Chapter 41
Relationship of Pain in the Lower Back and Knee with Gender, Age, and BMI of the Pharmaceutical Supply Chain Workers

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1 Introduction

"Musculoskeletal Disorders (MSD) are injuries and disorders that affect the human body's movement or musculoskeletal system (i.e. muscles, tendons, ligaments, nerves, discs, blood vessels, etc.)" (http://ergo-plus.com/musculoskeletal-disorders-msd/). And, work-related musculoskeletal disorders (WMSDs) are the musculoskeletal disorders that arise from activities such as bending, straightening, gripping, holding, twisting, clenching, and reaching. What makes these postures more harmful at workplace is the constant repetition and the long time spent in those postures (https://www.ccohs.ca/oshanswers/diseases/rmirsi.html). It was found out that 20.33, 34.33, and 45.32% of the workers were under high, medium, and low risk of MSDs, respectively, in a study of the work of 102 workers in a forging industry (Singh et al. 2012). Small-scale industries are important to the economy in countries like India and constitute a large workforce, but hardly any attention is given to the workplace design and postures adopted by the workers in these industries, which lead to WMSD among them (Mali and Vyavahare 2015; Sain and Meena 2016). It was found that 59.4% of workers from 60 small- and medium-sized factories reported musculoskeletal disorders in different body parts depending upon the type of industry they belonged to Joshi et al. (2001)

Workers in supply chain units of the pharmaceutical industry are involved in picking and packing medicines, and it requires them to walk, bend while sitting and standing, kneeling on the floor, and squat too often. Packing activities being static as well as repetitive demand fixed position and continued repetition of movements

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or both (Velaga and Telaprolu 2013). In the same study of pharmaceutical packing workers, the pain was reported to be 74% in the upper limb, 59.3% in the back, and 60% in the lower limb (Velaga and Telaprolu 2013). There was 36.8% incidence of back and spinal disorders were reported in a study of pharmacy packaging workers (Varmazyar et al. 2009). Prevalence of musculoskeletal disorders in the upper back, wrists/hands, low back, knees, neck, and shoulders symptoms were found to be the most common problems among packing workers (Pourmahabadian et al. 2008).

Canadian Centre of Occupational Health and Safety suggests that "hazards are best eliminated at the source; prevention strategies involving workplace layout, tool, and equipment design, and work practices should be considered" (https://www.ccohs.ca/oshanswers/diseases/rmirsi.html). Stooping and squatting squat sitting postures were the dominating postures in potato cultivation jobs. It was noted that the most affected body parts were the lower back (92.26%), the highest for all the activities (Pal et al. 2015).

A significant association between the gender of workers and self-reported musculoskeletal disorders was detected but not between the age of the workers and musculoskeletal disorders (Pourmahabadian et al. 2008). In another study of working conditions of pharmaceutical packing workers, pain in the neck, shoulder, and back was found to be related to the gender of the works, but the pain in low back wasn't (Kheiri et al. 2011–2012). Body Mass Index (BMI) of workers was found to be associated with the prevalence of MSD symptoms. However, this association was subject to the workers' physical workload (Viester et al. 2013).

The objective of this paper is to investigate if factors such as gender, age, and body mass index (BMI) of workers affect the presence of pain in the lower back and knee among workers of the pharmaceutical supply chain.

2 Methodology

2.1 Sample

A sample of 116 workers (91 male and 25 female) was chosen from 11 pharmaceutical supply chain units from India. The age of workers was 18–42 years, and the work experience was 1–15 years.

2.2 Tasks Performed by the Workers

As shown in Fig. 1, the main job of the workers at the distribution unit is to pick medicines from different parts of the godown, assemble them in one place, and pack them into customized packages for supply. The activities done by the workers to do this job include standing with bent back and legs, walking with load, and sitting in

Fig. 1 Main activities performed by the workers at distribution units in pharmaceutical supply chain

squatting and kneeling on the floor to pack medicines. The postures adopted while doing these activities are standing, standing with one or both legs bent, standing and sitting with bent and twisted back, squatting, and kneeling on the floor.

Observation of tasks performed by workers was done, and video recording and pictures were taken using a DSLR (Digital Single Lens Reflect) camera. Videos and photographs were then transferred to a computer for further evaluation.

2.3 Measurement of Pain, Demographic Details, and Anthropometric Measurements

Respondents were asked to mark body regions where they experience pain out of the nine anatomical regions prone to develop MSD. Nine anatomical areas are neck, shoulder, elbow, wrist/hand, upper back, lower back, hips/thighs/buttocks, knees, and ankles/feet (Kuorinka et al. 1987). A general questionnaire was used to collect the demographic data, and a weighing scale and anthropometric kit, and measuring tape were used to take anthropometric measurements.

Body Mass Index (BMI) of workers was calculated using the following formula:

$$\text{BMI} = \text{Mass/Square of Height} \tag{1}$$

Mass (in kilogram).

Height (in meters)

2.4 Analysis

Workers were classified into three BMI classes and three age groups. Table 1 shows

Table 1 Count and percentage of workers in each BMI and age group

BMI groups				
	13.2–18.5	18.6–24.5	24.6–30.6	Total
Count	17	80	19	116
% within each group	14.7%	69%	16.3%	100.0%
Age groups (Years)				
	18–25	26–34	35–42	Total
Count	40	50	26	116
% within each group	34.5%	43%	22.5%	100.0%

the count and percentage of workers in each category of BMI and age. The distribution of workers in the categories of BMI and age is also represented in Figs. 2 and 3.

Chi-square test with a 0.05 level of significance was used to determine the association of pain in body parts with gender, body mass index, and age of workers. SPSS software was used to do statistical analysis.

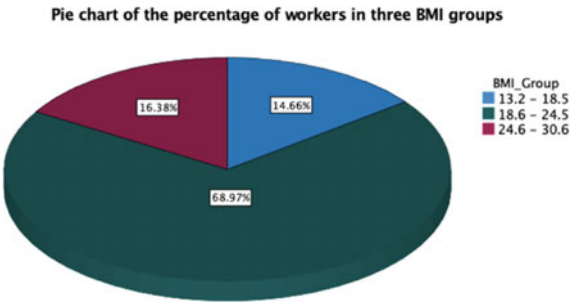

Fig. 2 Percentage of workers in three BMI groups

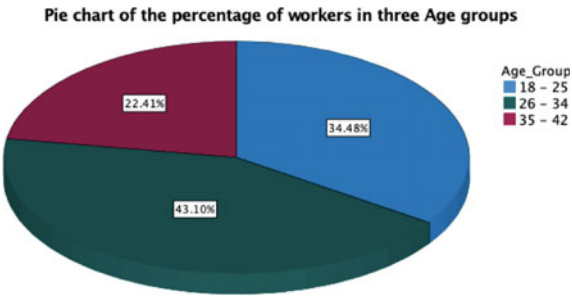

Fig. 3 Percentage of workers in three age groups

Table 2 Mean age, years of work experience, education, monthly income, and BMI of workers

Parameter	Mean ± SD (Total)	Range	Mean ± SD (Male workers)	Mean ± SD (Female workers)
Age (Yr.)	28.29 ± 6.15	18–42	26.87 ± 5.3	33.48 ± 6.41
Work experience (Yr.)	4.30 ± 3.44	1–15	4.41 ± 3.5	3.88 ± 3.3
Education (Yr.)	11.66 ± 2	3–17	11.82 ± 2	11.08 ± 2
Monthly income	9,688.79 ± 3923.44	3000–23,000	10,765.93 ± 3714.2	5,768.00 ± 1270.73
BMI	21.94 ± 3.07	13.24–30.6	21.83 ± 3.0	22.35 ± 3.3

3 Result

3.1 Subject Demographic Information

Table 2 presents the characteristics of the sample.

3.2 Presence of Pain in Lower Back and Knee

73 people (63%) and 37 people (32%) reported the presence of pain in the lower back and knee, respectively. Table 3 shows the frequency and frequency percentage of pain reported by both the genders separately and also, by the total number of respondents.

No significant association (p-value = 0.73) was found between the presence of pain in lower back and gender of the workers.

However, a significant association (p-value = 0.015) was found between the presence of pain in knee and gender of the workers.

Table 3 Frequency and percentage of workers with pain in low back and knee in gender categories

		Female	Male	Total
Pain in lower back	Count	15	58	73
	% within gender	60.0%	63.7%	62.9%
Pain in knee	Count	13	24	37
	% within gender	52.0%	26.4%	31.9%

3.3 Association Between Pain and BMI Levels

No significant association was found between the presence of pain in the lower back and BMI of workers, and pain in the knee and BMI of workers (p-value 0.726 and 0.87, respectively). Table 4 shows the frequency and frequency percentage of pain reported by each BMI group. Figure 4 shows the percentage of workers reporting pain in the lower back and knee in three categories of BMI.

Table 4 Frequency and percentage of workers with no pain and pain in low back and knee in BMI groups

			≤18.5	18.6–24.5	24.6+	Total
Pain in lower back	No	Count	5	30	8	43
		% within BMI group	29.4%	37.5%	42.1%	37.1%
	Yes	Count	12	50	11	73
		% within BMI group	70.6%	62.5%	57.9%	62.9%
Total		Count	17	80	19	116
		% within BMI group	100.0%	100.0%	100.0%	100.0%
Pain in knee	No	Count	12	55	12	79
		% within BMI group	70.6%	68.8%	63.2%	68.1%
	Yes	Count	5	25	7	37
		% within BMI group	29.4%	31.3%	36.8%	31.9%
Total		Count	17	80	19	116
		% within BMI group	100.0%	100.0%	100.0%	100.0%

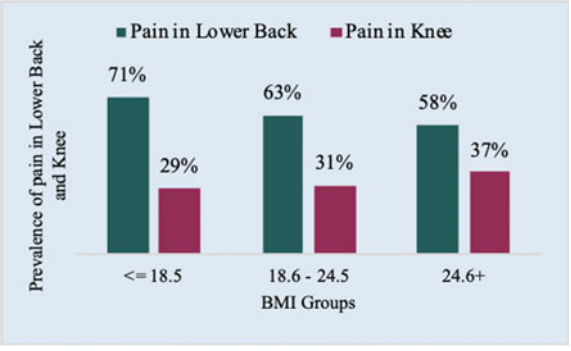

Fig. 4 Bar chart for percentage of prevalence of pain in lower back and knee for each BMI group

3.4 Association Between Pain and Age Groups

No significant association was found between the presence of pain in lower back and age group, and presence of pain in knee and age group of the workers (p-value 0.817 and 0.735, respectively). Table 5 shows the frequency and frequency percentage of pain reported by each age group. Figure 5 presents the percentage of workers who reported pain in the lower back and knee in three categories of age.

Table 5 Frequency and percentage of workers with no pain and pain in low back and knee in age groups

			≤25	26–34	35+	Total
Pain in lower back	No	Count	14	18	11	43
		% within age group	35.0%	36.0%	42.3%	37.1%
	Yes	Count	26	32	15	73
		% within age group	65.0%	64.0%	57.7%	62.9%
Total		Count	40	50	26	116
		% within age group	100.0%	100.0%	100.0%	100.0%
Pain in knee	No	Count	26	36	17	79
		% within age group	65.0%	72.0%	65.4%	68.1%
	Yes	Count	14	14	9	37
		% within age group	35.0%	28.0%	34.6%	31.9%
Total		Count	40	50	26	116
		% within age group	100.0%	100.0%	100.0%	100.0%

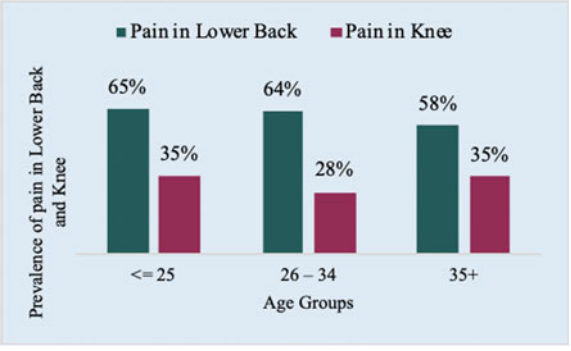

Fig. 5 Bar chart for percentage of prevalence of pain in lower back and knee for each age group

3.5 Results of Non-parametric Test

The prevalence of pain in the lower back and knee was the same across three BMI groups with *p*-values of 0.72 and 0.87, respectively. So was the prevalence of pain in the lower back and knee across three age groups with p-values of 0.81 and 0.74 each. The presence of pain in the lower back was identical for both genders ($p = 0.73$). Whereas, it was not identical for pain in the knee in male and female workers ($p = 0.015$). The significance level was 0.05.

4 Discussion

The prevalence of pain in the lower back and knee, respectively, is reported to be 63 and 32% in this study. Similar findings were seen in previous studies: 44.7% knee pain and 36.8% back pain were reported by pharmacy packing workers in a study in Iran (Varmazyar et al. 2009), and 47% low back pain and 43% knee pain were reported by pharmacy packing workers in another study (Pourmahabadian et al. 2008). For the workers of a tobacco factory who had to bend and stand with the flexed legs frequently, the prevalence of MSD in the low back (55%) and knees (45%) was noticed (Etemadinezhad et al. 2013).

Results of this study revealed that pain in the lower back and knee was the same across all categories of age and BMI level of workers. Pain in the lower back showed no dependence on the gender of the worker in this study, and this result was in agreement with a previous study where no relationship between pain in the low back and gender of packing workers was seen (Pourmahabadian et al. 2008, Viester et al. 2013). However, pain in the knee showed a dependence on the gender of the worker in this study. The results from the current investigation indicate that the presence of MSD symptoms could be related to the postures employed for the work of the supply of medicines. Former researches that are done on pharmaceutical packing workers explain the presence of musculoskeletal disorders, the need for posture correction, and a call for ergonomic intervention in the workplace. However, no work has been done on the posture, work pattern, and workplace of the workers in the pharmaceutical supply chain system. There is a scope to create a workstation design that can help in lessening the MSD symptoms in these workers.

The final RULA score (mean 4.87) emphasize on poor workstation design among pharmacy packaging workers (Varmazyar et al. 2009).

5 Conclusion

The relationship between pain in body parts and demographic factors such as age, gender, and BMI could not be established decisively. The prominence of pain in the

lower back and knee among workers of pharmaceutical supply chain units suggests that ergonomic evaluation work postures of pharmaceutical supply chain workers need to be done. There is also a scope of ergonomic intervention at work place to reduce musculoskeletal discomfort as no workplace has been designed for the pharmaceutical supply chain workers.

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References

Etemadinezhad S, Ranjbar F, Gorji M (2013) Posture analysis by Owas method and prevalence of musculoskeletal disorders among workers of Sourak tobacco factory. Iran J Health Sci 1(2):89–94

Joshi TK, Menon KK, Kishor J (2001) Musculoskeletal disorders in industrial workers of Delhi. Int J Occup Environ Health 7(3):217–221

Kheiri H, Moshfegh H, Hatami H, Ranjbarian M (2011–2012) Investigation of relationship between musculoskeletal disorders and working conditions among workers at a pharmaceutical industry in Iran. Iran J Health, Saf Environ 1(3):145–150

Kuorinka I et al (1987) Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon 18:233–237

Mali SC, Vyavahare RT (2015) An ergonomic evaluation of an industrial workstation: a review. Int J Curr Eng Technol 5(3):1820–1826

Middlesworth M The definition and cause of musculoskeletal disorders. Ergoplus. Retrieved from http://ergo-plus.com/musculoskeletal-disorders-msd/

Pal A, De S, Sengupta P, Maity P, Dhara P (2015) Evaluation of work related musculoskeletal disorder and postural stress among female potato cultivators in West Bengal. Ind Ergonom Sa 27(1)

Pourmahabadian M, Akhavan M, Azam K (2008) Investigation of risk factors of work-related upper-limb musculoskeletal disorders in a pharmaceutical industry. J Appl Sci 8(7)

Sain MK, Meena ML (2016) Occupational health and ergonomic intervention in Indian small-scale industries: a review. Int J Recent Adv Mech Eng (IJMECH) 5(1)

Singh J, Lal H, Kocher G (2012) Musculoskeletal disorder risk assessment in small scale forging industry by using RULA method. Int J Eng Adv Technol 1(5):513–518

Varmazyar S, Varyani AS, Zeidi IM (2009) Evaluation working posture and musculoskeletal disorders prevalence in pharmacy packaging workers. Eur J Sci Res 29(1):82–88

Velaga P, Telaprolu N (2013) Work posture and prevalence of musculoskeletal symptoms among women in packing activities of pharmaceutical industry. Ijcrr 05(17):57–64

Viester L et al (2013) The relationship between body mass index (BMI) and musculoskeletal symptoms in the working population. BMC Musculoskelet Disord 14:238

Work related musculoskeletal disorders, Canadian Center for Occupational Health and Safety. Retrieved from https://www.ccohs.ca/oshanswers/diseases/rmirsi.html