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Work Ergonomic Analysis: Application of a Postural Study on the Oysters Cultivation

Análise Ergonômica do Trabalho: Aplicação de um Estudo Postural no Cultivo de Ostras

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Abstract

The cultivation of marine mollusks is an activity of great importance in Brazil, providing employment and income for artisanal fishermen and fishing communities, contributing to local development. However, this type of cultivation is still carried out in a very handmade way with intense use of labor. The objective of this study was to describe the postures and movements of fish farmers during the oyster classification activity. Ten employees of a marine farm participated in the municipality of Florianópolis, SC. For the analysis of the posture and movements, the Rapid Entire Body Assessment (REBA) method and NIOSH method were used along with in situ observation and interviews with the workers. The task of oysters classification presents an average risk of injury or occupational diseases, especially in the cervical region and upper limbs, as it is developed with marked flexion of the head and shoulders, which requires a lot of the muscles involved to maintain the posture and perform repetitive movements. Many workers have muscle pains in the shoulders, lower back, hands, wrists and fingers. Simple and economically viable adaptations should be adopted, because through ergonomic evaluation it is possible to carry out interventions that are within the reach of the workers. It is necessary to transmit knowledge so that the workers are aware of the postures that they must adopt in the accomplishment of this aquaculture activity and thus to promote a better quality of life of this population.

Keywords: Aquaculture. Ergonomics. Occupational Health.

Resumo

O cultivo de moluscos marinhos é uma atividade de grande importância no Brasil proporcionando a geração de emprego e renda para pescadores artesanais e comunidades pesqueiras, contribuindo para o desenvolvimento local. Entretanto, este tipo de cultivo ainda é realizado de forma bastante artesanal com intensa utilização de mão de obra. Diante disso, este estudo teve por objetivo realizar uma descrição das posturas e movimentos de maricultores durante a realização da atividade de classificação de ostras. Participaram voluntariamente dez funcionários de uma fazenda marinha no município de Florianópolis, SC. Para análise da postura e movimentos, utilizou-se o método *Rapid Entire Body Assessment* (REBA) e método NIOSH juntamente com a observação in loco e entrevistas com os maricultores. A tarefa de classificação de ostras apresenta médio risco de lesão ou doenças ocupacionais, principalmente na região cervical e membros superiores, pois é desenvolvida com acentuada flexão de cabeça e ombros, o que exige muito da musculatura envolvida para manter a postura e realizar movimentos repetitivos. Muitos trabalhadores apresentam dores musculares nos ombros, lombar, mãos, punhos e dedos. Adaptações simples e economicamente viáveis devem ser adotadas, pois através da avaliação ergonômica é possível realizar intervenções que estão ao alcance dos trabalhadores. Necessita-se transmitir os conhecimentos para que os trabalhadores tenham consciência das posturas que devem adotar na realização desta atividade aquícola e assim promover uma melhor qualidade de vida desta população.

Palavras-chave: Aquicultura. Ergonomia. Saúde do Trabalhador.

1 Introduction

The State of Santa Catarina, in southern Brazil, is the largest national producer of mollusks, among which we highlight oysters, mussels and scallops. In the State, the activity is performed mainly by small producers, due to the low initial cost and reduced environmental impact, which began the production combining the routine activities with the maintenance of the cultivations in search of raising family income[1]. Despite the development of the sector, the activity of cultivation of mollusks in Brazil is in a constant process of transformation and improvement and needs improvement for the accomplishment of the tasks related to the process of production, limiting the productivity of marine farms and causing problems of occupational health in shell fishermen, who perform too much effort to manage the structures of the cultivation2[2-3].

The study of the relations between the man and the work provides a better understanding of the variables present in various labor activities. Currently, the improvement of work processes, related to physical, cognitive and emotional aspects, is given as a function of ergonomics, which also acts in a comprehensive way in improving jobs[2].

In aquaculture, the ergonomics is still not widely applied,

due to the relatively dispersed character of this activity. In this segment, the machinery and equipment used are still almost always rudimentary, which could be improved with the implementation of ergonomic and technological knowledge already available. Having as a direction the area of ergonomics and work-related aspects, the study described in this article applies the approach of Work Ergonomic Analysis in a specific job, aiming to generate a diagnosis of the studied working conditions[3].

In this sense, the understanding of the risk factors present in certain activities can assist the restructuring of the job position and the organizational changes, with the aim of reducing the physical overload during the work completion. Thus, the purpose of this study was to perform a qualitative analysis of movements and postures adopted by shell fishermen in activity of oysters classification of the city of Florianópolis-SC.

2 Material and Methods

The study was carried out on a farm of marine mollusks growing located in Ribeirão da Ilha, city of Florianópolis-SC (-27º48'57.03"S; -48º33'1"W). Ten shell fishermen were recruited, being all male, aged between 18 and 40 years, using as a criterion to work for at least one year in the company.

For the realization of the study methods of analysis were applied seeking to generate an understanding of the situation presented, as well as possible recommendations for the improvement of the working environment which will be described below. The methods included photos and video recording (SX500 IS Canon camera), postural analysis by method *Rapid Entire Body Assessment*(REBA) and environmental assessment (temperature, humidity and wind speed were measured by the equipment term-hygro-anemometer AKROM KR825 and noise by Digital noise level meter KR843), in addition to interviews with the shell fishermen which are described below.

For the application of the equation of NIOSH, the job position selected for the study was observed. The variables that compose the equation were measured one by one to all workers of the job position during a working day. The period of observation and data collection for each worker were at least 60 minutes. The measurements have not interfered in the pace of work, because in no case there was need for interruption of tasks. The NIOSH equation that calculates the recommended weight limit is the following:

$$LPR = 23 \bullet \left(\frac{25}{H}\right) \bullet \left[1 - (0.003 \bullet |V - 75|)\right] \bullet \left[0.82 + \left(\frac{4.5}{D}\right)\right] \bullet \left[1 - (0.0032 \bullet A)\right] \bullet F \bullet C$$

The NIOSH equation for the lifting of loads determines the recommended weight limit (LPR) from six factors to reduce the constant load. The coefficients, which vary between 0 and 1, take into account the horizontal distance between the load and the operator (H); the vertical distance (V) the origin of the load; the vertical displacement (D) between the source and the destination of the load; the angle of asymmetry (A) measured from the sagittal plane; the average frequency of lifting (F) and the quality of pick-up/catch. The value of the constant of load= was established for the NIOSH method in 23kg by means of biomechanical , psycho and physiological criteria. This value refers to the handling of load in the sagittal plane at a height of 75cm above the ground, for a vertical displacement of 25cm, upwards or downwards and with the load to a maximum distance of 25cm from the body of the operator[4].

The research was approved by the State Health Department of Santa Catarina, under the opinion #904845. A Free and Informed Consent Form (ICF) was signed by each participant before replying to the questionnaires.

This study can be characterized as "quasi-experimental", without a control group and intra-subject type, because each subject receives all experimental conditions and only generates a particular treatment; thus, each studied worker acts as his or her own control. We had as dependent variable the biomechanical hazards (repetitive movements and forced postures) and the independent variable, the guidance program in the short term, emphasizing appropriate postures and suitability in handling with the tool.

3 Results and Discussion

The initial demand was defined through the problems related to environmental and organizational aspects, to risk factors and physical overload required during the completion of the work, electing as the focus of this study, analysis of the situation of work of the auxiliaries of mariculture in step of oysters classification.

To start the study general factors related to the activity were raised. This preliminary stage of research is of paramount importance for the general understanding of the situation handled. The Ergonomic Work Analysis aims to establish a comprehensive look about the studied scenario, thus allowing a better understanding of the involved actors and their constraints. The company in which the study was applied performs activities of fishing and processing of mollusks. Its registration in the National Register of Economic Activity (CNAE) appears as a degree of risk 3. The functions of workers are distributed among operational, production and technical.

The analyzed task is characterized as the oysters separation per size class. After the withdrawal of animals from the sea, the same are stored in plastic boxes that are stacked and transported manually until a machine that performs automatic washing with salty water. The machine has a slope where the oysters are deposited on top, slide through a perforated stainless-steel cylinder which contains a pipe of PVC (polyvinyl chloride) microperforated with jets of salty water

at high pressure, and then they are removed in an outlet at the bottom of the machine. The placement of the oysters in the machine is performed by an employee and the withdrawal is carried out by another worker. The communication of the two workers in order to have synchronism between the placing and removal of oysters is done most of time by gestures.

To the extent that the oysters are being cleaned, workers put the animals on a bench where they are classified. The purpose of classification is to separate the oysters in three classes of size: small (6 to 8 cm), medium (8 to 10 cm) and large (greater than 10cm). The plastic boxes weigh approximately 20 kg each when full (20 dozens/box). The oysters with some defect, as for example shell with deformity, or impurities such as barnacles and algae are discarded on the floor of the place of work. After the end of the activities, oysters are placed in a purification tank for subsequent commercialization and the workers clean the entire site (floors and countertops) with soap and bleach. Figure 1 shows the location of the job site.

Figure 1 - Washing (A) and the classification of oysters by size (B)

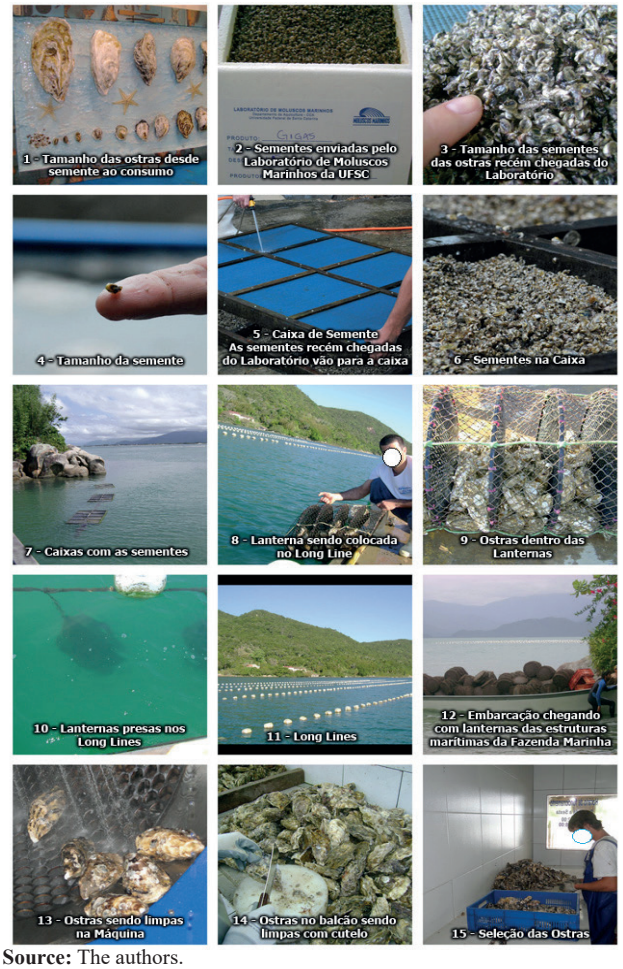
Source: The authors.

In order to better evaluate the job sites, visits were made where the structure for the classification of oysters was located. Auxiliaries of mariculture who performed the task on occasion were interviewed.

For the understanding of the activity that should be performed, one of the auxiliaries, delegated by the manager of the marine farm, coordinates the team activities, making the work schedules, rotations and filling out worksheets and have as practice to present the tasks prescription verbally. Another way to the auxiliary to understand how the activity works is by observation other colleagues with more time in undertaking this activity. There is not a formal training on the tasks that need to be carried out and about security practices at work. The workers have training on hygiene practices and handling of the animals in the work environment, to avoid contamination and ensure a quality product to the final consumer. This training was carried out less than a year ago by a skilled professional, in a course where all employees participated.

For a better understanding of the task involved in the work station a systemic diagram was built of the work process (Figure 2). In this diagram, it is possible to identify all activities involved in the classification of oysters, since the beginning of cultivation until the processing of the shellfish in the inner part of the marine farm. This diagram can be further elucidated also with Figure 2, which illustrates the location of work.

Figure 2 - Systemic diagram of the work process.



Source: The authors.

The environment of completion of tasks is located in an roofed area sheltered, the main building. Although roofed the site is exposed to the weather, as the sunlight, rain, wind and cold. The area of work for the implementation of the task is approximately 15m^2.

The type of floor of the site facilitates the collection of waste water and drainage for sewage and sanitation needed in this type of process. The floors and walls are lined with waterproofed tiles. The floor presents differences in points of entry and exit to the washing of oysters. The site has a cover with cement tiles without liner lean-to roofs (only a flat surface with a slope). The work environment (floors and countertops) is constantly flooded, since both the salty water (animals and washing oysters) as fresh water (cleaning boxes, machine, floor and benches) are present throughout the classification step of oysters.

The noise in the working environment remained at 77.21±2.58, although it is variable and change in accordance with the resources used in the process, did not exceed 85 dB(A) decibels for a day of eight hours/day, necessary for the granting of additional unhealthy conditions in medium degree. In the composition of the daily dose, historically, the sound pressure level is below 50%, therefore below the action level, not obliging the employer to require the use of ear

protector. Only the worker who uses the high-pressure washer (VAP) for cleaning the lanterns is that uses the earmuff.

The assessment of environmental conditions, in mariculture, is a factor of extreme importance for the health and safety of workers. Unfavorable environmental conditions, such as excessive heat, noise and vibrations, as well as the deficiency of lighting, are sources of tension at work and may cause discomfort, increase the risk of accidents and can cause considerable damage to health[5].

Regarding temperature and ventilation of the environment, over two years of collections, ranged from 23.28±10,05º C and 2.24±1.79 m/s. Whereas the relative humidity (RH) ranged from 78.54±16.56%. In accordance with the observations of the site, it is possible to consider that the temperature is variable, due to the fact that the environment should be open to the sea. However, some workers have reported the existence of winds which, according to them, cause thermal discomfort, especially in the winter. One of the interviewed employees reported feeling of intense cold, numbness or burning sensation in the feet.

The lighting of the sector is predominantly natural. However, on cloudy days, the sector has help of artificial lighting. The efficient lighting in the work environment is essential to avoid problems of visual fatigue, incidence of errors, drop in income and the occurrence of accidents. According to Iida and Buarque[2], light is paramount in the work place, not sufficing suitable intensity, but also bright adjusted contrast, with absence of brightness that outshine.

All the auxiliaries of mariculture receive additional for unhealthy conditions in medium degree (20% of the minimum wage) due to exposure to low temperature and humidity inside the manipulation room.

On very rainy days and with strong winds, the activities are suspended, dedicating themselves to other activities, such as: repair of lanterns, organization of work, business management and others. The use of hand tools is quite common; however, the available tools are often adapted from fishing or other activities. One example is the knife or knives, which are used to remove barnacles of oysters which are not removed in the washing process. Mariculture is a still recent activity, and in this sense the planning of activities happens almost daily, becoming very dependent on weather conditions. The need to adapt the work to natural conditions, related to meteorological and climatic variations, is one of the determinants of the flexibility of working hours in the marine farm.

The equipment used during t work are the following: uniform safety (overall), rubber apron, 4-yarn palm based knitted gloves, adjustable rubber boots with antibacterial, soft collar, non-slip boots, fabric cap to the head (beanie) on cold days. The workers also wear caps/hats and sunscreens when withdrawing the lanterns from the sea.

The constraints identified in the activity were classified into three groups: cognitive, emotional and physical constraints. To start the survey of data they will be exposed to the cognitive constraints, identified through conversations with the workers, their superiors and through observations of the activity. It was possible to consider some cognitive aspects inherent to the activity of the auxiliary of mariculture. The realization of the activities does not require complex skills or physical quantities, signaling or sound devices. Any problems are related to the fall of the oysters out of the machine or bench.

Regarding emotional factors, according to the worker's report, the activities are performed without the pressure of headship. They also mention the relaxed environment and contact with nature as positive. The breaks for lunch were also related as motivational factors. However, conditions of work, remuneration and physical wear are points that need improving in the workers' opinion. The workers reported that the work is stressful, but they did not identify suggestions for improvement of the same.

The perception of risk of accidents are also inexistent among the workers in the function. The possibility of occurrence of accidents and drownings, cuts or any other type of mechanic accident during the activity is imperceptible by the workers. According to the interviews, the majority does not consider these events (shocks, cuts) as accidents, but as events inherent to their activity. Muscle Pain, especially at the lumbar spine, wrists and fingers were reported in the interviews.

During the process of the oysters classification, the worker remains most of time standing up with association of flexion and rotation of the trunk in all the cycles. There are no seats or chairs for this activity. In the implementation of labor movements, the arms are mainly used, alternately or simultaneously.

To assist in the identification of the physical constraints of the job the method REBA wasapplied, seeking to assess the effort exerted by the limbs in the implementation of the activities. For a more systematic assessment of the physical constraints of the activities two more critical positions of the worker's activity were selected. The selected positions are illustrated in Figures 3 and 4.

Figure 4 - (A) posture with flexion of the neck and (B) posture with flexion of the trunk and neck.

Source: The authors.

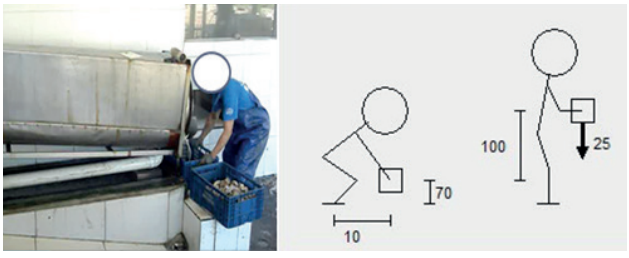
In the posture A the worker flexes the neck to more than 20º, which can lead to a weight of approximately 18 Kg in the vertebral column, in addition to pain in shoulders and arms. In posture B it is possible to observe a rotation and flexion of the

trunk, besides the neck at an angle greater than 20°. In this study, the final score ranged from 6 to 9 for the evaluated shell fishermen. According to the implementation of the REBA method (Rapid Entire Body Assessment) and in accordance with the on-site observations, the shoulders, lumbar spine, knees, neck and arms are the most affected parts of the body in the implementation of the activity. The level of risk of development of musculoskeletal injuries among the shell fishermen has indicated that the majority (82.5%) presented a medium risk for the development of lesions and 17.5% with high risk. The result reveals the need for changes in the form of work in the studied group, with the necessary actions for prevention of new dysfunctions.

Several studies have demonstrated the presence of ergonomic risks and high prevalence of musculoskeletal disorders among workers of the fish industry [6-9]. In relation to the cultivation of mollusks, Novaes *et al.10* [9] *evaluated 35* positions during the withdrawal of mussels from the sea and 28 postures during the breakdown of the mussels using the method OWAS (*Ovako Working Posture Analyzing System*). During the withdrawal of the mussels from the sea, 74.4% of the positions were classified as harmful to the workers' musculo-skeletal system , demanding immediate or short-term interventions at the place of work. Whereas in the breakdown of mussels, the percentage was 69%.

The Niosh equation was used to evaluate the biomechanical overload on lumbar spine during the transport of the boxes with the oysters classified for bench or to the washing machine. The measurements have not interfered in the pace of work, because in no case there was need for interruption of tasks. (Figure 5). The task assessed has become quite unfavorable, mainly on the destination of the survey, causing moderate risk for workers, as evidenced by the values of IL found. IL found was 1.45. When the risk is moderate (1< IL < 3), some employees may fall ill or suffer injuries if performing these tasks[11].

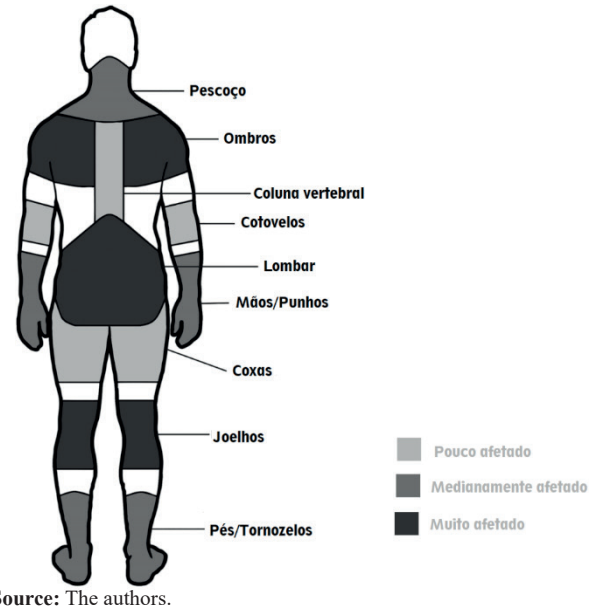
Figure 5 - Lifting of load on the process of oysters washing.



Source: The authors.

In the final step of postural diagnosis, a postural diagram was built to identify the most affected areas in the work completion. The diagram was structured based on observations with video, photos and results from the application of the method REBA. Figure 6 presents the postural diagram of the most affected areas by the activity of oysters classification by size. In the figure, it is possible to observe that the most affected regions were shoulders, lumbar and knees corroborating with the results found by guertler et al.[5].

Figure 6 - Parts of the body of the marine farmer that were affected by the activity of oysters classification.



Source: The authors.

The activities of handling of loads has been highlighted as the main cause of pain in the spine, generating high rates of musculo-skeletal disorders related to work, these activities do not overload only the vertebral column, but also the limbs, which are also required to maintain, lift and carry this load, requiring changes in the postural configuration and use of excessive force. Some studies relate the decrease of body-load distance as a reducing factor of overload on the vertebral column and others that identify the use of strategies of tilt of the cargo, which promotes a greater biomechanical advantage1[11].

Jeebhay *et al.*[12] raised critical issues related to the complaints of pain and legs, based on inadequate working conditions and the significant physical effort for collecting oysters from the sea, washing and classification, in standing up posture and with the torso flexed forward, almost all the time of the working day. Guertler *et al*[5] performed an ergonomic analysis of work in cultivation of oysters with the use of thermography, the REBA method and the Nordic questionnaire. The performed activities generate a high physical exertion, postures, excessive static and dynamic loads and repetitive movements. Most workers have muscle pain in their shoulders, lumbar, hands, wrists and fingers.

This scenario is especially due to pressure of the industry by increasing productivity and reducing the number of workers. These somatized factors can generate irreversible damage to the health of these professionals. However, it is necessary that this set of values present in companies can be reevaluated, allowing the health and safety act as the main guiders of labor relationships[6-9].

All handling of loads (raise, lower, pull, push, hold, carry

and drag) involves a lot of static and dynamic effort, and can be classified as heavy work. The main problem with these forms of work, is usually not the load on the muscles, but the wear of the column, mainly in the intervertebral discs of the lumbar region, which may generate many disorders. Overload disorders, mainly in the lower region of the spine, represent around a quarter of all registered occupational disorders in the United States[11.13].

The NIOSH method describes that there is an ideal load limit of 23 Kg which raised properly, offers no risk of overloading the spine of the worker, but each situation is unique, with different characteristics, making it impossible to find these characteristics. Thus, it is necessary to define each work situation in which the lifting of load is the main task, the recommended load limit, considering aspects such as the characteristics of the load, its packaging (to assess the handle), their actual weight, the position of cargo in space, the distance range, the time and frequency of maintenance of load[13].

The present study showed as limitations the scarcity of studies related to ergonomic work analysis and security and their correlations in mariculture or fishing activity corresponding to little importance which is given to the agricultural activities in Brazil, mainly from family farming.

4 Conclusion

The studied function has a set of inter-related factors, which exert influences on implementation of the activity. With the observations carried out in site, the exchange of information with employees and the application of ergonomic analysis tools it was possible to obtain a diagnosis of the job position of the oysters classification. In addition, it was possible to know the work routine and the factors that interfere in a positive or negative way in the process, and the confrontation of the information and data collected in the field and subsequently analyzed in evidenced vulnerable points in the job that harm the workers' health, safety and comfort.

The ergonomic instruments REBA, NIOSH along with the questionnaires and environmental analysis significantly contributed to analysis of the postures aiding the AET of the activity, so there is a contribution to the sector of mariculture, with the ergonomic risk of the work position. The constructive process, due to being characterized as an industrial and rationalized process, has ergonomic problems related to the working postures and problems of repeatability due to their nature.

It is important to emphasize that the preventive work in these cases combined with training and skills related to health and safety in the workplace, are extremely necessary in order to obtain the results desired by the company and guarantee of the workers' quality of life.

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