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Factors associated with musculoskeletal disorders in artisanal fisherwomen/shellfish gatherers in Saubara, Bahia, Brazil

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Abstract *This article aims to identify the factors associated with musculoskeletal disorders (MSDs) in the neck/shoulder and distal upper limb in artisanal fisher/shellfish gatherers in Saubara, Bahia, Brazil. This cross-sectional epidemiological study was conducted with shellfish gatherers. The Brazilian version of the Job Content Questionnaire (JCQ), the Nordic Musculoskeletal Questionnaire (NMQ), and a questionnaire containing physical demands adapted to the labour of shellfish gatherers were used in this study. Factor analysis was performed to aggregate the physical demands. Multivariate analyses were performed according to the risk factors for MSDs in the neck or shoulder and MSDs in the distal upper limb. For MSDs in the neck or shoulders, a prevalence ratio (PR) of 1.28 (95% confidence interval [95% CI]: 1.09-1.49) was found, according to the aggregate physical demands. For MSDs in the distal upper limb, the PRs were as follows: 1.26 (95% CI: 1.07-1.47) according to the daily hours devoted to work as shellfish gatherers, 0.74 (95% CI: 0.57-0.96) according to the development of other current work and 1.38 (95% CI: 1.05-1.83) according to the aggregate physical demands. The activities performed by shellfish gatherers contribute to the occurrence of MSDs.*

Key words *Artisanal fisherwomen, Shellfish gatherers, Musculoskeletal disorders*

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Introduction

There are few epidemiological studies in the literature that associate the work process with musculoskeletal disorders (MSDs) in artisanal fisherwomen[1]. Although a study with shellfish gatherers indicates an association with MSDs, the authors did not make it clear if the analysis was performed with informal workers[2].

Artisanal fisherman are different from commercial fisherman in that they typically live in traditional communities and develop the commerce and processing of shellfish in the informal sector[3,4]. Although they account for approximately 98.7% of 970,000 fisherwomen registered in Brazil as of September 2011[5], and despite their significant contribution to fishing production in Brazil[5], they are generally included among the poorest population groups[6].

The term artisanal fishing tends to imply a "simple and individual type (autonomous) or a family type of enterprise"[7], with shellfish gathering being considered artisanal fishing[8]. The shellfish gathering work involves several steps, including the collection of shellfish (on the beach, sea, mangrove or river), shelling (separation of shellfish from the shell) and following steps up to the final sale[1,8]. The activities performed by shellfish gatherers may cause health problems for these workers[9]. The working conditions of the artisanal fisherwomen are precarious and provide minimal support for the processing of the seafood produced.

The activities developed by the shell fisherwomen constitute an ergonomic risk due to "muscular overload, mainly in the neck, shoulders, back, upper limbs, lumbar region, and repetitive movements centred on the wrist"[8]. As an aggravating circumstance, shellfish gatherers do not take vacations, have weekly rest, or even paid holidays[8].

MSDs of the neck and upper limbs have multifactorial causes[10-14] and are among the main work-related diseases[15] reported in countries, regardless of the industrialization degree[11], with social and economic consequences, especially in the work environment[16]. Among the main risk factors for the emergence of MSDs are factors related to the individual, physical demands and psychological demands[13]. Each factor contributes to the aetiology of MSDs, varying between individuals and the workplace[13], and one or more factors may predominate[12].

The symptoms related to MSDs have already been reported in shellfish gatherers[2,17,18], fisherwomen[19] and workers in the fishing industry[20,21]. To understand the factors that may influence MSDs in these workers, it is necessary to know their characteristics and their relationship with the work they perform[1]. Therefore, the present study aims to identify factors associated with MSDs in the neck/shoulder and distal upper limbs in artisanal fisherwomen/shellfish gatherers in Saubara, Bahia, Brazil.

Methods

This study is part of a main survey titled *Health, Environment and Sustainability of artisanal fishers*. This cross-sectional study included artisanal fisherwomen/shellfish gatherers in Saubara, Bahia, Brazil. The consent of the subjects was obtained, and the project was approved by the Committee on Research Ethics (CEP) at the Faculdade de Medicina da Bahia.

Population and area

Saubara is located on the Bay of Todos os Santos (BTS), 94 km from Salvador by highway, and less than 20 km by boat. It has an approximate area of 163 km² [22] and a population of 11,201 inhabitants[23]; which 5196 correspond to the economically active population (EAP)[23].

Sampling and inclusion criteria

Random sampling was done simply and without replacement. A lottery was conducted based on 426 shellfish gatherers, all registered in the Association of Artisanal Fisherwomen/Shellfish Gatherers of Saubara. The final sample consisted of 209 shellfish gatherers, 3% more than the minimum sample. The inclusion criteria to participate in the study included being female, because this activity is exercised mainly in this community by women, an age greater or equal to 18 years and having performed the activity for at least one year. Female workers who were not engaged in shellfish activity had the opportunity to participate if they justified their removal due to diseases that could be related to MSDs to minimize the survival effect of healthy workers.

Most of the information was self-reported, with the exception of weight, height and waist circumference (WC), which were measured by trained interviewers. Measurements of weight and height were measured for the calculation of body mass index (BMI) and WC to assess the accumulation of fat in the abdominal region.

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The physical demands of the work were adapted for the work of the artisanal fisherwoman/shellfish gatherers from the questionnaire elaborated by Fernandes[24]. The psychosocial demands obtained through the psychological demand, control and social support at work and job dissatisfaction were collected through the *Job Content Questionnaire* (JCQ)[25], with the version validated for Portuguese [26]. Information on musculoskeletal symptoms was collected through the extended version of the *Nordic Musculoskeletal Questionnaire* (NMQ). Further information can be found in the study by Falcão et al.[1].

Outcomes variables

MSD was defined as the report of pain or discomfort for each region in the last 12 months, with a minimum duration of one week or a minimum monthly frequency, not caused by acute injury. The symptoms should be related to at least one of the following: degree of severity ≥ 3 on a scale of 0 to 5 (no discomfort to unbearable pain); seeking medical attention for the problem; absence from work (official or otherwise); or change of work due to health restrictions[27,28].

MSD were analysed according to the functional units of neck/shoulder and distal upper limbs (elbow, forearm, wrist/hand)[29,30].

Exposure definition

The exposure was defined by the physical demand at work, evaluated through questions answered by the shellfish gatherers on a scale ranging from 0 to 5 (duration, frequency or intensity, depending on the variable), with anchors at the extremes, representing the degree of evaluation that the worker made about her exposure[24].

Exposure to psychosocial demands was classified according to Devereux et al.[31] as: 1. high exposure to psychosocial demands: high psychological demands, low control over work and low social support; or 2. low exposure to psychosocial demands: low psychological demands, high control over work and high social support. At least two of these criteria must be met in both classifications. These criteria were developed from the epidemiological literature according to MSDs in the neck or shoulders and upper limbs[29,30].

Independent variables

The independent variables were age, sex, schooling, marital status, presence of children and children less than 2 years of age, smoking, alcohol consumption, BMI, WC, free time physical activity, medical diagnosis of diabetes, medical diagnosis of rheumatoid arthritis, development of another type of work currently and in the past, work time, daily hours dedicated to work, domestic activity and physical and psychosocial demands.

The continuous variables, age, working time, daily hours spent on shellfish gathering and weekly hours dedicated to domestic activity were dichotomized by quartiles (Q1, Q2 and Q3) that best correlated with the response variables.

Smoking was defined as the use of cigarettes more than once a week currently or within one year if she had stopped smoking[32]. Alcohol consumption was defined as a frequency greater than or equal to once per week[28].

BMI (kg/m^2) was evaluated according to the international classifications of low weight, overweight and obesity for the adult population[33]. For the statistical analyses, the corresponding values for low weight and normal weight were pooled, subdividing the BMI into 3 categories: low weight and normal weight (BMI ≤ 24.99); overweight (25 ≤ BMI ≤ 29.99); and obesity (BMI ≥ 30). To classify increased WC, the cut-off point was (≥ 80 cm)[34]. WC was not checked for shellfish gatherers who were pregnant.

Physical activity during leisure time was defined as activities such as running, gymnastics, swimming, playing football, cycling, walking, gardening or landscaping at least 3 times a week for at least 30 minutes at a time[17].

The physical demands were evaluated according to the phases of shellfish gathering: collection, transportation and shelling. The psychosocial demands were dichotomized by their medians into high exposure (demand greater than 34, control equal to or less than 66 and social support equal to or less than 13) and low exposure (demand equal to or less than 34, control greater than 66 and social support greater than 13). At least two of these criteria had to be met for the shellfish gatherer to be classified in each group. Satisfaction with work was also analysed by the median as low satisfaction (satisfaction > 0.40) and high satisfaction with work (satisfaction ≤ 0.40).

Statistical methods

The physical demands of posture (sitting, crouching, standing, walking, arms raised above shoulder height, trunk bent forward, trunk ro-

tated, making repetitive movements with hands and precise and very fine movements), muscular strength in the arms or hands, load handling (pushing, pulling and lifting the load) and physical pressure (physical pressure with the hands on the work tool) were considered for the steps of collecting, transporting and shelling the shellfish for requiring more time and higher load. The variables of physical demands that presented the highest intensity, duration or frequency according to the collection and sampling stages were considered and showed a linear correlation coefficient (r) greater than 0.30. The principal component analysis method was used to estimate factor loads. The rotation method used was the varimax with Kaiser normalization[35]. As a criterion for defining the number of factors, an eigenvalue greater than 1.0 was used. In the transportation stage, the factorial analysis was not performed since a correlation considered regular was not obtained for the variables. In this step, we considered the demands that obtained values greater than or equal to 2, on a scale of 0 to 5.

In the collection and shelling of shellfish, the factorial analysis explained 51.8% and 59.2% of the variability in the data, respectively. The factors generated from this analysis were categorized according to the quartiles that best correlated according to each response variable.

Variables that had more than two categories were dichotomized, with the exception of BMI. For the BMI, two design variables were created, corresponding to the three classifications (normal or low weight, overweight and obesity).

Two logistic regression models were constructed to identify the variables associated with MSDs in the neck or shoulder and distal upper limbs.

Pre-selection of the independent variables for entry into the two initial multiple logistic regression models was based on bivariate logistic regressions, considering a p-value less than 0.25 in the Wald test for significance of the coefficient. The biological plausibility of the associations was also considered for entry into the initial models.

The final models were obtained by the backward selection method, based on the likelihood ratio test and the Wald test, considering a significance level of 5%. The Delta method was used to calculate the adjusted prevalence ratios and their respective confidence intervals (95% CIs) for the variables of the final model.

For both models, the goodness of fit test of Le Cessie and Houwelingen[36] was performed, along with residual analyses to identify confounds and interactions.

The Statistical Package for the Social Sciences (SPSS) version 13.0 for Windows, Ri386 version 2.15.2 and Epi Info version 7.1.3.3 were used for the data analysis.

Results

Shellfish gathering in Saubara is a predominantly female activity, representing 75% of the individuals registered as shellfish gatherers in the Saubara Fisherwomen and Shellfish Gatherers Association. The mean age was 39.6 years (± 11.5 years). A large part of the sample identified as black or brown (96.2%) and had not completed secondary education (74.6%). The average number of years worked was approximately 27 years (± 12.9), and the average hours worked was 8.7 hours (± 3.1).

The values found for MSDs in the neck or shoulder and distal upper limbs were 71.3% (n = 149) and 70.3 (n = 147), respectively. A detailed description of the characteristics of the sample can be found in another study[1].

Tables 1 and 2 show the clustering of the physical demands on factors from an array of components corresponding to the harvesting and shelling stages. For the collection stage, three factors were generated. Factor 1 incorporated the demands from leaning on the elbow, leaning on the fist, rotated trunk, precise and very fine movements with the hands and pushing and pulling the load. Factor 2 is composed of the demands from lifting the load, muscle strength in the arms or hands and physical pressure with hands on the work tool. Factor 3 included the demands from walking and standing. For the shelling step, the physical demands were condensed in factor 1 (forward leaning trunk, physical pressure with the hands on the tool, muscular strength in the arms or hands, pulling the load and lifting the load) and factor 2 (repetitive hand movements and precise and very fine movements).

The prevalence rates and 95% CIs obtained from the bivariate analysis are shown in Table 3. According to the results of the bivariate analysis, MSDs of the neck and shoulder and distal upper limbs were 1.39 and 1.27 times more frequent among the older shellfish gatherers, respectively. Positive associations were also found, according to these two response variables, with daily work hours as a shellfish gatherer, rheumatoid arthritis, factor 1 of the collection stage and factor 1 of the shelling stage. Years of work also presented a positive association with MSDs of the neck or

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Table 1. Matrix of components rotated by the varimax method with Kaiser normalization for the physical demands corresponding to the step of collecting shellfish.

Physical demands	Components (factors)		
	1	2	3
Leaning on the elbow	.464	-.095	.321
Leaning on the fist	.705	-.067	.277
Wheeled trunk	.724	.077	-.115
Accurate and very fine movements with the hands	.522	.140	-.101
Pushing the load	.613	.181	.112
Pulling the load	.562	.426	.059
Lifting the load	.271	.464	.346
Muscle strength in arms or hands	.081	.808	-.063
Physical pressure with hands on tool	.034	.839	-.011
Standing	-.029	-.037	.777
Going	.080	.079	.791

Table 2. Matrix of components rotated by the varimax method with Kaiser normalization for the physical demands corresponding to the shelling stage of shellfish gathering.

Physical demands	Components (factors)	
	1	2
Forward-inclined trunk	.571	-.096
Physical pressure with hands on tool	.784	.260
Muscle strength in arms or hands	.778	.354
Pulling the load	.676	-.263
Lifting the load	.766	-.080
Repetitive movements with the hands	-.207	.776
Precise and very fine movements	.168	.776

shoulder. Another job at the time of the interview was a protective factor for shellfish gatherers that had MSDs in the distal upper limbs. There were positive associations between MSDs in the distal upper limbs with obesity and other work before shellfish gathering.

The two final models, obtained from multivariate analyses, are described in Table 4 and 5. Age was maintained in both models. The shellfish gatherers who performed their work resting on their elbows, with their trunks turned, making precise and very fine movements with their hands, pushing and pulling the load, in the collection stage, had 1.28 more MSDs of the neck or shoulder than those who varied their positions more. The relation of factor 1 of the shelling stage with MSDs in distal upper limbs can be interpreted similarly. Posture with arm above shoulder height in transport was maintained in the final model for MSDs in distal upper limbs due to its importance for the stage, despite being considered a borderline variable. Obese shellfish gatherers had 1.28 times more MSDs in the distal upper limbs than did non-obese gatherers. Other work was maintained in the final model as a protective factor, as seen in Table 5. Shellfish gatherers who had other jobs had 26% fewer MSDs in the distal upper limbs than those who worked only as a shellfish gatherer.

The goodness of fit test indicated a good fit of the models. The residuals graphs did not show any discrepant observations. No significant confounding and interaction terms were found at the 5% level.

Discussion

There was a high prevalence of MSDs in the neck or shoulder and distal upper limbs among artisanal fisherwomen/shellfish gatherers. This finding reveals the importance of this painful pathology for the Saubara shellfish gatherer population, which may contribute to the worsening of the workers' quality of life[37]. The main risk factors for the development of MSDs in the aforementioned functional units, as demonstrated by the literature, were analysed for shellfish gatherers, and statistically significant associations were identified with some physical demands of the work and individual characteristics.

The discovery of this problem revealed a prevalence of MSDs that was much higher than those of other workers, as can be verified in the study by Falcão et al.[1]. Because of the originality of the topic, a more rigid case definition and the method of analysis employed, it was difficult to compare these findings with other studies. Some authors have described the difficulty of comparing studies of MSDs in the upper limbs[11,37].

The shellfish gatherer performs all steps of the production process, including organizing and making their work tools[8]. The steps are divided into extra-domiciliary, peri-domiciliary and domiciliary[1], and correspond to the stages of the second washing, cooking, shelling, packaging and storage. The work environment of the shell-

Table 3. Prevalence ratios and 95% confidence intervals (CIs) of unadjusted models of MSDs in the neck or shoulder (n = 205 *) and the distal upper limbs (n = 196 *) in a sample of shellfish gatherers in Saubara, BA, 2013.

Variable	MSD in neck or shoulder (P/O)		MSD in distal upper limbs (MSD)	
	RP	(IC95%)	RP	(IC95%)
Age (≥ 38 years **)	1.39	(1.16; 1.67)	1.27	(1.05; 1.53)
Marital Status (Married/Dating **)	0.92	(0.77; 1.09)	0.95	(0.79; 1.13)
Education (< Incomplete middle school**)	1.19	(0.95; 1.50)	1.05	(0.84;1.29)
Children (≤ 2 years old **)	0.78	(0.54; 1.15)	0.86	(0.60; 1.21)
Years of work (> 26 years **)	1.22	(1.02; 1.45)	1.13	(0.95; 1.36)
Daily hours of work as shellfish gatherer (> 11 hours **)	1.26	(1.07; 1.50)	1.26	(1.06; 1.49)
Weekly hours of domestic work (> 7 hours **)	1.09	(0.87; 1.36)	1.01	(0.81; 1.25)
Current job (yes **)	1.01	(0.83; 1.22)	0.79	(0.62; 0.99)
Previous work (yes **)	1.12	(0.93; 1.34)	1.23	(1.01; 1.50)
Smoking habit (yes **)	0.98	(0.65; 1.49)	1.26	(0.98; 1.62)
Consumption of alcoholic beverage (yes **)	0.79	(0.61; 1.03)	0.83	(0.64; 1.09)
Practice of physical activity in free time (not **)	1.06	(0.88; 1.29)	0.88	(0.74; 1.05)
Waist circumference (≥ 80 cm **)	0.93	(0.77; 1.11)	1.09	(0.88; 1.35)
Overweight (25 ≤ BMI < 30 kg/m² **)	0.92	(0.76; 1.11)	0.94	(0.77; 1.13)
Obesity (BMI ≥ 30 kg/m² **)	1.08	(0.90; 1.30)	1.20	(1.01; 1.43)
Diabetes mellitus (sim **)	1.22	(0.97; 1.54)	1.20	(0.93; 1.54)
Rheumatoid arthritis (yes **)	1.32	(1.12; 1.56)	1.48	(1.33; 1.64)
Factor 1 collection - Leaning on the elbow, leaning on the fist, rotated trunk, precise and very fine movements with the hands, pushing and pulling the load (> Q3 **)	1.31	(1.12; 1.53)	1.25	(1.05; 1.48)
Factor 2 collection - Lifting the load, muscle strength in the arms or hands and physical pressure with the hands on the work tool (> Q2 ** - MSD P/O ***) (> Q1 ** - MSD MSD ***)	1.14	(0.96; 1.36)	1.86	(0.92; 1.51)
Factor 3 collection - walking and standing (> Q1- MSD P/O ***) (> Q3 ** - MSD MSD ***)	0.88	(0.74; 1.05)	1.07	(0.88; 1.30)
Standing in transport (≥ 2 **)	0.89	(0.74; 1.07)	0.94	(0.77; 1.15)
Walking in transport (≥ 2 **)	1.44	(0.72; 2.90)	1.14	(0.66; 1.97)
With arm above shoulder height in transport (≥ 2 **)	1.03	(0.81; 1.31)	1.37	(1.00; 1.89)
Use of muscle strength in the arms or hands in transport (≥ 2 **)	0.90	(0.67; 1.20)	0.82	(0.64; 1.06)
Physical pressure with the hands on the work tool in the transport (≥ 2 **)	1.00	(0.83; 1.22)	1.13	(0.91; 1.40)
Lifting the load in transport (≥ 2 **)	1.07	(0.76; 1.51)	0.94	(0.70; 1.27)
Factor 1 tilt - Trunk leaning forward, physical pressure with hands on tool, muscle strength in arms or hands, pulling and lifting load (> Q3 ** - MSD P/O) (> Q1 ** - MSD MSD)	1.26	(1.07; 1.48)	1.32	(1.02; 1.72)
Factor 2 shelling - Repetitive movements with hands and precise and very fine movements (> Q3)	1.11	(0.92; 1.33)	1.67	(0.97; 1.39)
Psychological demand (> 34)	0.97	(0.82; 1.16)	1.08	(0.90; 1.30)
Control (≤ 66)	0.97	(0.82; 1.16)	0.97	(0.81; 1.17)
Social support (≤ 13)	0.94	(0.79; 1.12)	0.95	(0.80; 1.14)
High psychosocial demand (≥ 2)	0.86	(0.72; 1.03)	1.00	(0.84; 1.20)
Satisfaction (> 0.40)	0.88	(0.72; 1.09)	0.99	(0.81; 1.23)

* The "n" was different because it was necessary to exclude shellfish gatherers with missing data to compare the models with alpha values of 0.25, 0.17 and 0.05. ** Exposure. *** Q1 (Quartile 1); Q2 (Quartile 2); Q3 (Quartile 3); MSD P/O (MSDs in the neck or shoulder); MSD MSD (MSDs in the upper limbs).

Table 4. Prevalence ratios adjusted for MSDs in the neck or shoulder and final model variables in a sample (n = 201) of shellfish gatherers, BA, 2013.

Variable	PR	(95% CI)
Age (≥ 38 years)	1.36	(1.13; 1.62)
Factor 1 collection - Leaning on the elbow, leaning on the fist, rotated trunk, precise and very fine movements with the hands, pushing the load and pulling the load (> Q3)	1.28	(1.09; 1.49)

Table 5. Adjusted prevalence ratios for MSDs of the upper distal limbs and final model variables in a sample (n = 201) of shellfish gatherers, BA, 2013.

Variable	PR	(95% CI)
Age (≥ 38 years)	1.30	(1.07; 1.57)
Daily hours of work as shellfish gatherer (> 11 hours)	1.26	(1.07;1.47)
Current job (yes)	0.74	(0.57;0.96)
Overweight (25 ≤ BMI < 30 kg/m²)	1.04	(0.86;1.27)
Obesity (BMI ≥ 30 kg/m²)	1.28	(1.06;1.53)
With the arm above shoulder height in transport (≥ 2)	1.36	(0.98;1.89)
Factor 1 tilt - Trunk leaning forward, physical pressure with hands on tool, muscle strength in arms or hands, pulling and lifting the load (> Q1)	1.38	(1.05;1.83)

fish gatherer consists of the sea, mangrove, sand or river, path to the residence, domicile and surroundings (i.e., yard, porch, neighbour's house).

The shellfish gatherer is highly susceptible to ergonomic risks at all stages of her work[1]. The most important steps were collection, transportation and shelling since they require more time to dedicate to the task, workload and load. Nag et al.[21] found a positive association between load handling and MSDs in the neck and hand. According to Andersen et al.[30], the physical demands of work are related to worsening pain in specific regions.

No articles were found that grouped the physical demands through the factorial analysis, as in the present work. It was considered important to group these variables both for the analyses, with the reduction of the variables, and for the best use of these demands according to the characteristics of the shellfish work in Saubara. These shellfish gatherers do not perform only a single stage of production, as observed in the industries; therefore, they are subject to different demands according to each stage of their work.

In the present study, statistically significant relationships were found in bivariate analyses for neck or shoulder MSDs and for MSDs in the distal upper limbs with factor 1 of the collection stage (leaning on the elbow, resting on the wrist, rotated trunk, precise and very fine movements with the hands, pushing and pulling the load) and factor 1 of the shelling stage (trunk leaning forward, physical pressure with hands on the tool, muscle strength in the arms or hands, pulling and lifting the load).

The adjusted prevalence ratios present in the final model according to MSDs in the neck or shoulder showed that these types are more frequent in shellfish gatherers that perform the physical demands related to factor 1 of the collection. Shellfish gatherers who perform these demands in the shellfish collection stage without varying their posture, use of muscular strength, repetitive and precise movements and handling of loads have more MSDs in the neck or shoulder. These findings were similar for MSDs in the distal upper limbs with trunk postures inclined forward, physical pressure with hands on the tool, muscle strength in the arms or hands, pulling and lifting the load in the shelling stage. The shellfish gatherers who varied these physical demands more had fewer MSDs in the given functional units.

The relative risks of developing musculoskeletal pain according to the physical demands were reported in the study by Andersen et al.[30]. In this study, there were statistically significant associations between pain in the neck or shoulder and lifting of the load and for the postures with arms above shoulder height, sitting and squatting. The physical demands associated with pain in the distal upper limbs were repetitive movements, pushing the load, postures with arms above shoulder height and sitting. Only the posture with the arm above shoulder height for pain in the neck or shoulder remained in the final model[30].

The performance of another work besides shellfish gathering was negatively associated with MSDs in the distal upper limbs. Lipscomb et al.[19] found that workers who had jobs other than fishing reported fewer musculoskeletal symptoms. These authors have suggested that the result may

represent a healthy worker effect or other selection biases. In the present study, it was noted that the shellfish gatherers who had other jobs had a lower median of daily hours of work in shellfish gathering than those who only worked in shellfish gathering. The "protective" result can be attributed to the reduction of time of exposure to the strenuous conditions related to shellfish gathering. Shellfish gatherers who spent more hours at work had approximately 23% more MSDs in the distal upper limbs than those who worked fewer hours at the job.

Among fisherwomen who had another job, eight (13.1%) worked with handicrafts, seven (11.5%) with fishing, and others engaged in less physically intensive work environments, such as commerce. In contrast to the present study, a good portion (45%) of shellfish gatherers from a fishing community in Piauí, Brazil, reported having a second paid activity, such as selling products or working in restaurants, cooking, day labourer, laundry or in commerce, when asked if they performed another function besides shellfish gathering[38]. Among commercial fisherwomen from North Carolina (USA), 45.3% had another job in addition to fishing[19]. In the study, it was observed that shellfish workers started their work early in life. Pena et al.[8] also reported on the work done since childhood by these shellfish gatherers and observed that the practice of bringing children to shellfish gathering still exists.

Working time in years had a statistically significant relationship with MSDs of the neck or shoulder but did not remain in the final model. The average years of work in the study were high, revealing the great experience of these shellfish gatherers and their prolonged exposure to the ergonomic risks inherent in the work. The average hours of work were also high (8.7 hours), with a considerable number of shellfish workers who worked more than 11 hours a day. Pena et al.[8], in an ethnographic study, reported that the daily workday of the shellfish gatherer varies between 10 to 14 hours. Other studies on shellfish gatherers reported averages of years worked of approximately 20 years[38], 22 years[2] and 12 years[39].

Antonopoulou et al.[40] conducted a study with residents of the Island of Crete (Greece) at a time when villagers were engaged in the intensive harvesting of grapes and olives, requiring hard manual labour with the spine in a curve over the work position for an extended period of time. In this study, a statistically significant relationship was found between years in the current work with shoulder MSDs.

Overload in the upper limbs and neck predisposes the shellfish gatherers to musculoskeletal problems. Consequently, the present study found high prevalence rates of painful affectations and MSDs of the neck/shoulder functional unit and the distal upper limbs.

Regarding the psychosocial demands and satisfaction with the work developed, almost half of the shellfish gatherers were classified as being subject to high psychosocial demand, and the majority were dissatisfied with the work; older shellfish gatherers were most satisfied with the work.

Psychosocial demands and job satisfaction were not statistically significant in the present study for MSDs of the neck or shoulder and the distal upper limbs. Andersen et al.[30] also did not find statistically significant associations for the psychosocial demands of the work. However, the association of low satisfaction with work and neck or shoulder pain was found in the partially adjusted model and in the final model.

Pena et al.[8] discussed the self-management of these women's work when they have musculoskeletal pain or when they already have MSDs. According to these authors, a shellfish gatherer can interrupt her work when she feels exhaustion or is physically tired or in pain, in theory protecting the shellfish gatherer from more serious consequences, but without taking away the risk of MSDs. These authors consider that "the condition of the shellfish work with chronic pain is a way of life" because they do not stop working, even when suffering from some type of MSD. This claim is supported in this study because, even with the high prevalence of MSDs among these workers, the work day is extensive.

Muscle activity depends on human motor behaviour, which comprises an extensive repertoire of postures, movements and strength[41]. According to Visser & van Dieën[41], individual and contextual factors can affect the way workers perform tasks. The individual risk factors for the development of MSDs include age, sex, BMI, personal habits such as smoking, activities outside the workplace[13], education level[30], rheumatoid arthritis and diabetes mellitus[12,30]. In the present study, an association of MSDs in the distal upper limbs with a BMI ≥ 30 was found. In the bivariate analysis, rheumatoid arthritis was related to MSDs in both functional units but did not remain in the final model adjusted according to the variables.

The literature shows that MSDs affect women more than men, and studies must consider

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the demands of work according to sex[40,42]. Antonopoulou et al.[40] found a statistically significant relationship between female sex and MSDs in the neck and shoulder. In the present study, the sample consisted only of women since they predominate in the shellfish activity in Saubara. This predominance has been quantified or reported in other studies[8,43,44], with the exception of an article with workers engaged in fishing and shellfish harvesting activities in the sea[19], where the majority were male (88.4%).

In the present study, the associations of age with MSDs of the neck or shoulder and the distal upper limbs were verified. Older shellfish gatherers (older than 38 years) had 36% more neck or shoulder MSDs and 30% more MSDs of the distal upper limbs than younger workers. Antonopoulou et al.[40] also found a statistically significant relationship between age, but only with neck MSDs.

In contrast to the present study, Andersen et al.[30] found a statistically significant association of low education level (relative risk [RR]: 1.8; CI: 1.1-3.0) with neck or shoulder pain in the partially adjusted model, but it did not remain in the final model adjusted for sex, age, occupational group, intervention group and all other factors in each column.

In the study by Rodriguez-Romero et al.[2] and in the present study, no statistically significant associations were found between MSDs in the upper limbs and smoking and upper limb MSDs with physical activity.

Among shellfish gatherers in Galicia, rheumatic disorders were among the most reported comorbidities (17.2%), but an association with MSDs in the upper limbs was not found[2]. As the study considered all rheumatic diseases (degenerative or inflammatory joint diseases), this result cannot be compared with that found in Saubara for rheumatoid arthritis.

Andersen et al.[30] found statistically significant associations of low education level (RR: 1.8; CI: 1.1-3.0) and obesity (RR: 1.8; CI: 1.1-2.8) with pain in the neck or shoulder in the partially adjusted model; however, these associations did not remain in the final model adjusted for sex, age, occupational group, intervention group and all other factors in each column.

The way the shellfish work is performed and the individual workers' characteristics are important for the occurrence of MSDs. These workers are the managers of their own work and have demonstrated great experience with the activity. Although they have autonomy in performing their work activities, it was noted that these shellfish workers have a long working day and live with pain, demonstrating that what really dictates their activity is the need to obtain sustenance and food security for their family through of the sale and consumption of seafood.

Conclusions

The present study analysed the main risk factors for the development of MSDs as demonstrated by the literature and characterized Saubara shellfish gatherers, comparing the findings from with study with those from other studies with shellfish gatherers, artisanal or not, and with classes of workers with MSDs that have been described in the literature.

The way the shellfish gatherer's work is developed and the individual characteristics of the workers have an effect on the occurrence of MSDs. High prevalence rates of MSD were found in the shellfish population studied. MSDs in the neck or shoulder were associated with the physical demands related to factor 1 of the collection (leaning on the elbow, leaning on the wrist, rotated trunk, precise and very fine movements with the hands, pushing and pulling the load). MSDs in distal upper limbs were associated with shelling factor 1 (trunk leaning forward, physical pressure with hands on the tool, muscle strength in the arms or hands, pulling and lifting the load). Shellfish workers who varied their posture, load handling, muscle strength and physical pressure had fewer MSDs in the two functional units reported.

No statistically significant relationships of MSDs in the neck or shoulder and the distal upper limbs were found with the psychosocial demands of the work. Associations were found between age and MSDs in the neck or shoulder and age, obesity, daily work hours and other work besides shellfish gathering (at the time of interview) with MSDs in the distal upper limbs.

Collaborations

IR Falcão, RCF Rêgo, PGL Pena, JS Müller, LLA Lino, MCBM Couto and WS Viana contributed to the literature review. IR Falcão, RCF Rêgo, JS Müller, LL Andrade, MCBM Couto and WS Viana contributed to study design and data collection. IR Falcão, RCF Rêgo and VMC Lima contributed to the statistical analysis. All authors contributed in the interpretation and writing. All authors had access to all data and have the responsibility in the final manuscript.

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