29 (17.9)	40 (24.6)	17 (10.4)	21 (12.9)
Dough (67)	13 (19.4)	27 (40.2)	12 (17.9)	14 (20.8)	25 (37.3)	19 (28.3)	18 (26.8)	17 (25.3)	21 (31.3)	16 (23.8)	17 (25.3)	14 (20.8)
χ^2	0.589	0.536	1.006	4.377	0.379	4.651	0.006	4.976	1.365	5.018	0.017	8.300
p value	0.443	0.426	0.316	0.036	0.538	0.031	0.926	0.026	0.243	0.025	0.897	0.004
Duration of work per day (hours)												
≤8 hours (156)	35 (22.4)	55 (35.2)	44 (28.2)	36(23.0)	49 (31.4)	43 (27.5)	49 (31.4)	33 (21.1)	33 (21.1)	39 (25.0)	29 (18.5)	22 (14.1)
≥8 hours (73)	17 (23.2)	26 (35.6)	23 (31.5)	18 (24.6)	18 (24.6)	22 (30.1)	38 (38.3)	14 (19.1)	17 (23.2)	17 (23.2)	5 (6.8)	13 (17.8)
χ^2	0.021	0.032	0.003	0.118	0.069	0.380	0.162	8.997	0.119	0.133	0.079	5.422
p value	0.886	0.823	0.958	0.731	0.793	0.537	0.687	0.003	0.730	0.716	0.779	0.020
History of MSD in past 12 months												
Yes (149)	49 (32.8)	81 (54.3)	55 (36.9)	40 (26.8)	53 (35.5)	49 (32.8)	61 (40.9)	37 (24.8)	40 (26.8)	41 (27.5)	27 (18.1)	27 (18.1)
No (80)	3 (3.7)	0 (0.0)	12 (15.0)	16 (20.0)	14 (17.5)	16 (20.0)	26 (32.5)	10 (12.5)	10 (12.5)	15 (18.7)	7 (8.7)	8 (10.0)
χ^2	23.977	22.311	64.741	17.660	2.082	5.198	3.606	1.089	4.304	5.631	1.747	3.627
p value	0.000	0.000	0.000	0.000	0.149	0.023	0.048	0.297	0.038	0.018	0.186	0.042
Heat exposure per day (hours)												
≤6 hours (123)	28 (22.7)	48 (39.0)	32 (26.0)	28 (22.7)	37 (30.1)	36 (29.2)	40 (32.5)	24 (19.5)	29 (23.5)	35 (28.4)	24 (19.5)	18 (14.6)
≥6 hours (106)	24 (22.6)	33 (31.1)	35 (33.0)	26 (24.5)	30 (28.3)	29 (27.3)	47 (44.3)	23 (21.6)	21 (19.8)	21 (19.8)	10 (9.4)	15 (14.1)
χ^2	0.006	0.016	1.551	0.298	0.098	0.007	0.102	3.376	0.167	0.473	2.303	4.574
p value	0.982	0.942	0.231	0.585	0.754	0.986	0.749	0.048	0.683	0.492	0.129	0.032

Table 3. *Association of socio-demographic, work related factors and reported musculoskeletal disorders.*

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Variables	B	Odd Ratio	95% CI of OR	p value
Neck Discomfort				
Type of bread	0.001	1.001	0.351-2.858	0.988
Age	-0.29	0.972	0.885-1.067	0.545
Experience	-0.081	0.922	0.764-1.112	0.396
Smoking	-0.827	0.438	0.215-0.891	0.023
Alcohol	-0.115	0.892	0.404-1.967	0.777
Duration work/day	0.024	1.024	0.736-1.425	0.886
Posture	-0.977	0.376	0.084-1.686	0.202
Type of involvement	0.275	1.317	0.651-2.664	0.444
Type of equipment	-0.427	0.652	0.294-1.446	0.293
Heat exposure	-0.003	0.997	0.731-1.359	0.982
Shoulder discomfort				
Type of bread	-0.363	0.695	0.209-2.311	0.553
Age	-0.213	0.808	0.369- 1.770	0.595
Experience	-0.528	0.590	0.191- 1.819	0.358
Smoking	0.936	2.549	1.163- 5.589	0.019
Alcohol	-0.285	0.752	0.307-1.839	0.532
Duration work/day	0.139	1.149	0.458-2.886	0.767
Posture	0.434	1.543	0.258-9.227	0.035
Type of involvement	-0.029	0.972	0.393-2.401	0.950
Type of equipment	0.433	1.541	0.593-4.003	0.032
Heat exposure	-0.161	0.851	0.361-2.009	0.713
Hand discomfort				
Type of bread	-0.751	0.472	0.095-2.238	0.358
Age	0.038	1.038	0.927-1.163	0.514
Experience	-0.067	0.936	0.748-1.171	0.560
Smoking	-0.316	0.729	0.338-1.572	0.421
Alcohol	-0.208	0.812	0.320-2.059	0.661
Duration work/day	0.329	1.390	0.854-2.262	0.186
Posture	-0.100	0.905	0.216-3.769	0.891
Type of involvement	-0.952	0.886	0.159-0.935	0.035
Type of equipment	-0.252	0.777	0.276-2.187	0.633
Heat exposure	-0.172	0.842	0.534-1.328	0.460
Upper back discomfort				
Type of bread	0.048	1.049	0.420-2.617	0.918
Age	-0.004	0.996	0.919-1.079	0.918
Experience	-0.011	0.989	0.850-1.150	0.884
Smoking	0.187	1.206	0.689-2.108	0.512
Alcohol	0.199	1.221	0.593-2.512	0.589
Duration work/day	0.008	1.008	0.754-1.343	0.958
Posture	-0.185	0.831	0.303-2.276	0.718
Type of involvement	-0.300	0.741	0.412-1.333	0.317
Type of equipment	-0.627	0.534	0.266-1.073	0.048
Heat exposure	-0.174	0.840	0.639-1.105	0.214
Middle back discomfort				
Type of bread	-0.281	0.756	0.266-2.142	0.598
Age	0.029	1.029	0.945-1.121	0.505
Experience	-0.140	0.870	0.722-1.048	0.142
Smoking	-0.399	0.671	0.360-1.250	0.208
Alcohol	-0.652	0.521	0.256-1.058	0.071
Duration work/day	-0.055	0.946	0.691-1.296	0.731
Posture	-0.758	0.469	1.132-1.667	0.242
Type of onvolvement	0.745	2.106	1.038-4.271	0.039
Type of equipment	-0.585	0.557	0.260-1.192	0.132
Heat exposure	0.081	1.084	0.811-1.450	0.586
Lower back discomfort				
Type of bread	-0541	0.582	0.146-2.324	0.444
Age	0.220	1.246	1.118-1.388	0.000
Experience	-0.788	0.455	0.295-0.699	0.000
Smoking	0.599	1.821	0.863-3.843	0.116
Alcohol	-0.659	0.517	0.210-1.273	0.151
Duration work/day	0.160	1.174	0.740-1.861	0.496
Posture	-1.026	0.359	0.087-1.475	0.155
Type of involvement	-1.297	0.273	0.109-0.686	0.006
Type of equipment	-0.079	0.924	0.355-2.402	0.871
Heat exposure	0.147	1.158	0.758-1.769	0.498

Variables	B	Odd Ratio	95% CI of OR	p value
Buttock discomfort				
Type of bread	0.854	2.349	0.794-6.951	0.023
Age	-0.068	0.934	0.838-1.041	0.220
Experience	-0.021	0.979	0.799-1.200	0.840
Smoking	-0.584	0.558	0.280-1.113	0.098
Alcohol	0.811	2.250	0.886-5.714	0.088
Duration work/day	0.132	1.142	0.745-1.750	0.544
Posture	1.169	3.219	0.827-12.530	0.012
Type of involvement	0.307	1.360	0.578-3.201	0.482
Type of equipment	-0.623	0.536	0.223-1.292	0.165
Heat exposure	-0.131	0.878	0.587-1.311	0.524
Thigh discomfort				
Type of bread	0.557	1.746	0.621-4.909	0.291
Age	-0.090	0.914	0.824-1.013	0.085
Experience	0.086	1.090	0.905-1.314	0.364
Smoking	-0.085	0.918	0.481-1.755	0.796
Alcohol	0.579	1.785	0.768-4.148	0.178
Duration work/day	0.354	1.424	0.960-2.113	0.079
Posture	0.390	1.477	0.379-5.760	0.575
Type of involvement	0.704	2.022	0.882-4.635	0.026
Type of equipment	-0.139	0.871	0.391-1.939	0.735
Heat exposure	-0.023	0.977	0.673-1.420	0.903
Leg discomfort				
Type of bread	0.311	1.365	0.368-5.066	0.642
Age	-0.034	0.967	0.857-1.091	0.583
Experience	-0.292	0.746	0.541-1.019	0.074
Smoking	0.098	1.103	0.522-2.331	0.796
Alcohol	0.948	2.580	0.785-8.477	0.018
Duration work/day	-0.035	0.966	0.603-1.546	0.884
Posture	1.044	2.840	0.698-11.550	0.045
Type of involvement	0.103	1.108	0.419-2.933	0.836
Type of equipment	-0.138	0.871	0.339-2.223	0.775
Heat exposure	0.153	1.166	0.750-1.812	0.496
Upper arm discomfort				
Type of bread	-0.075	0.927	0.299-2.880	0.896
Age	-0.128	0.880	0.704-1.100	0.261
Experience	0.398	1.489	0.727-3.099	0.277
Smoking	0.210	1.234	0.470-3.343	0.670
Alcohol	0.319	1.376	0.864-2.191	0.179
Duration work/day	-0.007	0.993	0.889-1.110	0.908
Posture	0.182	1.200	0.298-4.835	0.797
Type of involvement	0.504	1.655	0.641-4.277	0.298
Type of equipment	0.959	2.610	1.125-6.051	0.025
Heat exposure	-0.478	0.620	0.403-0.954	0.030
Chest discomfort				
Type of bread	1.015	2.759	0.735-10.356	0.133
Age	-0.083	0.920	0.795-1.065	0.264
Experience	-0.067	0.935	0.695-1.260	0.661
Smoking	0.069	1.071	0.462-2.485	0.872
Alcohol	0.318	1.375	0.352-5.374	0.647
Duration work/day	-0.328	0.720	0.383-1.355	0.309
Posture	-0.641	0.527	0.110-2.509	0.421
Type of involvement	-1.048	0.351	0.126-0.973	0.044
Type of equipment	0.384	1.468	0.510-4.225	0.476
Heat exposure	-0.054	0.947	0.564-1.590	0.837

Table 4. *Logistic regression analysis for predicting risk association among the participants.*

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involvement (both dough and bread making) (χ^2 = 5.018, p = 0.025) and MSD history in the past 12 months (χ^2 = 5.631, p = 0.028). In addition, chest discomfort was significantly associated with type of involvement (both dough and bread making) (χ^2 = 8.3, p = 0.004), duration of work per day (χ^2 = 5.422, p = 0.02), heat exposure per day (χ^2 = 4.574, p = 0.032) and MSD history in the past 12 months (χ^2 = 3.627, p = 0.042).

Association between participants' demographics and work-related factors with lower extremity discomfort

Lower extremity disorders denoted to discomfort of leg and thigh. Chi-square tests were accomplished to define the relationship between participants' demographics, work-related factors, and lower extremity discomfort *(Table 3)*. The results showed that age (χ^2 = 4.219, p = 0.031), experience level (χ^2 = 5.555, p = 0.018), posture (χ^2 = 5.916, p = 0.015) and MSD history in the past 12 months (χ^2 = 4.304, p = 0.038) were significantly associated with leg discomfort. Thigh discomfort was significantly associated with type of involvement (both dough and bread making) (χ^2 = 4.976, p = 0.026), duration of work per day (χ^2 = 8.997, p = 0.003) and heat exposure per day (χ^2 = 3.376, p = 0.048).

Logistic regression analysis for predicting risk factors

In this study, binary logistic regression was performed to understand the association of study variables with the occurrence of MSD in different body regions among bread making workers *(Table 4)*. Further comparisons showed that with regard to smoking habit, workers who smoke were at higher risk for neck discomfort (OR = 0.438, p = 0.023) and shoulder discomfort (OR = 2.549, p = 0.019). In addition, workers who consume alcohol was at higher risk for leg discomfort (OR = 2.580, p = 0.018). Regarding "type of involvement", workers involved in making both dough and bread daily were at higher risk of middle back discomfort (OR = 2.106, p = 0.039), lower back (OR = 0.273, p = 0.006), hand/wrist (OR = 0.886, p = 0.035), thigh (OR = 2.022, p = 0.026) and chest discomfort (OR = 0.351, p = 0.044) than those who only prepare dough. In addition, workers who bake bread using tandoor were at higher risk of shoulder discomfort (OR = 1.541, p = 0.032), upper back discomfort (OR = 0.534, p = 0.048) and upper arm discomfort (OR = 2.61, p = 0.025) than those who bake bread using gas. Furthermore, workers whose age were greater than 25 years (OR = 1.246, p <0.001) and having experience more than 5 years (OR = 0.455, p <0.001) were at higher risk for lower back discomfort. Buttock discomfort was more likely occurred in the workers engage in making naan (OR = 2.349, p = 0.023) in the standing posture (OR = 3.219, p = 0.012) in comparison to those workers making bread in sitting posture. In addition, shoulder discomfort (OR = 1.534, p = 0.035) and leg discomfort (OR = 2.840, p = 0.045) was also highly influenced by posture.

DISCUSSION

This study assessed the prevalence of WMSDs and its associated risk factors among bread making workers in terms of daily working hours, types of bread baked, equipment's used to bake bread, types of involvement (only dough or bread preparation and/or both), heat exposure duration and posture used. However, there are insufficient studies on WMSDs among bread making workers in developing countries, especially in India. The current results showed 149 (65.1%) study participants reported MSD symptoms in past 12 months, with highest discomfort in the shoulder (46.7%) followed by in the buttock (37.9%) and lower arm (30.1%), lower back (28.4%), hand/wrist (24.5%), neck (22.7%), thigh (20.5%), and chest (15.3%). The current results are consistent with a very high prevalence of WMSD (84%) mainly in the shoulders (58%), neck (54%), lower back (53%) and fingers (46.5%) in the restaurant workers[13]. Additionally, Subramaniam and Murugesan[20] reported high prevalence of lower back (65.8%), shoulder (62.3%), fingers/wrist (43.9%), knee/foot (42.1%), neck region (38.6%), elbow / forearms (31.6%), thighs (30.7%), upper back (21.1%) and chest (20.2%) discomfort among kitchen workers in India. Consistent with the current study, Habib et al.[6] reported that only 23% of bakery workers had upper extremity pain. A recent study among kitchen workers in Egypt showed a WMSD prevalence of 90.6%, with increased pain in the lower back (64.8%), knees (46.9%), feet (46.1%), neck (29.7%), and shoulders (23.4%)[21].

Chen et al.[9] reported that the number of hours worked per day, length of employment, and age affected the incidence of shoulder discomfort, while age also contributed to lower back discomfort. However, in the current study, age was also a factor for MSD complaints and significantly affected the buttocks (p = 0.035), upper back (p = 0.048), lower arm (p = 0.017) and upper arm (p = 0.028). Several studies have shown and reported that MSD increases with age group and prolonged work time[11,22]. Additionally, workers with 6-10 years of experience reported the greatest discomfort with high-risk elements such as prolonged standing and repetitive tasks[22]. In addition, sixty (41%) workers aged 18-25 reported buttock discomfort, followed by shoulder (n = 52, 35.6%) and lower back (n = 46, 31.5%). Further, workers older than 25 years (OR = 1.246, p <0.001) and having more than 5 years of work experience had a higher risk of developing lower back discomfort. Factors that contribute to shoulder and lower back discomfort include the need to frequently lift objects (such as moving flour sacks, making dough and bread/naan) and how often the bread/naan are placed/removed from the tandoor daily. Similar to the present findings, several studies have inferred that the high prevalence of WMSDs among kitchen worksrs is closely associated with heavy lifting activities with poor posture, long working hours, prolonged standing, highly repetitive tasks, and overexertion[23-25]. These findings corroborate earlier findings on the association between awkward working posture and musculoskeletal pain in bakery

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workers, especially in the shoulders, hands/wrists, and lower back[14]. It was important to note that the majority of respondents reported symptoms that slightly reduced their ability to work and occurred on an almost daily basis, but these symptoms were largely ignored or untreated. This may be attributable to their socioeconomic status[26], as they ignore WMSD symptoms and disease if they need to work to ensure financial support for their families, and thus stop working only when they are unable to continue. This can prevent them from fully recovering and make symptoms worse.

In addition, workers who worked in a standing position were 3 times more likely to have buttock pain (OR = 3.219, p = 0.012), 1.5 times more shoulder pain (OR = 1.534, p = 0.035) and 2.8 times more likely to have leg pain (OR = 2.840, p = 0.045) then those who worked in a sitting position. Therefore, musculoskeletal symptoms may be attributed to long hours of standing and awkward postures. The risk factors associated with severe lower back discomfort included jobs requiring repetitive heavy lifting and cigarette smoking[27]. With regard to smoking habit, present study showed that workers who smoke were at higher risk for neck discomfort (OR = 0.438, p = 0.023) and shoulder discomfort (OR = 2.549, p = 0.019). In addition, workers who consume alcohol were at higher risk for leg discomfort (OR = 2.580, p = 0.018). Chen et al.[9] also found the strong association between lower back pain and cigarette smoking (OR = 1.52) among kitchen workers. Several occupational factors predispose kitchen workers to MSD, including posture (bending and leaning forward), exertion (lifting heavy objects), repetition (food/dough preparation), and duration (long working hours) [28]. Kitchen workers are also reported to be one of the occupational groups at highest risk for work-related injuries due to the nature of their work and the types of materials they handle[29,30]. In addition to these reports, bakers are at high risk of developing musculoskeletal disorders from repetitive movements in their daily work, which include handling dough with awkward postures, lifting heavy objects, and working long shifts[9,31]. The present study also confirm that workers involved in making both dough and bread daily were at higher risk of middle back discomfort (OR = 2.106, p = 0.039), lower back (OR = 0.273, p = 0.006), hand/wrist (OR = 0.886, p = 0.035), thigh (OR = 2.022, p = 0.026) and chest discomfort (OR = 0.351, p = 0.044). Exposure to high temperatures has a decisive effect on the strength of unprotected people, especially those in occupations characterized by high-temperature environments[10]. In the current study, the duration of daily heat exposure also played a key role in MSD pain and discomfort in the lower arm region (p = 0.027), hand (p = 0.032) and lower back (p = 0.029).

Compared to other occupations, this study reported lower MSDs than a study of factory workers in Nigeria, which reported the highest incidence of lower back (85.7%), followed by upper extremity injuries and shoulder discomfort[32]. This study was also compared with other occupations reporting high rates of MSD symptoms, such as sugar factory workers[33], Iranian petrochemical industry[34], handicraft workers[35] and healthcare nursing staff[36,37]. Risk factors such as awkward work positions, manual material handling and prolonged standing are most common across all workstations and work activities.

The above results suggest that musculoskeletal discomfort is not only associated with physical hazards and heavy physical workload; it is also associated with other important psychological factors that contribute to the increased incidence of musculoskeletal discomfort among bread making workers. These results suggest a need to focus interventions on improving workplace ergonomics and implement workplace safety training among bread making workers. Finally, we attempted to assess the prevalence of work-related musculoskeletal disorders and its associated risk factors among bread making workers. However, the differences in the degree of musculoskeletal discomfort during bread making may also be related to other unmeasured variables.

LIMITATIONS AND FUTURE SCOPE

This was a cross-sectional study, a causative relationship between MSDs and risk factors could not be established; only associations between work variables could be identified. Furthermore, the prevalence estimates of MSD may be underestimated, i.e. workers with severe MSD may be familiar but may be overlooked due to financial constraints. Because workers had to report MSD that occurred within the past 12 months, some of them may have underestimated the results due to difficulty with recall. The survey is limited to one geographic area (Aligarh, Uttar Pradesh). Other geographic and racial affiliations of workers may vary significantly across demographics, resources, and ecosystems. Although type of working is also different with geographical difference. The findings further underscore the association between MSD and both personal and work-related factors. As a future direction of this study, multivariate binary logistic regression methods can also be used to assess risk factors.

A possible additional limitation of this study is the use of self-reported symptoms rather than clinical diagnoses. Accurate description of MSD requires medical examination and diagnosis[38], but simple methods such as self-modified questionnaires filled out by workers are often used to perceive the occurrence of MSD[39]. Probably the most well-known tool for this purpose is the Nordic Questionnaire, which has been validated and is widely used to define the occurrence of MSD in different populations. Descatha et al.[40] has established a good agreement between MSD outcomes assessed by the Nordic questionnaire and clinical examinations. Additionally, Mehlum et al.[41] established the rationality of workers' perceptions of the work-relatedness of their self-reported MSD symptoms in a study that compared their perceptions with assessments conducted

by medical professionals. Therefore, future research should focus on the need for prevention and treatment programs to protect vulnerable workers in precarious jobs from the effects of musculoskeletal pain, including the risk of disability and loss of productivity.

CONCLUSIONS

This cross-sectional study assessed the prevalence and associated risk factors of MSD among bread making workers. Overall, the evidence from the results showed a high prevalence of MSD, with the shoulder, buttock and lower arm being the most affected body parts. Although the bread making workers spends most of the time sitting/standing and leaning forward to frequently lift objects (such as moving flour sacks, making dough and bread) and how often the bread are placed/removed from the tandoor on a daily basis, other physical and psychological factors, viz. type of involvement, type of equipment used, working hours, heat exposure during baking were also found a key role in the development of MSD. Exposure of this workforce to ergonomic hazards and WMSDs increases the urgent need for public policy to address work strategies that protect workers and place this issue at the top of occupational health priorities.

Recommendations

It is essential to emphasize the importance of prioritizing the protection and promotion of worker safety, health, and well-being in the bread making industry. This can be accomplished by employing widespread safety protocols, providing suitable training programs, and ensuring the use of protective equipment. Regular monitoring and assessment of occupational hazards must be directed to recognize possible risks and take essential protective measures. Study goal was to create a measure that will be widely useful and valid across the bread making industry and could contribute to the understanding of differences and similarities by other industries. Therefore, it is necessary to emphasize the importance of continuous evaluation and adoption of innovative technologies in bread making industry. It is crucial to recognize the significance of directing frequent impact assessments to appropriately assess the effects of interventions on health, safety, and the operating environment. Through rigorous investigation of these factors, we increase valuable insights that can escort future decision-making processes while recognizing areas that require additional attention or targeted developments.

REFERENCES

1. Mishra S, Avinash G, Kundu MG, Verma J, Sheth A, Dutta A. Work-related musculoskeletal disorders among various occupational workers in India: a systematic review and meta-analysis. J Occup Health. 2024;67(1):uiae077. doi: 10.1093/joccuh/uiae077.
2. Global Burden of Disease Study. Data resources 2019. IHME. https://ghdx.healthdata.org/gbd-2019
3. Cha EW, Jung SM, Lee IH, Kim DH, Choi EH, Kim IA, Kim YK, Lee KJ, Kang YW, Kim HG, Kim YK. Approval status and characteristics of work-related musculoskeletal disorders among Korean workers in 2020. Ann Occup Environ Med. 2022;34:e31. doi: 10.35371/aoem.2022.34.e31.
4. Neupane S, Miranda H, Virtanen P, Siukola A, Nygård CH. Do physical or psychosocial factors at work predict multi-site musculoskeletal pain? A 4-year follow-up study in an industrial population. Int Arch Occup Environ Health. 2013;86(5):581-9. doi: 10.1007/s00420-012-0792-2.
5. Forcier L, Lapointe C, Lortie M et al. Supermarket workers: their work and their health, particularly their self-reported musculoskeletal problems and compensable injuries. Work. 2008;30(4):493-510. doi:10.3233/WOR-2008-00763.
6. Habib R, El-Harakeh A, Hojeij S. Musculoskeletal pain among bakery workers in Lebanon: A national survey. Cogent Eng. 2019;6(1):1608669. doi:10.1080/23311916.2019.1608669.
7. Kang D, Kim Y, Lee YI, Koh S, Kim I, Lee H. Work-related Musculoskeletal Disorders in Korea Provoked by Workers' Collective Compensation Claims against Work Intensification. Ann Occup Environ Med. 2014;26:19. doi: 10.1186/2052-4374-26-19.
8. Kondo Y, Sato Y, Takashima H et al. Occupational stress of assembly line female workers in confectionery work. Sangyo Igaku. 1985;27(5):308-17. doi: 10.1539/joh1959.27.308.
9. Chen YL, Zhong YT, Liou BN, Yang CC. Musculoskeletal Disorders Symptoms among Taiwanese Bakery Workers. Int J Environ Res Public Health. 2020;17(8):2960. doi: 10.3390/ijerph17082960.
10. Yamamoto T, Fujita M, Oda Y et al. Evaluation of a Novel Classification of Heat-Related Illnesses: A Multicentre Observational Study (Heat Stroke STUDY 2012). Int J Environ Res Public Health. 2018;15(9):1962. doi: 10.3390/ijerph15091962.
11. Haukka E, Ojajärvi A, Takala EP, Viikari-Juntura E, Leino-Arjas P. Physical workload, leisure-time physical activity, obesity and smoking as predictors of multisite musculoskeletal pain. A 2-year prospective study of kitchen workers. Occup Environ Med. 2012;69(7):485-92. doi: 10.1136/oemed-2011-100453.
12. Pehkonen I, Miranda H, Haukka E et al. Prospective study on shoulder symptoms among kitchen workers in relation to self-perceived and observed work load. Occup Environ Med. 2009;66(6):416-23. doi: 10.1136/oem.2008.043349.
13. Chyuan JY, Du CL, Yeh WY, Li CY. Musculoskeletal disorders in hotel restaurant workers. Occup Med. 2004;54(1):55-7. doi: 10.1093/occmed/kqg108.
14. Chyuan JY. Ergonomic assessment of musculoskeletal discomfort among commissary foodservice workers in Taiwan. J Foodservice Bus Res. 2007;10(3):73-86. doi:10.1300/j369v10n03_05.
15. Abebaw T, Destaw B, Yenealem DG, Tesfaye AH, Melaku C, Mamaye et al. Work-related musculoskeletal disorders: prevalence, associated factors, and impact on quality of life among kitchen workers in hospitality industry, Bahir Dar City, Northwest Ethiopia, 2023. Front Public Health. 2024;12:1358867. doi: 10.3389/fpubh.2024.1358867.
16. Patil S, S AS, Sonawane SK, Dabade A. Recent advances in the technology of chapatti: an Indian traditional unleavened flatbread. J Food Sci Technol. 2021;58(9):3270-3279. doi: 10.1007/s13197-020-04902-8.
17. Ozkaya N, Aktar S, Algan S, Akkaya H. A retrospective analysis of tandoor burn injuries in Eastern Anatolia. Turk J Plast Surg. 2019;27(1):23-9. doi:10.4103/tjps.tjps_47_18.
18. Kuorinka I, Jonsson B, Kilbom A et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon. 1987;18(3):233-7. doi: 10.1016/0003-6870(87)90010-x.
19. Dawson AP, Steele EJ, Hodges PW, Stewart S. Development and test-retest reliability of an extended version of the Nordic Musculoskeletal Questionnaire (NMQ-E): a screening instrument for musculoskeletal pain. J Pain. 2009;10(5):517-26. doi: 10.1016/j.jpain.2008.11.008.
20. Subramaniam S, Murugesan S. Investigation of work-related musculoskeletal disorders among male kitchen workers in South India. Int J Occup Saf Ergon. 2015;21(4):524-31. doi: 10.1080/10803548.2015.1096063.
21. Abdelsalam A, Wassif GO, Eldin WS, Abdel-Hamid MA, Damaty SI. Frequency and risk factors of musculoskeletal disorders among kitchen workers. J Egypt Public Health Assoc. (2023) 98:3. doi: 10.1186/s42506-023-00128-6.
22. Zain M,Kashif M, Zerish Z, Larib A. Prevalence of musculoskeletal

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disorder and work related associated factor among nurses of Allied and DHQ hospital, Faisalabad. J Pharm Alt Med. 2014;3(3): 30-35.
23. Ghadge SS, Kulkarni VA. Prevalence of musculoskeletal disorders in upper limb in cooks working at Chinese food stall. Int J Appl Res. (2021) 7:202–6.
24. Liu L-W, Wang A-H, Hwang S-L, Lee Y-H, Chen C-Y. Prevalence and risk factors of subjective musculoskeletal symptoms among cooks in Taiwan. J Chin Inst Indust Eng. (2011) 28:327–35. doi: 10.1080/10170669.2011.573005.
25. Shakya NR, Shrestha S. Prevalence of work-related musculoskeletal disorders among canteen staff of Kathmandu university. J Kathmandu Med College. (2018) 17:162–7. doi: 10.3126/jkmc.v7i4.23318.
26. Genebra CVDS, Maciel NM, Bento TPF, Simeão SFAP, Vitta A. Prevalence and factors associated with neck pain: a population-based study. Braz J Phys Ther. 2017;21(4):274-280. doi: 10.1016/j.bjpt.2017.05.005.
27. Frymoyer JW, Pope MH, Clements JH, Wilder DG, MacPherson B, Ashikaga T. Risk factors in low-back pain. An epidemiological survey. J Bone Joint Surg Am. 1983;65(2):213-8. doi: 10.2106/00004623-198365020-00010.
28. Xu YW, Cheng AS, Li-Tsang CW. Prevalence and risk factors of work-related musculoskeletal disorders in the catering industry: a systematic review. Work. 2013;44(2):107-16. doi: 10.3233/WOR-2012-1375.
29. Buchanan S, Vossenas P, Krause N et al. Occupational injury disparities in the US hotel industry. Am J Ind Med. 2010;53(2):116-25. doi: 10.1002/ajim.20724.
30. Nagasu M, Sakai K, Ito A et al. Prevalence and risk factors for low back pain among professional cooks working in school lunch services. BMC Public Health. 2007;7:171. doi: 10.1186/1471-2458-7-171.
31. Afshari D, Shirali G. The effect of heat exposure on physical workload and maximum acceptable work time (MAWT) in a hot and dry climate. Urb Clim. 2019;27: 142-8. doi:10.1016/j.uclim.2018.11.008.
32. Saidu IA, Utti VA, Jaiyesimi AO et al. Prevalence of musculoskeletal injuries among factory workers in Kano Metropolis, Nigeria. Int J Occup Saf Ergon. 2011;17(1):99-102. doi: 10.1080/10803548.2011.11076874.
33. Choobineh A, Tabatabaee SH, Behzadi M. Musculoskeletal problems among workers of an Iranian sugar-producing factory. Int J Occup Saf Ergon. 2009;15(4):419-24. doi: 10.1080/10803548.2009.11076820.
34. Choobineh A, Sani G, Rohani M. Perceived demands and musculoskeletal symptoms among employees of an Iranian petrochemical industry. Int J Ind Ergon. 2009;39(5):766-70. doi: 10.1016/j.ergon.2009.01.001.
35. Das D, Singh AK. Risk factors associated with work-related musculoskeletal disorders among floor-sitting precision handicraft workers. Int Arch Occup Environ Health. 2022;95(5):1129-1145. doi: 10.1007/s00420-021-01817-5.
36. Alam MM, Ali MA, Rafey M, Sufyaan M, Ahmad I, Zarrin S. Work-Related Risk Factors for Musculoskeletal Disorder among Nurses in Indian Hospitals. Muscles, Ligaments & Tendons J. 2023;13(2):273-82. doi:10.32098/mltj.02.2023.11.
37. Khamaj AM, Ali AM, Alam MM. Investigating factors affecting musculoskeletal disorders: Predictive models for identifying caregivers at risk. Work. 2022;72(4):1311-1320. doi: 10.3233/WOR-210309.
38. Hamberg-van Reenen HH, van der Beek AJ, Blatter BM, van der Grinten MP, van Mechelen W, Bongers PM. Does musculoskeletal discomfort at work predict future musculoskeletal pain? Ergonomics. 2008;51(5):637-48. doi: 10.1080/00140130701743433.
39. Oliveira Dantas FF, de Lima KC. The relationship between physical load and musculoskeletal complaints among Brazilian dentists. Appl Ergon. 2015;47:93-8. doi: 10.1016/j.apergo.2014.09.003.
40. Descatha A, Roquelaure Y, Caroly S et al. Self-administered questionnaire and direct observation by checklist: comparing two methods for physical exposure surveillance in a highly repetitive tasks plant. Appl Ergon. 2009;40(2):194-8. doi: 10.1016/j.apergo.2008.04.001.
41. Mehlum IS, Veiersted KB, Waersted M, Wergeland E, Kjuus H. Self-reported versus expert-assessed work-relatedness of pain in the neck, shoulder, and arm. Scand J Work Environ Health. 2009;35(3):222-32. doi: 10.5271/sjweh.1327.

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