

Assessing the impact of weaving on musculoskeletal disorders among handloom and Powerloom weavers in Varanasi, India: a cross-sectional study

Introduction

India has always been known for its splendid crafts and Indian handlooms have attracted attention among the people all over the world. This sector is an informal sector where workers have long working hours, extremely low wages, without any job security and social security benefits, with unsatisfactory working and living conditions. Handloom weaving involves numerous activities which includes raw material (yarn) collection, winding, denting and then continuously sitting in static posture to weave fabric (Koiri, 2020). The process of weaving encompasses a multitude of activities involving repeated movement of upper and lower limbs to operate pedals and shuttles, with arms rose away from the body (Nag et al., 2016). As a result of this weaving and other handloom activities become a high risk occupation for developing musculoskeletal disorders (Awasthi et al., 2018).

Work-related musculoskeletal disorders (WMSDs) are the painful disorders often caused by overuse of the muscles, joints, nerves, tendons and soft tissues of the body. WMSDs are accounted for one of the costly occupational disorders because of its consequential impact on worker's health and productivity at work (Eurofound, 2017). MSDs are a major cause of morbidity and in many countries have emerged as the leading cause of occupational injury, illness and disability (Gerr et al., 2002; Guo et al., 2004; Morken et al., 2000). Earlier literature based on handloom workers of Bangladesh have concluded that work related musculoskeletal disorders were widespread among the workers and the most affected areas were neck, shoulders, back and wrist (Hossain et al., 2018). Past studies based on the handloom workers have shown widespread prevalence of MSD among the workers mostly attributable to the working condition and aggravated by work related stress (Choobineh et al., 2004, 2007; Ramdan et al., 2018). Different studies on workers of weaving industry of India reported that workers were having significant MSDs related to work (Awasthi et al., 2018; Goel & Tyagi, 2012; Nag et al., 2016; Pandit et al., 2013). Globally the burden of MSDs led WHO to declare 2000-2010 as the Bone and Joint Decade (WHO, 2003).

The economic loss due to such diseases not only affects the individual, but also the organizational level and company as a whole. Studies on MSDs in the handloom as well as power loom industry are very few in Indian context. In light of this situation, the present study focuses on identifying the WMSDs among the handloom and power loom workers. The present study focuses on the

relative risk of MSDs among handloom and power loom workers. An attempt has been made to identify associated factors that raised the risk of MSDs among these craftsmen.

Material and Methods

This study is based on cross-sectional to assess the prevalence of MSDs among handloom worker compared with Power loom worker. The study was carried out in one of the oldest weaving hub in India, Varanasi a district of Uttar Pradesh. The exposed population consisted of weavers engaged in handloom industry for at least 10 years. Weavers engaged in power loom industry for at least 10 years served as the control group and lived in or close to the handloom weavers and in similar socio-economic conditions. Most of the respondents were daily wage labourers working in Varanasi Saree weaving industry and their workplace i.e. the handloom and power loom workshops were mostly in close vicinity of their home. PVCHR reports estimate that at least 5 lakhs weavers reside in the Varanasi City (cite and full form). The estimated sample size was 364 households with a p value 0.71, a response rate 0.90 of and a design effect of 1.5. In the study area, since there were more of handloom workers and less of the power loom workers, for comparison purpose the study population could not be divided into two equal parts and hence 234 handloom workers and 102 power loom workers engaged in the weaving industry for at least 10 years were selected. The data were collected from November 2020 to February 2021.

Ethical Consideration

The study was approved by the institute research committee. Before data collection, the informed consent of the participants was obtained in the respondent's own language; the interviewer read the consent statement for illiterate respondents. The consent statement identified the researcher and the purpose of study. Respondents were informed that participation was voluntary, that they need not answer any questions they did not want to, and they could leave the study if they so wished. The confidentiality and privacy of the information provided by the respondent was assured.

Study Tools and Methods

Our survey instrument for measuring musculoskeletal symptoms was adapted from the Standardized Nordic Questionnaire (Kuorinka et al., 1987) and translated into the Hindi language. An anatomical diagram with labels and arrows clearly indicating different body parts was used for assessing musculoskeletal symptoms. Information on musculoskeletal symptoms, and occupational and demographic characteristics was collected from respondents. Descriptive statistics were used to summarise the results. The prevalence of musculoskeletal symptoms that

prevented normal work inside or outside the home was calculated for the handloom weavers and power loom weavers. Differences in the prevalence of MSDs among the groups were tested using the χ^2 test.

Variables

Risk Factors

Handloom is a machine made of wood and of iron (some portion) and used to produce woven fabric. It is run manually with hand and foot combination. The workers perform strenuous activities such as manual handling and long hours of bending forward, which may compress tendons and nerves and lead to complaints of MSDs. Previous studies have indicated that activities which involve heavy use of hands, shoulder and legs with long working hours of repetitive task are at higher risk of MSDs (Rahman M et al.,2020; Singh S and Chokhandre P. 2015; Salve PS and Chokhandre P. 2016; Koiri P. 2020; Nag A et al., 2016). The control group consisted of weavers engaged in power loom industry which requires little different type of physical activity.

Response Variables

Respondents who reported pain in the neck, hands, upper and lower back, thigh, knees or ankle in the past 12 months were considered to have an MSD. In addition, inability to do normal work (inside or outside the home) in the past 12 months due to an MSD was the response variable.

Confounding Factors

The selected confounding factors include age-group (50-54 years and 55-65 years), work profile (worker; own workshop, other activities related to weaving), work satisfaction (yes, no) and years of working (11-24; 25-34; 35-45 years). Earlier studies have shown that complaints of MSDs were exclusively identified to be related with age (Rahman M et al.,2020; Lagerstrom M and Wenemark M. 1995; Vyas H. and Nag PK. 2010). Similarly, studies have also suggested that increase duration of work increases the MSD among the workers engaged in physical activity (Satheeshkumar M. and Krishnakumar K. 2020; Neeraja T. et al.,2016). Earlier studies have also indicated that job dissatisfaction, lack of support from employer had positive impact on MSD (Nag A et al., 2016; Neeraja T. et al.,2016).

In order to examine the exposure of the weaving occupation to the development of MSDs, the study adopted the nearest neighbourhood method of propensity score matching (PSM). This approach gives an opportunity to assess the impact of exposure on outcomes through cross-sectional survey data (Rosenbaum PR. and Rubin DB. 1983) . The propensity score is estimated

by logistic regression with dichotomous exposure variable, for instance 1 = exposed to the weaving using handloom and 0 = exposed to the weaving using power loom, using associated observed demographic and occupational characteristics of both the type of weavers as predictor variables. For identifying the covariates affecting MSDs and related disabilities among handloom as well as power loom workers, the multiple logistic regression analysis was employed. The propensity score was calculated using the probability of exposure assignment given pre-exposure characteristics:

$$P(x) \equiv \text{prob}(D=1|X_i) = E(D|x_i)$$

where, $D = \{0, 1\}$ is the indicator of exposure and x is the multidimensional vector of pre-exposure characteristics. The average exposure effect for the exposed (AEEE) was defined as the conditional expectation of the difference in exposure effect for exposed units only:

$$\begin{aligned} \text{AEEE} &= E(\Delta|p(x), D=1) \\ &= E(y_1|p(x), D=1) - E(y_0|p(x), D=0) \end{aligned}$$

After matching propensity scores, the outcomes of exposed and counterfactual scores of control observations were compared:

$$\text{AEE} = E(\Delta) = E(y_1|x, D=1) - E(y_0|x, D=0)$$

The average exposure effect (AEE) has been defined as the expected (mean value) difference in potential outcomes across all units in the target population, which was identical to the difference in the expected potential outcomes of the control group, that is, $E(Y_1)$ and $E(Y_0)$. In this case, difference in MSDs between exposed (exposed to the handloom industry) and control groups (exposed to power loom industry) could have been directly compared to show the impact of exposure on the exposed group, known as AEEE. When the impact of handloom activity on MSDs, as well as MSDs that prevented normal work inside or outside the home was calculated, the average effect in both the groups was weighted by the proportion of respondents in the exposed and control groups, which measured the increase/decrease in MSDs due to working in handlooms. For a given occupation, the effect of risk factors (duration of occupation and age) on the incidence of MSDs among workers was established by applying multivariate logistic regression. Here, occupation was considered the exposure variable, the confounding factors were duration of work and age, and socio-economic and demographic characteristics were controlled for. Analysis was performed using STATA V.16.1 software.

Results

Table: 1 Socio-demographic and occupational profiles of the study groups

Background Variable	Handloom Worker (N=234)	Powerloom Worker (N=102)
Respondent Age		
50-54 age	44.02	40.2
56-65 age	55.98	59.8
Mean age \pm SD	54.65 \pm 3.15	55.09 \pm 3.27
Education		
No Education	44.44	37.25
Up to Primary	48.72	55.88
Secondary & above	6.84	6.86
Family Size		
Less than 7 Member	23.5	30.39
8 to 12 Member	48.29	38.24
13 and above Member	28.21	31.37
Mean size of family \pm SD	10.49 \pm 3.00	10.52 \pm 3.18
Religion		
Hindu	8.12	13.73
Muslim	91.88	86.27
Type of Family		
Nuclear Family	74.36	80.39
Joint Family	25.64	19.61
Work Profile		
Worker	24.89	25
Own workshop	40.17	49
Other work related to weaving	34.93	26
Work Satisfaction		
Yes	60.26	69.61
NO	39.74	30.39
Any other work do for livelihood		
Yes	9.17	7
No	90.83	93
Years of working		
15-24 years	44.02	55.88
25-34 years	23.93	23.53
35-45 years	32.05	20.59
Mean number of years \pm SD	28.52 \pm 8.39	26.40 \pm 8.17
Economic status in this work		
Good	41.45	50.98
Medium	16.24	22.55
Low	42.31	26.47

Table 1 shows the socio-economic and occupational profile of the handloom and power loom workers. Majority (44.02%) of the handloom workers were in the age group of 50-54 years compared to power loom workers. The mean age of the handloom workers were 54.65 years and those of the power loom workers were 55.09 years. Most of the handloom (48.72%) and power loom (55.88%) workers received primary education. Majority of the handloom (91.88%) as well as the power loom (86.27%) workers are Muslim. Most of the handloom (74.36%) and power loom (80.39%) belong to nuclear families. Nearly 40% of the handloom workers and 49% of the

power loom workers owned workshop.60.26% and 69.61% of the handloom and power looms workers reported to have job satisfaction. The mean years of working was 28.52 years for the handloom workers and 26.40 years for the power loom workers. Majority of the handloom workers (42.31%) had low economic status, while most of the power loom (50.98%) of the power loom workers had good economic status in work.

Table 2 Prevalence and incidence of musculoskeletal disorders and disabilities among handloom and Powerloom weavers in the past 12 months and 7 days.

Body Regions	Handloom Worker (N=234)	Powerloom Worker (N=102)	Total	chi-2 test (χ^2)
Any*				
Past 12 months	100	87.25	96.13	Pearson $\chi^2(1) = 31.02$; p = 0.000
Disabled in past 12 months	99.15	80.39	93.45	Pearson $\chi^2(1) = 40.82$; p = 0.000
last 7 days	57.26	31.37	49.4	Pearson $\chi^2(1) = 19.05$; p = 0.000
Neck				
Past 12 months	35.04	15.69	29.17	Pearson $\chi^2(1) = 12.88$; p = 0.000
Disabled in past 12 months	32.91	13.73	27.08	Pearson $\chi^2(1) = 13.23$; p = 0.000
last 7 days	4.7	0.98	3.57	Pearson $\chi^2(1) = 2.85$; p = 0.091
Shoulder				
Past 12 months	76.07	42.16	65.77	Pearson $\chi^2(1) = 36.28$; p = 0.000
Disabled in past 12 months	67.95	38.24	58.93	Pearson $\chi^2(1) = 25.91$; p = 0.000
last 7 days	20.09	16.67	19.05	Pearson $\chi^2(1) = 0.53$; p = 0.46
Elbows				
Past 12 months	31.62	14.71	26.49	Pearson $\chi^2(2) = 12.22$; p = 0.002
Disabled in past 12 months	20.51	12.75	18.15	Pearson $\chi^2(1) = 2.88$; p = 0.089
last 7 days	3.85	2.94	3.57	Pearson $\chi^2(1) = 0.16$; p = 0.681
Wrists/hands				
Past 12 months	64.53	23.53	52.08	Pearson $\chi^2(1) = 47.84$; p = 0.000
Disabled in past 12 months	58.12	15.69	45.24	Pearson $\chi^2(1) = 51.63$; p = 0.000
last 7 days	13.68	4.9	11.01	Pearson $\chi^2(1) = 5.57$; p = 0.018
Upper back				
Past 12 months	84.19	45.1	72.32	Pearson $\chi^2(1) = 54.22$; p = 0.000
Disabled in past 12 months	59.4	24.51	48.81	Pearson $\chi^2(1) = 34.61$; p = 0.000
last 7 days	5.13	3.92	4.76	Pearson $\chi^2(1) = 0.22$; p = 0.633
Low back (small of the back)				
Past 12 months	82.91	50	72.92	Pearson $\chi^2(1) = 38.94$; p = 0.000
Disabled in past 12 months	61.11	38.24	54.17	Pearson $\chi^2(1) = 14.97$; p = 0.000
last 7 days	8.55	3.92	7.14	Pearson $\chi^2(1) = 2.29$; p = 0.130
One or both hips/thighs				
Past 12 months	31.62	18.63	27.68	Pearson $\chi^2(1) = 5.99$; p = 0.014
Disabled in past 12 months	9.4	3.92	7.74	Pearson $\chi^2(1) = 2.98$; p = 0.084
last 7 days	5.13	2.94	4.46	Pearson $\chi^2(1) = 0.79$; p = 0.372
One or both knees				
Past 12 months	60.26	35.29	52.68	Pearson $\chi^2(1) = 17.75$; p = 0.000
Disabled in past 12 months	44.44	10.78	34.23	Pearson $\chi^2(1) = 35.75$; p = 0.000
last 7 days	22.65	3.92	16.96	Pearson $\chi^2(1) = 17.68$; p = 0.000
One or both ankles/feet				
Past 12 months	10.68	4.9	8.93	Pearson $\chi^2(1) = 2.92$; p = 0.087
Disabled in past 12 months	3.42	0.98	2.68	Pearson $\chi^2(1) = 1.62$; p = 0.203
last 7 days	0.85	0.98	0.89	Pearson $\chi^2(1) = 0.01$; p = 0.910

*Either the neck, shoulder, elbow, wrists, upperback, low back, hips, knee, ankle

Table 2 shows the prevalence of MSDs in different parts of the in the last 12 months among handloom and power loom workers. 96.13% of the total workers including both handloom and power loom workers reported to have problem in any of the body region. All the handloom workers had problem in any part and most of the problems registered by them in the last 12 months were related to upper back (84.19%), low back (82.91%), shoulder (76.07%), wrist (64.53%) and knees (60.26%). On the other hand, 87.25% of the power loom workers had problem in any part and registered problems mostly in the low back (50%), upper back (45.1%), shoulder (42.16%) and knees (35.29%).

The study examined the impact of handloom work on MSDs by the estimated difference in the outcomes between the exposed workers (handloom) and the control group (power loom) using PSM. PSM reduces the bias found in an estimate of the exposure effect obtained by comparing outcomes among units of an exposed group versus a control group by controlling the demographic and occupational variables.

Results from **table 3** show the AEE for MSDs in various body parts during the last 12 months. Findings revealed that 14% of the handloom ($p<0.01$) and 15% ($p<0.01$) of the power loom workers registered MSDs. Among the handloom workers 34% had shoulder problem, 46% had problem in the wrist, 35% had problem in upper back and 38% had problem in the lower back. Similar patterns were also observed in the AEEE results. Both the handloom and power loom workers had same normal work prevention days due to MSDs (19%, $p<0.01$). More handloom worker had affected normal working due to problem in the wrist (45%) and shoulder (25%) compared to power loom workers.

Table 3: Average exposure effect (AEE) and average exposure effect in those exposed (AEEE) to the occupation of weaver on musculoskeletal disorders (MSDs) and for MSDs preventing normal work in the past 12 months

Body Region	MSDs				Normal work prevented due to MSDs			
	AEE		AEEE		AEE		AEEE	
	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
Any Problem*	0.14***	0.08 to 0.21	0.15***	0.08 to 0.22	0.19***	0.1 to 0.28	0.19***	0.09 to 0.29
Neck	0.2***	0.11 to 0.29	0.19***	0.09 to 0.29	0.2***	0.1 to 0.29	0.19***	0.09 to 0.28
Shoulder	0.34***	0.22 to 0.45	0.35***	0.22 to 0.47	0.25***	0.12 to 0.38	0.24***	0.1 to 0.38
Elbow	0.15***	0.05 to 0.24	0.15***	0.04 to 0.25	0.05	(-0.04 to 0.15)	0.04	(-0.06 to 0.14)
Wrists/hands	0.46***	0.37 to 0.55	0.46***	0.37 to 0.56	0.45***	0.36 to 0.54	0.43***	0.34 to 0.53
Upper back	0.35***	0.25 to 0.45	0.35***	0.24 to 0.46	0.35***	0.24 to 0.46	0.35***	0.23 to 0.47
Low back	0.38***	0.26 to 0.50	0.39***	0.27 to 0.52	0.2***	0.09 to 0.31	0.2***	0.08 to 0.31
Both Hips/thighs	0.18***	0.10 to 0.25	0.18***	0.11 to 0.26	0.06**	0.01 to 0.11	0.06***	0.02 to 0.11
Knees	0.25***	0.14 to 0.36	0.24***	0.13 to 0.36	0.32***	0.24 to 0.40	0.32***	0.24 to 0.40
Ankle	0.06**	0.01 to 0.12	0.07**	0.01 to 0.12	0.03**	0.01 to 0.05	0.03***	0.01 to 0.06

Note: * $p<0.1$, ** $p<0.05$, *** $p<0.01$, *Either the neck, shoulder, elbow, wrists, upperback, low back, hips, knee, ankle

Table 4 describes the relationship between risk factors for MSDs in the different areas of the body with adjustment for demographic and occupational characteristics. Compared to the power loom workers the handloom workers had significantly higher complaints of MSDs in neck (OR: 2.88; $p < 0.01$), shoulder (OR: 4.52; $p < 0.01$), elbow (OR: 2.96, $p < 0.01$), wrist (OR: 6.17, $p < 0.01$), upper back (OR: 6.9, $p < 0.01$), low back (OR: 5.63; $p < 0.01$), hip (OR: 2.18, $p < 0.01$), knee (OR: 3.23, $p < 0.01$) and ankle (OR: 2.97, $p < 0.01$). The result indicates that with increasing age significantly greater problem is registered in the shoulder (OR: 1.69, $p < 0.01$), low back (OR: 2.35, $p < 0.01$) and knee (OR: 2.79, $p < 0.01$). Those who owned a workshop had significantly greater problem in the elbow (OR: 2.83, $p < 0.01$) compared to the worker. Compared to those who had work satisfaction, those without work satisfaction had significantly greater odds of having neck problem (OR: 2.8, $p < 0.01$) and upper back (OR: 1.93, $p < 0.01$). With increasing years of work there are greater odds of having MSDs for instance compared to those working for 11-24 years those working for 35-45 years had 4.36 greater odds of having shoulder problem, 10.47 greater odds of having upper back problem and 3.35 greater odds of having problem in the low back.

Table 5 shows the result of logistic regression examining the effects of demographic and occupational characteristics on musculoskeletal disorders in those unable to do normal work, for various body regions in the last 12 months. It is seen from the results that the handloom workers had significantly greater odds of being unable to work due to MSD complaints in the neck (OR: 2.98; $p < 0.01$), shoulder (OR: 3.15; $p < 0.01$), elbow (OR: 1.88, $p < 0.01$), wrist (OR: 7.85, $p < 0.01$), upper back (OR: 4.91, $p < 0.01$), low back (OR: 2.33; $p < 0.01$), hip (OR: 2.82, $p < 0.01$), knee (OR: 7.06, $p < 0.01$) and ankle (OR: 4.54, $p < 0.01$) compared to the power loom workers. Compared to those workers in the age group of 50-54 years, those in the age-group of 56-65 years significantly greater odds of being unable to work due to problem in the upper back (OR: 1.99, $p < 0.01$), low back (OR: 1.82, $p < 0.01$) and knee (OR: 2.2, $p < 0.01$). Those who owned a workshop had significantly greater lost working days due to problem in the elbow (OR: 2.86, $p < 0.01$) and low back (OR: 1.63, $p < 0.01$) compared to the worker. Those who did not do any other work for livelihood were significantly more likely to be unable to work due to problem in neck (OR: 2.74, $p < 0.01$) and wrist (OR: 2.75, $p < 0.01$).

Table 4: Results of logistics regression analysis examining the effects of demographic and occupational characteristics on musculoskeletal disorders in the last 12 months for various body regions

Background Variable	Neck	Shoulder	elbow	Wrist	Upper back	Low back	Hips	Knee	Ankle
Weaver type									
Powerloom weavers®									
Handloom weavers	2.8*** (1.47 - 5.22)	4.52*** (2.63 - 7.76)	2.96*** (1.55 - 5.68)	6.17*** (3.56 - 10.7)	6.9*** (3.79 - 12.54)	5.63*** (3.19 - 9.95)	2.18** (1.2 - 3.95)	3.23*** (1.91 - 5.48)	2.97** (1.04 - 8.48)
Respondent Age									
50-54 age®									
56-65 age	1.5 (0.82 - 2.56)	1.69* (0.99 - 2.88)	0.94 (0.54 - 1.63)	1.41 (0.84 - 2.35)	1.16 (0.64 - 2.08)	2.35*** (1.32 - 4.18)	0.53** (0.31 - 0.9)	2.79*** (1.68 - 4.63)	1.45 (0.62 - 3.37)
Work Profile									
Worker®									
Own workshop	0.5* (0.28 - 1.05)	0.69 (0.35 - 1.33)	2.83*** (1.39 - 5.79)	1.28 (0.68 - 2.39)	1.23 (0.6 - 2.54)	1.22 (0.6 - 2.45)	0.87 (0.46 - 1.64)	0.98 (0.53 - 1.81)	0.41* (0.16 - 1.04)
Other work related to weaving	0.6 (0.31 - 1.23)	0.75 (0.36 - 1.56)	1.15 (0.52 - 2.58)	1.15 (0.59 - 2.24)	1.18 (0.52 - 2.66)	0.8 (0.38 - 1.67)	0.78 (0.38 - 1.59)	0.95 (0.49 - 1.83)	0.25** (0.07 - 0.84)
Work Satisfaction									
Yes®									
NO	2.8*** (1.49 - 5.12)	1.36 (0.73 - 2.55)	0.8 (0.41 - 1.57)	0.98 (0.55 - 1.76)	1.93* (0.94 - 3.97)	0.82 (0.43 - 1.55)	0.55* (0.29 - 1.03)	0.75 (0.42 - 1.34)	0.37* (0.12 - 1.11)
Any other work do for livelihood									
Yes®									
No	3.1** (1.03 - 9.06)	1.5 (0.59 - 3.8)	0.31** (0.13 - 0.72)	1.96 (0.82 - 4.7)	0.27* (0.07 - 1.08)	1.67 (0.66 - 4.25)	0.71 (0.28 - 1.77)	3.23** (1.32 - 7.9)	0.2*** (0.06 - 0.6)
Years of working									
11-24 years®									
25-34 years	0.9 (0.44 - 1.78)	2.72*** (1.44 - 5.13)	0.98 (0.51 - 1.89)	0.93 (0.51 - 1.69)	2.66** (1.33 - 5.35)	1.86* (0.96 - 3.6)	0.74 (0.39 - 1.37)	0.64 (0.35 - 1.15)	1.57 (0.59 - 4.18)
35-45 years	1.4 (0.79 - 2.63)	4.36*** (2.18 - 8.72)	1.4 (0.75 - 2.62)	1.7* (0.94 - 3.07)	10.47*** (4.06 - 27.04)	3.35*** (1.59 - 7.06)	0.61 (0.32 - 1.16)	1.15 (0.65 - 2.04)	1.22 (0.47 - 3.19)

Note: *p<0.1, **p<0.05, ***p<0.01. ® reference category

Table 5: Results of logistics regression analysis examining the effects of demographic and occupational characteristics on musculoskeletal disorders in those unable to do normal work, for various body regions in the last 12 months

Background Variable	Neck	Shoulder	elbow	Wrist	Upper back	Low back	Hips	Knee	Ankle
Weaver type									
Powerloom weavers®									
Handloom weavers	2.98*** (1.54 - 5.74)	3.18*** (1.91 - 5.28)	1.88* (0.95 - 3.74)	7.85*** (4.27 -14.43)	4.91*** (2.81 - 8.58)	2.33*** (1.4 - 3.86)	2.82* (0.91 - 8.77)	7.06*** (3.45 -14.42)	4.54 (0.51 - 40.12)
Respondent Age									
50-54 age®									
56-65 age	1.4 (0.79 - 2.5)	1.07 (0.65 - 1.76)	0.97 (0.53 - 1.79)	1.21 (0.72 - 2.04)	1.99** (1.19 - 3.32)	1.82** (1.12 - 2.97)	1.15 (0.46 - 2.84)	2.21** (1.26 - 3.89)	2.07 (0.43 - 9.93)
Work Profile									
Worker®									
Own workshop	0.69 (0.35 - 1.37)	0.67 (0.37 - 1.25)	2.99** (1.31 - 6.83)	0.94 (0.5 - 1.78)	1.93** (1.03 - 3.61)	0.66 (0.37 - 1.2)	0.88 (0.29 - 2.64)	0.68 (0.34 - 1.36)	0.37 (0.06 - 2.22)
Other work related to weaving	0.7 (0.35 - 1.41)	0.92 (0.47 - 1.8)	1.25 (0.5 - 3.17)	0.92 (0.47 - 1.8)	1.77* (0.91 - 3.45)	0.96 (0.5 - 1.84)	1.07 (0.32 - 3.59)	1.66 (0.81 - 3.42)	0.57 (0.09 - 3.61)
Work Satisfaction									
Yes®									
NO	2.86*** (1.52 - 5.36)	1.27 (0.71 - 2.27)	1.07 (0.5 - 2.26)	0.87 (0.48 - 1.57)	1.23 (0.69 - 2.21)	1.63* (0.93 - 2.87)	0.55 (0.18 - 1.66)	0.36*** (0.18 - 0.71)	0.35 (0.05 - 2.36)
Any other work do for livelihood									
Yes®									
No	2.74* (0.93 - 8.12)	1.87 (0.8 - 4.41)	0.59 (0.23 - 1.53)	2.75** (1.09 - 6.94)	0.52 (0.21 - 1.31)	1.75 (0.74 - 4.14)	0.27** (0.08 - 0.89)	2.01 (0.75 - 5.35)	0.14** (0.03 - 0.74)
Years of working									
11-24 years®									
25-34 years	0.89 (0.44 - 1.81)	1.79* (0.99 - 3.23)	0.82 (0.39 - 1.71)	0.94 (0.51 - 1.74)	1.47 (0.81 - 2.68)	1.59 (0.89 - 2.83)	0.19** (0.04 - 0.85)	0.92 (0.47 - 1.82)	1.67 (0.32 - 8.71)
35-45 years	1.47 (0.8 - 2.69)	2.51*** (1.39 - 4.53)	1.22 (0.61 - 2.42)	1.38 (0.77 - 2.49)	1.76* (0.98 - 3.15)	1.66* (0.94 - 2.92)	0.39* (0.13 - 1.13)	1.93** (1.06 - 3.53)	0.69 (0.12 - 4.09)

Note: *p<0.1, **p<0.05, ***p<0.01. ® reference category

Discussion

WMSDs is a graving issue among the informal sectors and the handloom industry is no exception to this. Working for long hours, sitting in static posture make the workers vulnerable to MSDs. In view of this the present study aims to investigate the prevalence of MSDs among the weaving community which includes workers at both handlooms and power looms. Bivariate analysis suggested a high prevalence of MSD among the handloom and power loom workers. The problems encompassed by the handloom workers is more in the upper back (84.19%), lower back (82.91%), shoulder (76.07%) and the wrist/hands (64.53%). Compared to the handloom workers the problem is less severe among the power loom workers. They mostly have problems in their lower back (50%), upper back (45%) and knees (35.29%).

Analysis of impact of exposure on the handloom workers after matching with the power loom workers using PSM revealed that working in handloom increased the prevalence of MSDs of the shoulder (34%), wrist (46%), upper back (35%) and lower back (38%). A similar pattern was found for those unable to perform normal activities due to MSDs. When adjusted for demographic and occupational variables in the multivariate logistic regression model the findings suggested that handloom workers were more likely to have MSDs compared to the power loom workers. Compared with the power loom workers the handloom workers were more likely to complain of neck (OR: 2.8; $p<0.01$), shoulder (4.52; $p<0.01$), elbow (2.96; $p<0.01$), wrist (OR: 6.17; $p<0.01$), upper back (OR: 6.9; $p<0.01$), lower back (OR: 5.63, $p<0.01$), hips (OR: 2.18; $p<0.01$), knee (OR:3.23, $p<0.01$) and ankle (OR:2.97, $p<0.01$) MSDs. Similarly, wrist (OR 7.85; $p<0.01$), knee (OR: 7.06; $p<0.01$) and upper back (OR 4.91; $p<0.01$) MSDs preventing normal activity were significantly higher among handloom workers compared to power loom workers. This may be because hand loom workers have to work in sitting posture for long hours and work with their hands engaging their wrist compared to the power looms where most of the works done are machine operated.

The health issues reported by the handloom workers are similar to issues reported by various other sectors which include metal industry, construction work, mining industry, spinning industry (Gamperiene & Stigum, 1999; Holmström, 2009; Lagerstrom & Wenemark, 1995; Weston et al., 2016). Literature particular to carpet weaving industry have also indicated high prevalence of musculoskeletal symptoms due to various working factors like postures, loom type, working hours, poor lighting & ambient conditions, poor air quality, lack of work-rest regime and seat type which led to loss of more than fifteen-thousand-man days and less

productivity in subsequent years of employment (Choobineh et al., 2004, 2007; Motamedzade & Moghimbeigi, 2012). Earlier study on handloom workers of Bangladesh and Nepal also showed similar problems and the major affected areas were neck, shoulder, back and wrist (Paudyal et al., 2013; Rahman et al., 2017). Studies in Indian context on workers of handloom and power looms in textile industry of India reported that both male and female workers were having significant MSD related to work (Goel & Tyagi, 2012; Nag et al., 2016). The most prominent MSDs among weavers were shoulder's pain, backache, pain in palm & joints and spondylitis (Goel & Tyagi, 2012). The MSDs found in the study of handloom workers of North East India affected the anterior and posterior muscles, quadriceps muscles, muscle fatigue, impeded blood circulation and venous blood pooling and prolonged sitting position also lead to in-vertebral joint laxity and fluid loss in spine and hamstring muscles (Pandit et al., 2013). Our study finding that with increase in the years of working the prevalence of MSDs increases is similar to earlier study based on handloom weavers of Kerala which indicates that MSD prevalence is different at different age group and increase with the duration of employment. Workers working in the dying sector have highest risk of MSDs followed by the weaving, winding, and finishing sector workers. The study also concluded that light, heat, noise, dust, and odour also affect the MSDs among the workers in the industry (Satheeshkumar & Krishnakumar, 2020). Handloom weavers in West Bengal also suffered from lower back pain and this is directly related to the number of years of working experience (Durlov et al., 2014). The handloom workers of Varanasi district are prone to MSDs related to wrist, shoulder, upper and lower back. These conditions deteriorate with increase age as well as increasing years of employment. They work in makeshift arrangement within their houses and the tradition is passed on from one generation to the other. They are not protected by any occupational health and safety measures and are not entitled to any benefits or job security. Their lower socio-economic position and poor housing conditions also increase their health risks.

Limitations of the Study

The present study has used cross sectional survey design to gather data. The use of a cross-sectional survey to collect data could have resulted in underestimation of true prevalence of MSDs. Since the MSD prevalence was based on self-reporting, this could have led to recall bias. Moreover, MSD severity was not quantified. Studies shows that self-reports on musculoskeletal disorders show over estimation of risk factors than the observation and direct measurement methods (Morse et al., 2010). Data were collected from handloom and power

loom weavers of Varanasi district of India and generalisation of the results to similar occupations must be done carefully.

The study recommends some preventive measures to minimise the prevalence of MSDs among the study population. The health providers can play an active role to minimise the burden through educating these people about the early signs of MSDs, and promoting the need of physical exercises to minimise the pains related to MSDs. Since most of the study population are from low socio-economic background and do not have enough to meet the health care needs, they should be made aware of all the central and state sponsored health care schemes like the Rajeev Gandhi Jeevandayee Aarogya Yojana, Swasthya Bima Yojna and should effectively utilise the schemes. Moreover, there is a need to improve the work environment with proper lighting and sitting arrangement. The work hours should also be restricted to few hours and should not work continuously sitting in static position.

The present study has highlighted the prevalence of MSD among the handloom workers. However, it has not explored the inpatient and outpatient health care costs. Thus future study should focus on the cost of meeting the health care needs, the coping mechanism and the economic burden of MSDs among the handloom weavers.

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