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Human factors at work: OWAS application for identification of musculoskeletal disorders in a maintenance assistant

Fatores humanos no trabalho: OWAS na identificação de distúrbios muscoloesqueléticos em um assistente de manutenção

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Abstract

The activities of maintenance and cleaning of swimming pools require several efforts and postures that could cause discomfort and injuries. In this way, this research aimed to identify, applying the OWAS method, the musculoskeletal disorders that affect these workers. The results obtained have made it possible to identify the risks and consequently actions to reduce or eliminate them. The most critical posture identified was the kneeling pose when he is brushing the sides of the swimming pool. To eliminate this posture, it is proposed to change a manual brush to a brush with telescopic stick, designed with an angle that allows the worker to stand upright without flexed his trunk while cleaning the pool. This change improves the working conditions, providing well-being and reducing as negative consequences.

Key-words: Ergonomics; Human Factors; Ergonomic Work Analysis (EWA); Ovako Working Posture Analysis System (OWAS); Swimming pool maintenance.

Resumo

As atividades de manutenção e limpeza de piscinas exigem diversos esforços e posturas que podem provocar desconforto e lesões. Desta forma, esta pesquisa objetivou identificar, usando o método OWAS, os distúrbios musculoesqueléticos que acometem esses trabalhadores. Os resultados obtidos permitiram identificar os riscos e, consequentemente, ações para minimiza-los ou eliminá-los. A postura mais crítica identificada foi a pose ajoelhada quando ele está escovando os lados da piscina. Para eliminar essa postura, propõe-se substituir a escova manual por uma com haste telescópica, projetada com um ângulo que permite ao trabalhador ficar em pé sem flexionar o tronco durante a limpeza da piscina. Essa mudança melhora as condições de trabalho, proporcionando bem-estar e reduzindo as consequências negativas.

Palavras-chave: Ergonomia; Fatores Humanos; Análise Ergonômica do Trabalho (AET); *Ovako Working Posture Analysis System* (OWAS); Manutenção de piscina.

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1 INTRODUCTION

While a job, people are exposed to multiple factors that can contribute to accidents or diseases. Regarding different postural problems in the work activities, problems such as Repetitive Stress Injuries (RSI) and Cumulative Trauma Injuries (CTI). These two kinds of musculoskeletal problems are named Work-related Musculoskeletal Disorders (WMSD) have been identified in recent years as the leading work-related diseases (CARDOSO-JUNIOR, 2006; KOUKOULAKI, 2014).

WMSDs are assuming epidemic proportions, where some of their pathologies are difficult for therapy. The most WMSD affect the hands, wrists, elbows, neck, and shoulders. Occupations using the legs can lead to WMSD on legs, hips, ankles, and feet. They are chronic, and the relapses will renew easily by continuing making of simple repetitive movements. These diseases produce an inability to maintain a normal life, which is not only limited to the job (SALIM, 2003). The World Health Organization (WHO) revealed in 2009, musculoskeletal disorders were responsible for over 10% of all years lost due to disability.

These kinds of musculoskeletal disorders arise from the intensification of work and represent wear in the worker´s musculoskeletal system. Jobs which require the execution of repetitive motions, sometimes associated with physical activity and the maintenance of specific postures for an excessive time. These diseases can evolve slowly and not always are perceived early by workers. Sometimes the use of anti-inflammatory medications masks the problem and delay the search for aid, which causes unnecessary suffering with great impact on their lives.

The application of Ergonomic Work Analysis (EWA) methodology helps in the evaluation process for generating actions to reduce WMSD. EWA aims to apply the knowledge from ergonomics to analyze, diagnose, and fix the real working situation. Detecting the level of risk factors for worker's health problems can be defined ergonomic recommendations (IIDA; BUARQUE, 2016). There are several studies relating problems of occupational origin with the presence of risk factors, on a certain level. Therefore, it is necessary to perform EWA to classify the level of risk factors. In this methodology, several tools or methods can be applied to identify and evaluate the level of the risks existed in the workstation.

Inside the area of ergonomics and the work-related aspects, this study applies an ergonomic analysis approach in a specific workstation, in order to generate a diagnosis of working conditions (CARDOSO-JUNIOR, 2006). Working conditions include aspects related to elevation, transporting and unloading materials, use of furniture, equipment and environmental conditions of the workplace, and the organization of work (GUÉRIN et al., 2001).

The management of ergonomics in the work environment can be characterized with the structural form that it is organized hierarchically, with the practices that got in a routine. It considers the kind of relationship it has with the other interfaces of work (DANIELLOU; BÉGUIN, 2007).

With a focus on the managing ergonomic programs of EWA, considering biomechanical issues, there are three main elements: (i) the identification of the prevalence

and type of musculoskeletal problem; (ii) the analysis of the risk factors that expose the person to the specific risk of musculoskeletal problem; and, (iii) the evaluation to determine the degree of risk in certain populations of workers (CHAFFIN; ANDERSON; MARTIN, 2001).

To perform an EWA contributes to identifying problems in a work activity and generating proposals for improvement. Within this methodology are applied different methods or tools to carry out the collection of information and know the activities. These tools or methods are selected depending on the type of problem existing in the workstation. The aim of the current paper is to identify which activities or work tools are responsible for generating musculoskeletal problems in a swimming pool maintenance assistant.

1.1 Ergonomic postural assessment

Postural assessment plays an important role in the overall context of the EWA, allowing the description of postures assumed in work activity. Postural assessment methods allow establishing a careful understanding of human behavior in work situations, enabling the prevention of problems and diseases that affect the health of the worker (LIMA, 2000). Several recent studies have collaborated to identify diseases associated with physical aspects-postures at work. WMSD may be highlighted as some of these problems (CARDOSO-JUNIOR, 2006).

However, it is necessary to understand that the human body may not be treated as a machine that performs a specific set of movements. A holistic vision should be applied, seeking to establish a comprehensive understanding of the biological, physical, and psychological aspects involved in the work (LIMA, 2000). Taking the discussion to a more technical level, it is possible to cite a variety of postural assessment methods, such as the OWAS method - Ovako Working Posture Analysis System (Karhu et al., 1977), REBA -Rapid Entire Body Assessment (CARDOSO-JUNIOR, 2006), QEC - Quick Exposure Checklist (LI; BUCKLE, 2005), and RULA -Rapid Upper Limb Assessment (MCATAMNEY; CORLETT, 1993).

The presence of WMSD alters the quality of life, resulting in multiple risk factors related to work, mainly to repetitive movements and postures. In this way, the ergonomic intervention is the most used in prevention (ZELTZER, 2000). These diseases are manifestations in worker body, related to physical damage caused by work, there is evidence in ergonomics for a preventive instrument to avoid them (OLIVEIRA, 1998). Therefore, prevention involves changes in forms of work organization, complying with the specifications of each workplace and its workers (MACIEL, 1995).

WMSD suffer from the lack of scientific studies that might contribute to disease prevention, therefore they are considered as one of the serious problems for health. Also, the lack of statistical data makes it difficult to identify their reality. Only a few branches of activity have expressed greater concern through their unions, as the case of banking (SETTIMI, 2001). Companies, in many cases, do not recognize the WMSD as an occupational disease, and consequently, it is not reported to the corresponding governmental agency. Such a perspective contributes to the lack of statistical data.

The quality of life is directly related to the human needs and expectations, and satisfaction of these. Those which corresponds to the well-being of the individual in their desktop expressed through healthy and harmonic relations (KANNANE, 1999). Within this context, the ergonomic collaborate to improve working conditions and, as a result, for the prevention of work health and safety.

In the literature are approaches for performance management of ergonomics within the industry considering programs, committees and ad-hoc interventions (BUTLER, 2003; HÄGG, 2003; JOSEPH, 2003; MOREAU, 2003). These approaches present actions characterized by ergonomic assessments, improvements in workplaces, directed the worker's health. Ergonomics is considered a strategy seemed as critical to workplaces performance (DUL; NEUMANN, 2009).

The ergonomic program creates conditions for increasing the level of performance of the work with the minimization of the risk factors that influence workplace health and safety (MARKOVÁ et al., 2015).

2 MATERIALS AND METHODS

This research is of the exploratory, carried out through a case study with the qualitative approach in its results. For that, it was applied the French-tradition Ergonomic Work Analysis (GUÉRIN et al., 2001). This methodology is composed of five steps, presented in figure 1. First, it is identified the demand. Second, the description of task analysis. Third, the activities analysis. Fourth step, the diagnosis and finally, the ergonomics recommendations.

Figure 1- Ergonomic Work Analysis methodology scheme
Source: Elaborated by the authors based on Fialho and Santos (1997)

The activities were carried out taking in the academic context, and into account the principles of research ethics by resolution 510/2016 of delimited National Council of Health of Brazil; all participants were voluntaries, they signed an informed consent (TCLE), and did not receive monetary compensation.

For data collection, this study used unstructured interviews, directed for the worker, and the division chief. Other data were registered through direct observation and photographs of the activities carried out by maintenance assistant during a day's work. The unstructured interview aims to obtain the most relevant aspects of the activities carried out by the worker. Through guided conversation, we intend to identify who, how, and why are the actions of the employee in order to fulfill the tasks assigned (RICHARDSON; PERES, 1989).

2.1 Tool applied

An EWA methodology can be performed by applying one or more tools, depending on the characteristics of the work performed and the risks associated with it. For this case study, it was identified that the problem to analyze is the posture load of the worker. Being that during the occupational activities his legs adopt varied postures (standing, flexed, sitting, kneeling or walking). It was identified that the OWAS method analyzes this type of posture and is therefore selected to qualify the workstation.

This method aims to generate an understanding of the postures practiced during work activity, providing create a diagnosis that allows the identification of movements that may cause discomfort and pain for the worker (QUERINO et al., 2009; ZUQUE; NECCHI JUNIOR, 2007). This method assigns values to evaluate when the worker is kneeling and allows the evaluation of the legs in various postures, being a weighty tool to identify the potential occupational risks of this workstation. OWAS is characterized by its ability to evaluate globally all the postures assumed during the performance of the activity. This method was chosen due to biomechanical data collection, structured and systematized in the form of a checklist.

The assessment of postural load was classified based on the protocol of the OWAS method. The method is based on the observation of the postures in the activities at regular intervals, with the frequency and the time spent in each posture. This method was chosen because he defined 252 postures that resulted from different combinations of body parts (KARHU; KANSI; KUORINKA, 1977). Unlike other methods, he considers the position of the worker's back, arms, and legs.

This tool, such any method of postures analysis, needs a detailed observation of the activity that is performing and wants to evaluate and must observe various work cycles to select the postures to be scanned. The observation considers the postures of the back, arms, and legs indicating the use of forces at each stage of the activity. In this case, the leg posture allows evaluating when the worker is standing, sitting, kneeling, or bending. For each combination of body postural, it is determined a risks level from 1 (one) acceptable condition, both the posture and the application of forces, to 4 (fourth), worst condition (KARHU; KANSI; KUORINKA, 1977).

3 ERGONOMIC WORK ANALYSIS FOR THE MAINTENANCE ASSISTANT

3.1 Demand analysis

The demand for an ergonomic intervention in maintenance assistant, in charge of maintenance of swimming pools, was the result of the concern of the company based on firstly, a record of frequent complaints of muscle pain in the back and muscle fatigue, which caused absence from work for several days. Secondly, identification of possible causes in the work environment contributing in WMSD worker. And thirdly, identification of corrective measures necessary and sufficient to correct the risks arising from the ergonomic agents, in environments and activities at the workplace.

3.2 Task analysis

The company in which the analysis was applied is a Resort Club and has attractions such as cottages, game room, restaurant, swimming pools, football field, tennis courts, multi-sports court, playground, and auditoriums. This Club counts with 64 workers: 11 administrative and 53 operational.

The maintenance assistant evaluated in this study worked for the company 18 years ago, 3 of them in charge of maintenance of swimming pools, he is 49 years old. The schedule is from 7:00 to 12:00, and from 13:00 to 16:00, Monday to Friday. This work activity is held outdoors (85.5% of the journey), having direct sunlight, exposing the worker to non-ionizing agents such as ultraviolet rays, the remaining time is occupied in the engine room.

Technical actions are: pool cleaning, brush the sides of the pool, to purify the pool and daily opening of the filters located in the engine room of each pool.

The tools used to perform those activities are: Hose pool vacuum (6 m, 2 kg); three sections of telescopic pole (8 m, 10 kg); leaf skimmer (3 m, 2.35 kg); pool vacuum (3 kg); manual brushes, bucket, plastic beaker 50 g; pool detergent, and pool chlorine. For carrying out the activities, the employee uses as personal protective equipment (PPE): half face respirator and PVC chemical resistant gloves. The uniform consists in: cap, short sleeve shirt, jeans, and work boots.

For the worker activities, he gets 85.5% of the time standing outdoors, with exposure to rain, sunlight, wind, and cold for the poolside; and 14.5% of remaining activities, happens in the engine room located in the basement along the pool area.

3.2 Activities analysis

After knowing the tasks assigned to the worker the following step is to observe the activities carried out during the working day. General factors were raised to related activities to perform the EWA. Table 1 describes the activity distribution and the time employed for them.

Time	min.	Activities
07:00-07:30	30	Opening of pool filters #2 and #3
07:30-07:40	10	Transport of tools, pool #1
07:40-08:00	20	Skimming and Removing
08:00-11:50	240	Clean the bottom of the pool
11:50-12:00	10	Keep tools
12:00-13:00	60	Lunchtime
13:00-13:05	05	Transport of tools
13:05-15:15	130	Brush the sides of the pool
15:15-15:20	05	Keep tools
15:20-15:25	05	Put PPE and take chlorine
15:25-15:35	10	Purify the pool
15:35-15:40	05	Keep PPE and bucket
15:40-16:00	20	Opening of pool filters #1 and #4
		Cleaning and purification record on the form

Table 1 – Activity distribution
Source: Elaborated by the authors according to the research done

Pool maintenance

The activities, listed in table 1, were observed along the worker's journey, performing photographic records to identify risks and analyze the postures adopted. The sequence of activities is shown below, in the end, it is indicated the risk resulting from the analysis of the main stock postures.

The opening of pool filters

The two swimming pool filters are opened earlier in the day, and after completing the process of maintenance in the third pool are open the third and fourth filters.

When the employee performs four different postures adopted by opening, there are described and evaluated following: Filter 1, back flexion 42º and supported in the filter, an outstretched arm 77º, and semi-flexion legs. Filter 2, sloping back 24º, arms extended 61º and forearms flexed 145º. Filter 3, sloping back 32º and flexion legs 137º. And Filter 4, sloping back 38º, flexion legs 67º and arms flexed 32º.

Skimming and Removing (SR)

To remove leaves, the worker walks around the swimming pool with the leaf skimmer in hands, removing and putting all leaves in a bag. The worker removes leaves and other debris from the pool with leaf skimmer (2.35 kg).

Clean the bottom of the pool

The worker engages manually the hose pool vacuum, telescopic pole, and the vacuum cleaner, turn on the vacuum pump and clean manually the pool floor draining dirt, walking around the swimming pool. He performs extensive movements with his upper limbs. During the activity the employee is stand, pushing and pulling the

telescopic pole, cleaning up the pool floor during 240 min.

Brush the sides of the swimming pool

The activity consists of rubbing the grooves at the top of the pool walls, with brush and pool detergent, Figure 2. The worker moves from the engine room to the pool, with manual brush and bucket for cleaning the sides of the pool.

Posture: Shoulder 1 is flexed between 70º and 80º, elbow 1 is 130º, hand 1 is flexed from 20º to 30º. The shoulder 2 is supported on the floor and shaking the body, is flexed between 40º and 50º. The back is flexed between 50º to 65º, bending and rotating his back in a simultaneous way. The legs are kneeling with both legs flexed from 45º to 55º, or one leg at an angle of 90º and the other knee on the floor. During this activity is used a brush of 0.5 kg. The measurement of the angles between the body segments was made with the software Ergonautas in the method Static biomechanical calculus coplanar based on Chaffin method (DIEGO-MAS, 2015a).

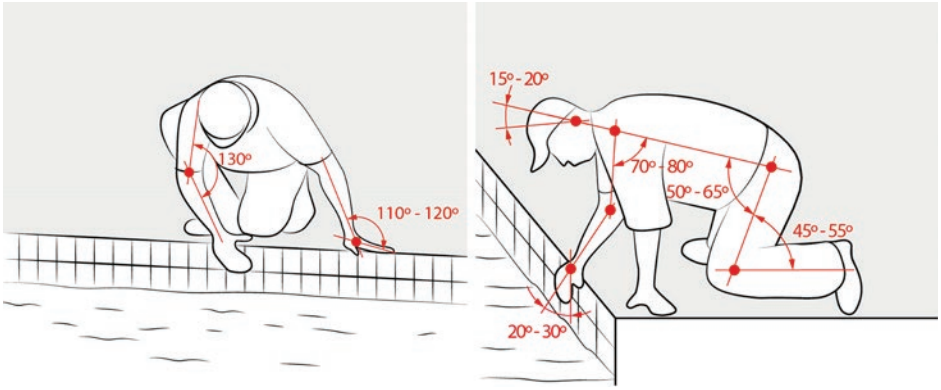

Figure 2 - Brushing the sides of the swimming pool
Source: Elaborated by the authors according to the research

When the worker finished this activity reveals that it is a very exhausting work, that remains with pain in the back, arms, and legs. Evidence that it is an activity in which needs to make modifications in the tools used to avoid the awkward postures of the worker when doing the work.

Purify pool

When he finished the cleaning, the worker purifies the pool. In the engine room, the worker puts the half face respirator and PVC chemical resistant gloves to put 2 kg chlorine powder in the bucket, using a plastic beaker of 50 g. Posture: Keep the back tilted 20º, arm 90º performing movements of flexion and extension to deposit the 2 kg into the bucket, approx. 3 min. To perform the activity, he walks around the swimming pool for 10 min, so the bucket in one hand and on the other the plastic beaker to spread chlorine.

To identify the position adopted by each part of the worker's body during the working day, it is carried out the verification of how long stays in each posture. Figures 3, 4, and 5 illustrate the time percentage assumed by the posture of each body region.

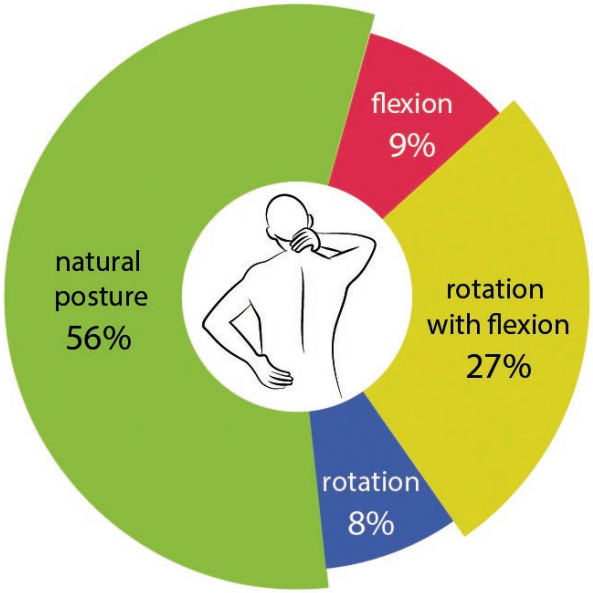

Figure 3 – Back posture
Source: Elaborated by the authors according to the research

The worker remains with his back in natural posture 56% of the day (270 min), when he is cleaning the lowest of the pool; the 9% with flexion back (40 min), during the activity opening the filters; rotating his back 8% (40 min), part of this time is removing the leaves and the other part is opening the filters; he has his backs in rotation and flexion the 27% of the day(130 min), corresponds to the process of brushing the sides of the pool; shown in Figure 3.

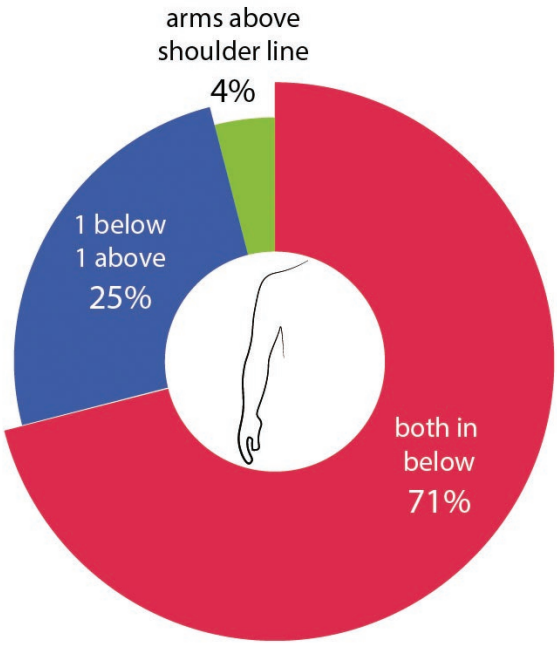

Figure 4 – Arm Posture
Source: Elaborated by the authors according to the research

The total amount of time on each arm posture, Figure 4, indicates that 4% of the time the worker carries out activities with the arms above the shoulder line, 25% with one arm above the line of the shoulders and the other in front of the trunk; the 71% remaining activities with both arms in front of the trunk.

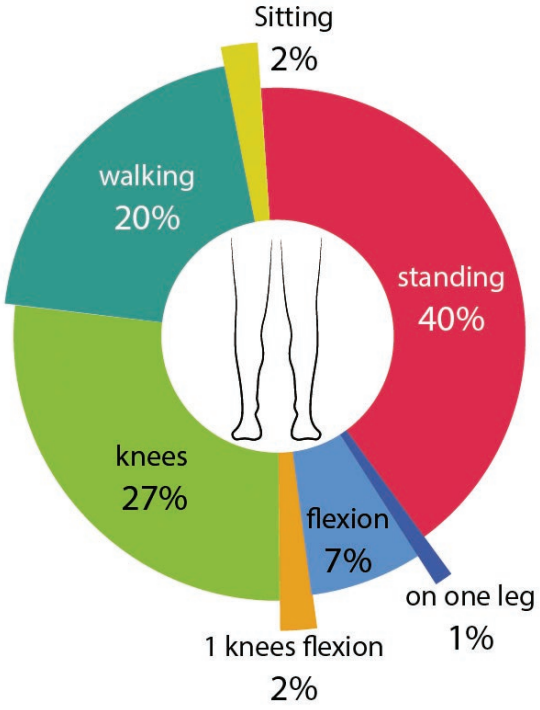

Figure 5– Legs posture
Source: Elaborated by the authors according to the research

When analyzed the legs posture, shows that 40% of the day this worker is standing, 27% on his knees, 7% with his legs in flexion, 20% are walking, 2% the worker is leaning on one leg and the other flexed, the remaining 2% he is sitting. The posture generating the greatest discomfort and pain to the worker is when he stays on his knees, in this case, he performs the brushing on the pool sides. In addition, the percentage is high, it is necessary to change the activities where it requires to be in that posture.

3.3 Diagnostic

As a general diagnosis, it is possible to consider that occupational activities present a set of varied constraints. With the comments made and ergonomic analysis applications, it is possible to establish a set of information that allows the formulation of a diagnosis. With this is possible to generate recommendations aiming to modify some postures assumed in the work activity.

This working environment where the activities are done expose the worker to the rain, sunlight, wind, and cold. However, the ambient lighting was deemed appropriate because it is the outdoor site. And the equipment used by the worker in the activities were considered, by the user, as appropriate, and not representing a general inconvenience in the handling effort.

And to do the postural diagnosis is used the OWAS method. It has a number assigned to identify the position of each body part, with this classification of postures is possible assessment the value of each risk level. To each body part is assigned a number like a code to identify the characteristic of position. OWAS makes the classification of the back position in: (1) Straight, (2) inclined, (3) twisted, (4) inclined with twisted. To the arms, the position is: (1) Both arms are low, (2) one low and the other elevated, (3) The two arms elevated. To legs, positions are: (1) Sitting, (2) Standing with the two straight legs, (3) Standing with one straight leg and another flexed, (4) Standing or squatting with both legs flexed and the balanced weight, (5) Standing or squatting with both legs flexed and unbalanced weight, (6) Kneeling, (7) Walking. And to classify how much weight the worker is handling: (1) <10Kg, (2) between 10 – 20 kg, and (3) >20 Kg.

For each work activity was classified the position of the body parts to identify the critical activity. The number that classifies each body part is defined by OWAS method, as indicated above this number does not represent the level of the risk. He is qualified at a later step.

Analyzing the skimming and removing activity the worker is walking around the swimming pool with his back straight, both arms below the shoulder level and using the pool with leaf skimmer whose weight 2.35 kg for removing the leaves and debris. This body part classification is presented in figure 6, where each position assumed by the worker is filled in different colors. The same form of representation was used in figures 6 to 9.

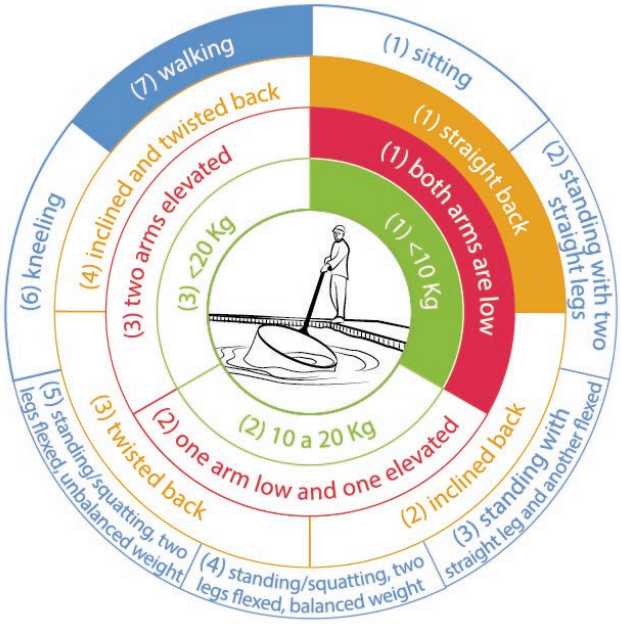

Figure 6 – Classification of body part posture in Skimming and Removing
Source: Elaborated by the authors as a result of the OWAS assessment

After that, it was analyzed the activity of clean the bottom of the pool. At this moment, the worker is standing with one straight leg and another flexed, remaining with his back straight, and the two arms are elevated above the shoulder level while he is pushing and pulling the telescopic pole whose weight is 10 kg. The figure 7 show this body part classification.

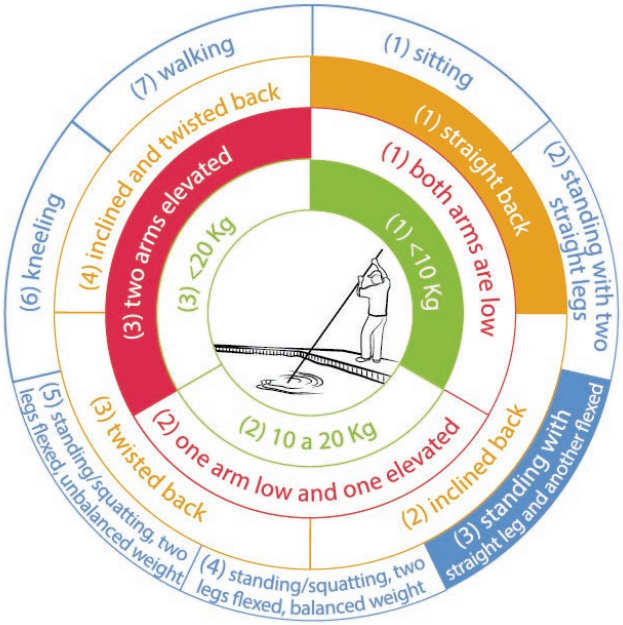

Figure 7 - Classification of body part posture during cleaning the bottom of the pool
Source: Elaborated by the authors as a result of the OWAS assessment

Next, analyzing the activity of brushing the sides of the pool to identify the work posture. He is kneeling, inclined and twisting his back, brushing the wall with one arm and using a brush of 0.5 kg, presented in figure 8.

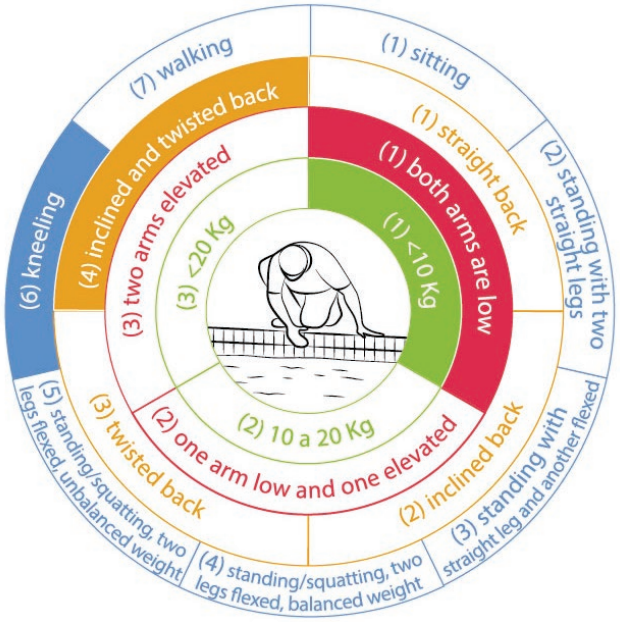

Figure 8 - Classification of body part posture in brushing the sides of the pool
Source: Elaborated by the authors as a result of the OWAS assessment

In the last activity, the worker is walking around the swimming pool taking out the chlorine. He is with both arms down, his back straight and using the bucket with 2 kg of chlorine, which is played with a plastic cup of 50 g. Figure 9 shows the postures of the body part.

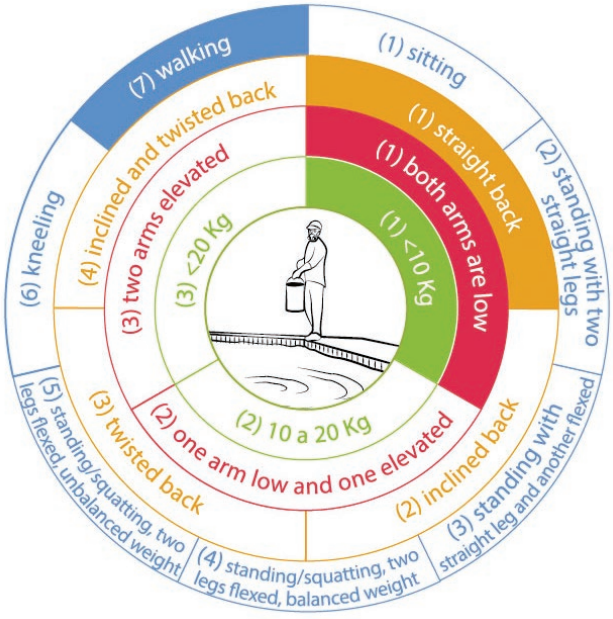

Figure 9 - Classification of body part posture in purify the swimming pool
Source: Elaborated by the authors as a result of the OWAS assessment

To explain how the risk level is measured in each work activity is presented, as an example, the brushing on the pool sides analysis. It was constructed the table 2 to describes the classification details.

Body part	Posture Image	Value
Arms Shoulder 1 is flexed between 40º and 50º, elbow 1 is between 120º and 140º, hand 1 is flexed from 5º to 15º. The shoulder 2 is supported on the floor and shaking the body.		1
Back Flexed between 130º to 115º bending and rotating his back in a simultaneous way.		4
Legs Kneeling with both legs flexed from 45º to 65º. Or one leg at an angle of 90º and the other knee on the floor.		6
Weight Brush 0.5 kg		1

Table 2 - OWAS body parts classification of brushing the pool sides
Source: Elaborated by the authors according to DIEGO-MAS, 2015

With the classification of the posture of the body part, it is possible to identify the category of risks defined by the OWAS method. Table 3 is showing the risk categories matrix. With it is set the priority of the corrective actions.

	Legs	1			2			3			4			5			6			7		
	Weight	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Back	Arms																					
1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1
	2	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1	1	2	2	3	2	2	3	1	1	1	1	1	2
2	1	2	2	3	2	2	3	2	2	3	3	3	3	3	3	3	2	2	2	2	3	3
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	3	3	3	4	2	2	3	3	3	3	3	4	4	4	4	4	4	4	4	2	3	4
3	1	1	1	1	1	1	1	1	1	2	3	3	3	4	4	4	1	1	1	1	1	1
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4	1	2	3	3	2	2	3	2	2	3	4	4	4	4	4	4	4	4	4	2	3	4
	2	3	3	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4
	3	4	4	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4

Table 3 – Matrix of risk categories by posture codes
Source: (DIEGO-MAS, 2015b)

The level indicated by the intersection of posture body parts is 4, back (4), arms (1), legs (6), and weight (1). This score indicated that investigations and changes are required immediately, it is considered that the posture of the worker's back and legs, evaluated with the OWAS method, is far from an appropriate posture for the work done.

The assessment result of the different postures assumed during all work activities is presented in table 4.

	F1	F2	F3	F4	SR	Clean	Brush	Purify
Arms	2	1	1	1	1	3	1	1
Back	2	2	2	2	1	1	4	1
Legs	3	3	4	4	7	3	6	7
Weight	1	1	1	1	1	1	1	1
Risk level	**2**	**2**	**3**	**3**	**1**	**1**	**4**	**1**

Table 4 - Assessment postures in all work activities
Source: Elaborated by the authors according to the research done

After the mapping, the values found are faced with the table for data risk category, this table identified risk level according to the combination of the data from each body part posture, getting the result that indicates the level of risk, Table 5. After determining the risk level, the result indicates the category of action and intervention to be taken.

Action categories	Intervention
1	Unnecessary corrective measures
2	Corrective measures in the near future
3	Corrective measures as soon as possible
4	Corrective measures immediately

Table 5 - OWAS method action categories
Source: Karhu et al., (1977)

The diagnosis of postures shows that the activity of brushing the pool sides is considered critical, obtained the highest score in the OWAS level of risk. It was identified that the worker is kneeling, and he is bending and rotating his back in a simultaneous way, being a posture assumed the 27% of the working time. The OWAS method diagnosed the value 4 (four) score to consider that the position should be investigated and modified immediately. Since the effort is of great importance one needs to adopt a more appropriate posture. It is fitting that the process of brushing the pool sides is held between 1:00 pm - 3:30 pm, with the presence of high temperature generated by the sun situation that increases the physical wear on the worker. Moreover, it notes that the worker does not perform gymnastics activities during the workday.

In addition, he does not use, all along the way, sunscreen creams, or sunglasses to protect his eyes. Also, it is important to consider that the outdoor work, or open-air work, opens up possibilities for the health hazard allowance, establishing the prevention with special measures against heatstroke, heat, cold, humidity, and winds drawbacks (ASCC, 2008). It is considered that non-ionizing agents such as ultraviolet rays may cause cataracts, unhealthy, cancer, and other diseases on eye or skin. Symptoms vary from mild irritation to severe pain. Also, it considers that the outdoor work makes the body less resistant to infections.

It should be noted that the outdoor work or open sky is not necessarily considered as unhealthy. The appearance or not of disease would vary according to the day, the hour and the climatic conditions experienced by the worker.

3.4 Ergonomic recommendations

Some recommendations are suggested, aimed at the well-being of the worker. Among these:

- Change the position of the worker during the activity of brush the pool sides, in which proposes to use a brush with telescopic stick (Figure 10), which allows the worker to remain standing up without flexed his trunk.
- Perform the activity of brush the sides of the pool at the beginning of the workday, from 7:30 am to 9:00 am, at this time the presence of sun is less.
- Because they are outdoor activities the employee should use sunscreen lotion, reapply sunscreen every 2 hours, at least.
- To use long-sleeved blouse in the lightweight fabric to avoid excessive heat.
- To wear sunglasses, preferably with UV ray protection.

• To prefer the shorts covering his legs up to the knees.
• To instruct and to monitor the realization of gymnastics by the worker.

To work safely in the sun, workers must follow certain procedures and sun protection policies in the workplace, participate in training, follow the instructions and recommendations, and use protective equipment in accordance with the instructions (ASCC, 2008; THE CANCER COUNCIL AUSTRALIA'S SKIN CANCER COMMITTEE, 2007).

There is evidence that chronic exposure to solar UVR contributes to age-related macular degeneration and cataracts, both can be a cause of blindness. Long-term effects may also include pterygium (white or opaque cream growth over the cornea), squamous cell carcinoma of the conjunctiva, and skin cancer around the eye (THE CANCER COUNCIL AUSTRALIA'S SKIN CANCER COMMITTEE, 2007).

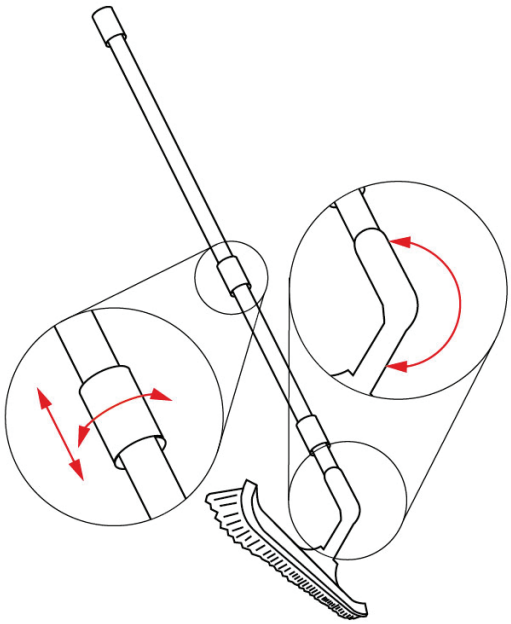

Figure 10 – Brush with telescopic stick proposed
Source: Elaborated by the authors

To modify the worker's posture during the cleaning activity of the pool walls it is recommended to use the brush with the telescopic stick (figure 10). Tool fulfillment can be adjusted according to the worker's need. When the worker uses the proposed brush with telescopic stick, he can stand upright, with his arms in front of the body, and his back in neutral posture. Thus, the most tiring and stressful position identified in this evaluation is eliminated.

Reapplying the OWAS method, the new postures using the brush with telescopic stick proposed, obtains: back 1, arms 1, legs 2, and weight 1, giving as result a risk level 1, according to the matrix of risk categories (table 3). Showing a reduction from level 4, former posture, to level 1 with the new posture.

Based on this study, it is possible to relate the factors and causes of musculoskeletal complaints that interfere with the worker health.

To validate the proposal is analyzed the percentage of each body part with the adoption of the new body posture. When using the new telescopic brush, the worker has his backs in a natural posture for 91% of the time (including all occupational activities), figure 11.

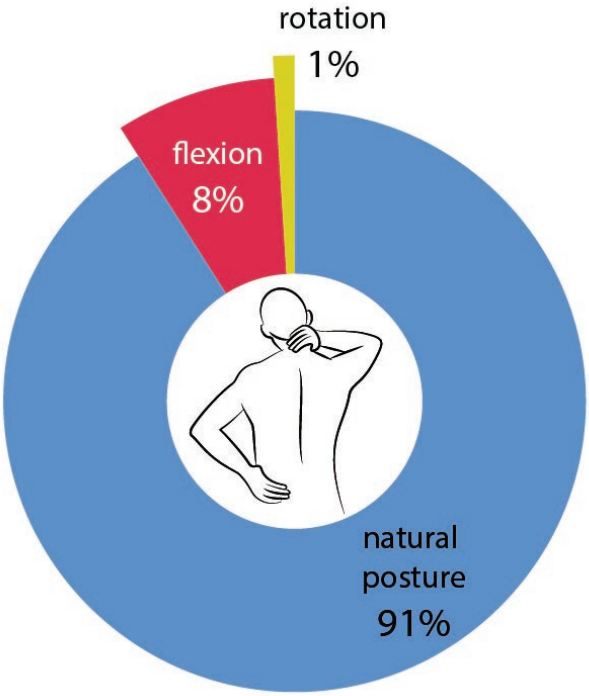

Figure 11– New back posture
Source: Elaborated by the authors according to the research

As far as the arm posture is concerned, figure 12 it maintains 28% of the working day, with one arm above the shoulder line and the other arm below for only 1%. With the use of the new tool, the worker remains 52% of the time with the two arms in front of the trunk, thus reducing the wear of the joints and the muscles of the shoulder and arm.

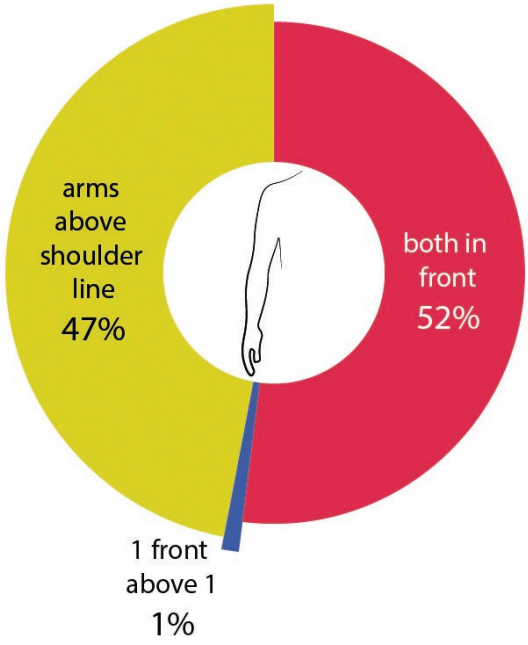

Figure 12 – New arms posture
Source: Elaborated by the authors according to the research

With regard to the posture of the legs, the activity that obliges the worker to stay on his knees is eliminated; and now he performs the activities standing during 82% of the time (Figure 13).

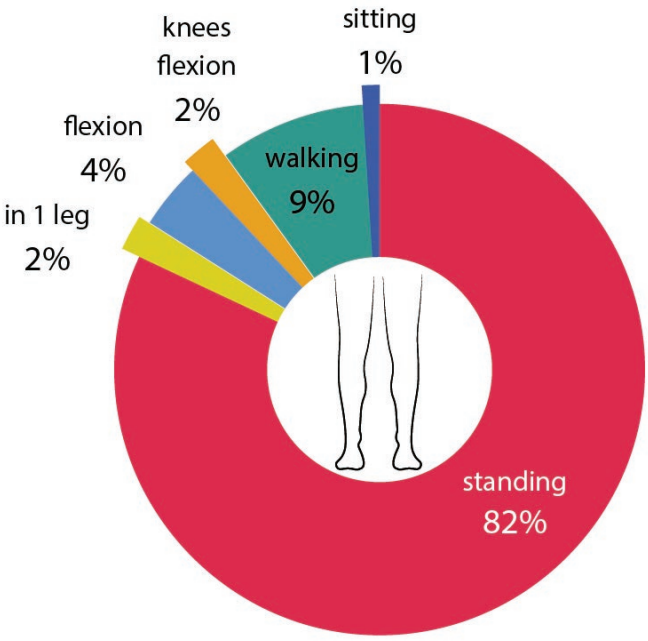

Figure 13 – New legs posture
Source: Elaborated by the authors according to the research

4 CONCLUSIONS

The use of instruments (questionnaires, observation, and interviews) has allowed to assess the characteristics and level of the risks that exist in the work activities. Applying the OWAS method, within the EWA methodology, it was possible to identify the posture and activities causing the musculoskeletal problems in this swimming pool maintenance assistant (stay on his knees when brushing the pool sides).

The adaptation proposed for the tool used to perform the process of brush the swimming pool sides, with a low investment estimated and a quick possibility of implementation, may reduce the risk of musculoskeletal injuries derived from this activity.

The valuation of the worker using the brush with telescopic stick proposed shows a level reduction to level 4 to1 in the risk category of the OWAS method. The figures 11, 12 and 13 represent the postural changes, showing a remarkable improvement in risk control while brushing the sides of the pool.

Workers also have the duty to take care of their own health and safety and cooperate with the efforts of employers to improve health and safety, participating in, for example, gymnastic activities, using the cream with sunscreen and hat.

Occupational safety and health legislation require employers to monitor workers' health. In relation to skin cancer, this involves encouraging workers to examine their skin, as well as damage to the eyes by long exposure to the sun. This information can be delivered through flyers and posters (ASCC, 2008), and monitored to follow up the preventive instructions.

Companies that voluntarily have implemented ergonomic programs have demonstrated that effective ergonomic interventions reduce WMSDs. Many of these interventions are simple and inexpensive; however, they have a significant effect on the occurrence of work-related musculoskeletal disorders. Benefits include substantial savings in workers' compensation costs, increase productivity, and reduction in turnover. If the ergonomics become allied with the company's strategy, integrated to their goals, positive results in humans, in operational, and financial efficiency may appear (HÄGG, 2003).

The main objective of all the ergonomic intervention is the proposition of improvements in working conditions for the comfort and well-being of the worker, applying EWA (MACIEL, 1995). Faced with this problem, an appropriate methodology of ergonomic intervention can contribute to a broader analysis of the factors causing musculoskeletal problems in occupational activities.

From the results of the analysis of the work can be defined a tree of cause-effect relationships, that allows to point out the critical anomalies of the work process (SANTOS; FIALHO; CAVALCANTE, 2011).

The analysis of the activity provides real data from the worker's relationship to the occupational environment, also provide the information necessary to propose modifications that bring benefits to both the worker and the company.

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