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Original Article

Ergonomic evaluation of work-related musculoskeletal disorders in informal work on fish vendors in Ampara, Sri Lanka

Mohamed Thariq MG[1], Safna SF[1], Nikzaad RM[1]

[1] Department of Biosystems Technology, Faculty of Technology, South Eastern University of Sri Lanka, Sri Lanka

Corresponding author:

MG Mohamed Thariq, Department of Biosystems Technology, Faculty of Technology, South Eastern University of Sri Lanka, Oluvil, Sri Lanka

E-mail: mgmthariq@seu.ac.lk

ORCID ID: https://orcid.org/0000-0002-4348-0396

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ABSTRACT

Introduction: Fish vending, an informal work, is expected to cause WMSDs due to prolonged standing, shoulder elevation, bending and twisting, repetitiveness and high physical activities. The study was carried out to investigate the prevalence of WMSDs and the associated factors among fish vendors.

Methods: In a cross sectional study, 202 fish vendors were selected using simple random sampling technique with face to face interview to solicit data on working conditions and WMSDs in the coastal areas of the Ampara district during June to August 2022. Fish vendors were video recorded for postural analysis using RULA.

Results: The WMSDs among fish vendors in neck, shoulder, upper back, lower back, elbow wrist, hip, knee and feet were 52%, 55%, 53.3%, 49.1%, 52%, 65.3%, 56%, 57.4% and 46% respectively. The final RULA score of 7 was obtained for 56% of fish vendors. The awkward working posture was significantly associated with WMSD in wrist while heavy lifting was associated with WMSDs in neck. The humidity was significantly associated with WMSDs in shoulder, lower back and knees and thermal comfort was significantly associated with WMSDs in lower back and knees. The age and experience significantly associated with WMSDs in all the body regions investigated.

Conclusion: The majority of fish vendors had WMSDs in different body regions. The awkward posture, heavy lifting, age, experience, humidity and thermal comfort were associated with WMSDS. Fish vendors are required to use a recommended size of boxes to lift and carry fish and to have correct standing work surface height and also to use knife designed with proper weight, handle size and shape.

Keywords: Head posture, Heavy lifting, Knife design, Standing work height, Wrist posture

Introduction

Manual tasks such as lifting and carrying cartons, unloading onto the table, sorting, peeling, weighing and sizing, ring cutting and packing are some of the essential activities in fish processing involving higher levels of physical activity and increasing the risk of work-related musculoskeletal disorders (WMSDs) in women workers.[1] Further, standing for long hours in standard and awkward postures increased the risk of WMSDs among male and female workers involved in fish processing activities.[1,2] According to Garcia et al.[3] muscle fatigue in lower limbs develops if standing posture is maintained for more than 5 hours. Another study found that stooping posture, holding heavy loads in positions and working with arms above shoulder

level were related to shoulder pain.[4] The WMSDs, in addition to their physical effects, can cause unfavorable consequences such as a reduction in work capacity, a lower level of income, deterioration of quality of life, and the onset of other health consequences such as stress and depression.[5] Further, WMSDs are the leading cause of absence from work in the UK.[6]

Fish vending is an informal work involving various manual tasks. Street vending is considered an informal work, and a large population is engaged in informal jobs, 63% in Sri Lanka, 70% in Central America, and more than 90% in India.[7,8,9] Previous studies reported that musculoskeletal disorders are a common problem among street vendors.[9,10] It was found that WMSDs are the most frequent health problem (82.7%) reported by street vendors as a result of poor manual handling practices involving awkward posturing.[11] Workers in the informal sector are the population who lack health services, especially occupational health.[12] Therefore, the tasks in the informal businesses are associated with very high health risks, mainly WMSDs. Jobs in the informal sector are characterized by the features of a relatively small business scale, use of manual and straightforward technology, low-income levels, and low skills.[13] Further, the informal sector is poorly regulated and does not have written rules. Moreover, a lack of awareness and carelessness and negligence about threats and dangers that occur because of poor working conditions may aggravate the risk of work accidents and other occupational diseases.

According to Ruiz de Porras et al,[8] compared with formal workers, informal workers reported a higher prevalence of WMSDs in the body regions. Fish vending is mainly carried out in a prolonged standing posture; therefore, fish vending is expected to cause WMSDs due to ergonomic risk factors, i.e., prolonged standing, shoulder elevation, abducted arms, bending and twisting of the torso, repetitiveness, and high physical activities. The prevalence of WMSDs among fish vendors and the associated risk factors are limited in the literature. Therefore, the objectives of the present study were to investigate the prevalence of WMSDs among fish vendors and the associated factors.

Methods

It was a cross-sectional study involving fish vendors administering a pre-tested questionnaire with face-to-face interview. The study was carried out at the coastal areas of Ampara district in Sri Lanka, from where five locations were selected after a preliminary field appraisal where fish vendors are concentrated during June to August 2022. The population of the fish vendors in the study area is not known. Hence the sample size was determined according to the formula recommended by Pourhoseingholi et al. (2013).[14]

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where,

n - Sample size

Z – Confidence level (95%)

P – Expected prevalence (5%)

d – Precision (0.03)

Calculations as follows:

$$n = \frac{(1.96)^2 0.05(1-0.05)}{(0.03)^2}$$

=202.75

~202 Samples

Accordingly, 202 fish vendors were selected from Akkaraippattu, Pottuvil, Nintavur, Karaitivu and Kalmunai areas as representative samples to obtain accurate results. Each participant was explained the study and their written consent was obtained. The study was approved by the Ethics Review Committee of the Faculty of Technology of the South Eastern University of Sri Lanka (ERC No. ERC/FT/2022/14). The sample included only males since no females were involved in fish vending work in the study locations. Healthy fish vendors who were involved only in fish vending between the ages of 31 and 66 years old and with more than 5 years' experience in fish vending were selected.

The pretested questionnaire consisted of personal information and information on WMSDs and

workplace environmental conditions. In a cross-sectional study, the questionnaire was filled out by interviewing each participant when they engaged with the fish vending activities. The RULA postural risk assessment tool was used to obtain observational data. The fish vendors willing to be video recorded (n=35) were selected for the RULA analysis. The video recordings were retrieved carefully to analyze the body postures at the Department of Biosystems Technology laboratory, and RULA sheets were filled; the researcher was trained in retrieving video recordings for RULA. A manual thermometer and hygrometer were used to measure temperature and relative humidity. The weight was obtained using a weighing scale. The data was analyzed using SPSS version 25 and Excel 2013.

Results

More than seventy percent of the fish vendors (73%) were between 41 and 60 years of age. More than half of the fish vendors (52%) worked 7 – 8 hours per day (Table 1).

Table 1: Characteristics and working conditions of fish vendors

Variable		Numbers (Percentage)
Age (in years)		
	31 – 40	31 (15.34)
	41 – 50	71 (35.14)
	51 – 60	77 (38.11)
	61 – 70	23 (11.38)
Gender		
	Male	202 (100)
	Female	0 (0)
Work experience (in years)		
	05 – 10	58 (28.71)
	11 – 15	63 (31.18)
	16 – 20	62 (30.69)
	21 – 25	18 (8.19)
	26 – 30	1 (0.49)
Body weight (Kg)		
	30 – 50	17 (8.41)
	51 – 70	178 (88.11)
	71 – 90	7 (3.46)
Working hours		
	Below 6 hrs.	6 (2.97)
	6 – 7	82 (40.59)
	7 – 8	106 (52.47)
	8 – 9	8 (3.96)
Alcoholic		
	Yes	22 (10.90)
	No	180 (89.10)
Smoking		
	Yes	38 (18.81)
	No	164 (81.19)
Health issues		
	Chest pain	36 (17.82)
	Cough	37 (18.31)
	Depression	15 (7.42)
	Fever	13 (6.43)
	Headache	38 (18.81)
	Mid fever	51 (25.24)
	Wheezing	12 (5.94)

Weight of fish box carried (kg)	10 – 29	14 (6.93)
	30 – 49	74 (36.63)
	50 – 69	114 (56.43)
	70 – 90	13 (6.43)
Type of work		
	Cutting	189 (93.56)
	Taking fish from box	3 (1.48)
	Carrying the box	2 (0.99)
	Lifting the box	2 (0.99)
	Cleaning	1 (0.49)
	Trimming	2 (0.99)
	Packing	1 (0.49)
	Weighting	1 (0.49

A sizable portion, 11% and 19%, of the fish vendors were found to be alcoholics and smokers, respectively. More than half of the fish vendors (56%) handled fish boxes weighing 50 – 69 kg. More than ninety percent of the fish vendors (93%) were involved in cutting fish to give away to buyers (Table 1).

Table 2: Rating of pain in different body regions by fish vendors

Pain rating	Neck pain %	Shoulder pain %	Upper back pain %	Lower Back pain %	Elbow pain %	Wrist pain%	Hip pain %	Knee pain %	Feet pain %
1 - no pain	47.5	45.0	46.5	50.9	48.0	34.7	44.0	42.6	54.0
2	41.5	38.6	41.6	37.6	44.5	52.5	44.6	44.5	35.6
3	9.5	13.9	9.4	7.4	4.0	7.4	7.9	8.9	7.4
4	1.5	2.5	2.5	4.1	3.5	5.4	3.5	4.0	3.0
5	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-
7- extreme pain	-	-	-	-	-	-	-	-	-

A significant percentage (34%) to more than half of fish vendors (54%) had no pain in the neck, shoulder, upper back, lower back, elbow, wrist, hip, knee, and feet. No one had extreme level or level 5 and level 6 pain in the body regions studied (Table 2). A significant percentage (35.6%) to more than half of respondents (52.5%) had level 2 pain. A lower rate of respondents (1.5% - 13.9%) had level 3 and level 4 pain in the body regions studied (Table 2).

Table 3: Percentage of RULA score in different body regions among fish vendors.

RULA score	Upper arm score (%)	Lower arm score (%)	Wrist score (%)	Score A	Neck score (%)	Trunk score (%)	Leg score (%)	Score B (%)	Final RULA score (%)
1	4	44	NF	NF	NF	4	100	NF	NF
2	29	56	11	4	22	59	NF	22	NF
3	67	NF	85	63	63	151	NR	37	NF
4	NF	NR	4	33	15	15	NR	11	4
5	NF	NR	NR	NR	NF	7	NR	15	7
6	NF	NR	NR	NR	NF	NF	NR	7.5	33
7	NR	NR	NR	NR	NR	NR	NR	7.5	56
Mean ± SD	2.26± 0.526	1.56± 0.506	2.93± 0.385	3.30± 0.542	2.93± 0.616	2.63± 1.043	1.04± 0.192	3.70± 1.540	6.41± 0.797

More than half of the fish vendors (56%) had a final RULA score of 7, another 33% had a final RULA score of 6, another 7% had a final RULA score of 5, and the remaining 4% had a RULA score of 4. No respondents were found with the final RULA scores of 3, 2, and 1 (Table 3).

Table 4: Association of WMSDs in different body regions with various factors among fish vendors.

Factors	Neck	Shoulder	Elbow	Upper back	Wrist	Lower back	Hip	Knees	Feet
Age	0.001	0.045	0.007	0.007	0.02	0.019	0.021	0.007	0.018
Experience	0.017	0.018	0.015	0.008	0.024	0.000	0.010	0.030	0.002
Body height	0.005	0.027	0.001	0.895	0.997	0.369	0.865	0.997	0.989
Difficult working posture	0.929	0.724	0.824	0.840	0.008	0.318	0.538	0.279	0.860
Heavy lifting	0.013	0.157	0.078	0.112	0.488	0.397	0.340	0.571	0.165
Indoor humidity	0.749	0.021	0.133	0.569	0.561	0.029	0.798	0.046	0.874
Indoor thermal comfort	0.974	0.410	0.112	0.396	0.570	0.002	0.165	0.045	0.784

Body regions against the different factors with a p-value of $P<0.05$ are significant.

The higher the final RULA score, the greater the risk of sustaining WMSDs. In the analysis of factors associated with WMSDs in different body regions, the factors statistically associated with WMSDs in at least one body region are presented in Table 4. More than half of the fish vendors (56%) had a work posture with a final RULA score of 7, another 33% with a final RULA score of 6, 7% with a final RULA score of 5, and the remaining 4% with a RULA score of 4. No respondents were found with the final RULA scores of 3, 2, and 1 (Table 3).

In the analysis of factors associated with WMSDs, the factors with statistically significant associations are presented in Table 4. With regard to the demographic variables analyzed, age and experience were significantly associated with WMSDs in the neck, shoulder, elbow, upper back, wrist, lower back, hip, knees, and feet. The awkward working posture was significantly associated with WMSD in the wrist, whereas heavy lifting was associated with WMSD in the neck (Table 4).

Indoor humidity was significantly associated with WMSDs in the shoulder, lower back, and knees, and indoor thermal comfort was significantly associated with WMSDs in the lower back and knees (Table 4).

Discussion

The present study found the absence of pain (pain level 1 – no pain) in different body regions among many fish vendors (34.7% - 54%). However, the WMSDs were prevalent among fish vendors in various body regions as found i.e., 52% (neck), 55% (shoulder), 53.5% (upper back), 49.1% (lower back), 52% (elbow), 65.3% (wrist), 56% (hip), 57.4%(knee), and 46% (feet). The aforesaid WMSD percentages in different body regions were obtained by adding pain levels 2, 3, and 4, which were reported by participants on a 1 - 7 scale. Further, the present study found that only a smaller percentage of fish vendors (1.5% - 5.4%) had pain level 4 (may indicate a moderate pain level). In the previous studies, a higher prevalence of WMSDs was found in various manual operations; for example, 71% of women workers engaged in fish processing[1] and 95% of informal manual workers in Calcutta, India.[15] The WMSDs are street vendors' most frequent health problem (82.7%).[11] Gangopadhyay et al.[16] found higher prevalence of discomfort in body regions in various other tasks involving manual work, i.e., in meat cutters (80%), in tailors and typists (84%), and weavers (92%). However, these studies have not investigated the pain level in different body

regions. In the present study, pain level 2 (denoted as a very low level of pain) was reported by many fish vendors (35.6% - 52.5%), and no one reported pain levels 5, 6, and 7. These results may indicate that fish vendors had a moderate and below moderate pain level in different body regions studied. Our postural risk analysis revealed that the tasks involved in fish vending were associated with a higher risk level. According to our RULA analysis, the final RULA score for work postures was 7 for 56% of fish vendors, which indicates a higher risk level for developing WMSDs. This study found that 93.5% of people engaged in the fish cutting task in a standing posture. This could be the reason for the higher percentage of fish vendors reporting pain in the wrist (65.3%) compared to the other body regions. Therefore, it is concluded that WMSDs are prevalent among fish vendors, and the tasks related to fish vending are associated with a higher risk of developing WMSDs.

Girish et al. [17] found that 71.5% of workers in the cashew factory had no pain, which is in agreement with the findings in the present study. However, according to RULA analysis, 56% of fish vendors' final RULA score for work postures was 7, which indicates a higher risk level for WMSDs among fish vendors.

It was found that fish vendors are at high risk of developing WMSDs, and a multitude of factors contributed to this. Those were demographic factors such as age and experience, work-related factors such as awkward working posture and heavy lifting, and work environment factors such as indoor humidity and indoor thermal comfort.

Fish vendors performed their tasks in a prolonged standing posture; meanwhile, they lifted and carried heavy fish boxes. The results show that heavy lifting is significantly associated with WMSDs in the neck. The weight of fish box lifted and carried by 93% of fish vendors varied from 30kg to 69kg. According to Waters et al.[18], the maximum recommended weight for lifting at the standard lifting location under optimal conditions is 23kg. Therefore, in the present study, the weight lifted and carried by fish vendors was higher than the weight recommended for lifting. The finding in the present study is consistent with previous studies where heavy lifting[19] and heavy lifting by hands and arms[20] are associated with WMSDs in the neck region as a result of shared muscular contraction.[20] The WMSDs in the neck region can be avoided by reducing the weight being carried, which can be implemented by using the recommended size of the box. Further, the relevant authorities can consider enforcing the use of the recommended fish carrying box size. Secondly, workers involved in fish vending need to be educated about the handling and carrying of weights close to the body.

The significant association of awkward working posture with WMSDs in the wrist may indicate that the wrist is the body part affected in the fish vending task. The present study found that around 93% of the fish vendors were involved in the fish cutting task. The fish vendors are engaged in repeated fish cutting. They used knives with various weights and various designs. The weight of the knives varied from 300g to 800g. Further, the standing work surface height used for fish cutting differed in different locations. All these factors together led to the awkward wrist posture, resulting in WMSDs in the wrist. In addition, the wrist score obtained using the RULA tool showed that the fish vendors' wrists were in a poor posture while cutting fish. Our results also indicated that 65.3% of fish vendors had pain (different pain levels) in their wrists. The wrist posture can be improved by using a knife designed with ergonomic principles of manual hand tool design. Secondly, the right standing working surface height will also help to improve the wrist posture. In addition, fish vendors can be educated on proper manual material handling methods.

In addition to lifting and carrying of heavy loads and awkward working posture, the age and experience of fish vendors also influenced the WMSDs in all the body regions investigated. With regard to age, previous studies found that with the increase of age, the prevalence of WMSDs among

workers increases. [21,22]. Because, when workers become aged, a decrease in their physical work capacity/work ability, an increase in the development of joint problems, and a decrease in general health issues[23,24] are observed, which aggravate the increase of WMSDs in older age workers. However, Yang et al.'s findings[25] contradict the present study's findings. Yang et al.[25] found that age is not associated with WMSDs among workers. Therefore, the age factor is not considered an independent variable influencing WMSDs but co-exists with other likely factors.

Concerning the experience, the present study found that the experience of fish vendors is one of the crucial factors associated with the WMSDs. Previous studies found that employees with higher experience had the higher risk of developing WMSDs.[21, 26, 27, 28] The reason could be, according to Yang et al.[25], workers with a long experience in manual and physical works are more exposed to risk factors than workers with a short experience because, the WMSDs are gradually developed through overuse of body parts and by nature they are repetitive strains or cumulative trauma.

About the workplace environment, previous studies found the relationship between environmental factors and WMSDs.[29, 30] In the present study, we found that the workplace environmental factors were with a risk of developing WMSDs i.e., indoor humidity was associated with shoulder, lower back, and knee pain whereas indoor temperature associated with lower back and knee pain. It was found that during the high wind, moisture and precipitation, their research participants experienced pain.[29] Further, a strong association between temperature and WMSDs was found.[29] Our findings in the present study align with previous findings that the workplace environmental factors are associated with WMSDs. However, the mechanism by which these workplace environmental factors affect WMSDs is yet to be explored.[29]

Conclusions

The majority of fish vendors had WMSDs in different body regions. An awkward posture, heavy lifting, age, experience, humidity, and thermal comfort were associated with WMSDS. It is recommended to regulate the use of fish box sizes for lifting and carrying. The right standing work surface height should also be considered, in addition to designing a knife with ergonomics and using it properly to have the right wrist posture while cutting fish.

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