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STUDY OF DIFFERENT ERGONOMIC METHODS AND THEIR APPLICATIONS

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Summary

Ergonomics is a science that studies the interaction between man, machine and the environment in which he is inserted, in order to improve psychophysical well-being and increase the system's productivity. To measure this interaction, ergonomic assessment methods are adopted. That said, this research aimed to compare different methods, exposing the advantages and disadvantages of each one, pointing out those considered efficient for certain purposes. Among the existing methods, seven were studied: RULA, REBA, OWAS, NIOSH, SI, EAMETA and OCRA. After carrying out the research, it was possible to realize that each method has positive and negative aspects and that the choice of the method to be used will depend on the situation in question. It is worth noting that, with the use of the correct postural analysis technique, the risk of bodily injury in workplaces can be reduced, thus avoiding accidents and a high number of absenteeism.

Key words: Ergonomics, methods, workstation, posture.

1. Introduction

Ergonomics is the science that studies the triple relationship between the human being, the activity they wish to carry out and the physical space used, with the aim of providing well-being to man. In order to reduce the risk of injuries during the work period or, also, dissatisfaction in this environment, there are specific ergonomic methods for evaluating the conditions of space and movement (posture) of workers.

Just as every job has its laws and correct ways of proceeding, ergonomics has a standard that supports all the necessary precepts applicable to this science. Regulatory Standard 17 – NR 17 – was created in 1978 and deals with general aspects and topics such as cargo, environment, organization, equipment and furniture.

Therefore, this standard aims to establish parameters that allow the adaptation of working conditions to the psychophysiological characteristics of workers, in order to provide maximum comfort, safety and efficient performance (NR 17/2007 apud Másculo and Vidal, 2011), as it knows It is known that the majority of work accidents or injuries within workplaces are caused mainly by a lack of environmental planning.

That said, this research aimed to compare different ergonomic assessment methods, exposing the advantages and disadvantages of each one and pointing out the methods considered efficient for certain applications. To this end, a bibliographical research on ergonomics was initially developed. Next, some of the most used methods in evaluations were researched and, finally, the main results achieved from the study were highlighted.

2. Materials and Methods

According to Másculo & Vidal (2011), ergonomic methods consist of the use of resources from different fields of knowledge that make it possible to investigate, survey, analyze and systematize work and working conditions. To carry out this research, seven ergonomic methods were sought that have been used to identify problems caused in workplaces. Below we seek to relate them and, succinctly, explain them.

2.1 *Rapid Upper Limb Assessment* (RULA)

Created jointly by Mc Attamney and Corlett in 1993, the RULA method has the function of observing postural damage obtained during efforts made at work, evaluating upper limbs and legs. For Másculo & Vidal (2011), the method aims to assess the worker's risk of exposure to inappropriate postures and muscular activities and acquisition of Repetitive Strain Injuries (RSI) or Work-Related Osteomuscular Disorder (WMSD). The difference brought by this method is the items evaluated. RULA also takes into account the muscular effort that this person performs and the load they carry during their work.

To apply it, the observer must observe the worker's posture regarding the shoulder, elbow, wrist, neck, trunk and legs, in addition to the muscular effort and the load exerted. With the help of figure 1, the data obtained after each observation are displayed. In the spaces where the score is found, already formulated tables are needed to be replaced when the data is collected.

Source 1. Scheme prepared by authors.

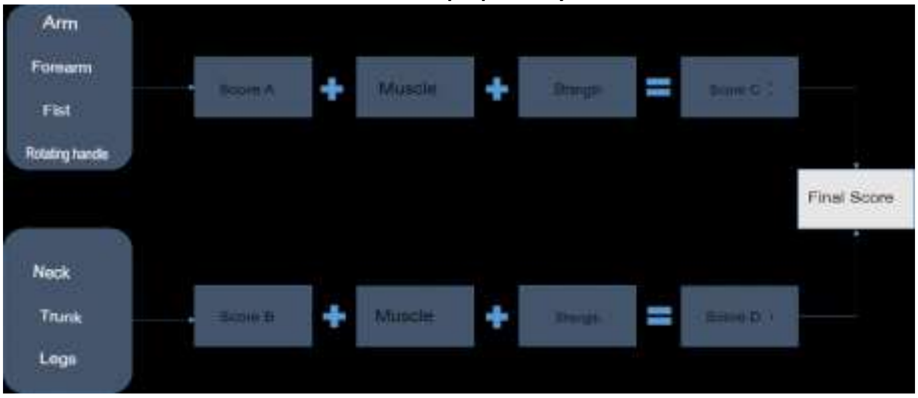

Figure 1. Scheme to obtain the final RULA score.

When the sums are completed, a final score is reached. This score obtained is translated into a level that will indicate whether a change in job position is necessary. The first level shows that the posture is acceptable and does not require change. The last level, with a value of 4, requires immediate changes to the workplace.

2.2 *Rapid Entire Body Assessment* (REBA)

The REBA method, proposed by Sue Hignett and Lynn McAtamney in 2000, allows an analysis of all the positions adopted by the upper limbs of the body, evaluating the arm, forearm and wrist, as well as the trunk, neck and legs. Some other determining factors are also taken into account, such as the load handled and the holding time. Figure 2 shows an illustrative scheme for obtaining the risk level using this method.

Source 2. Scheme prepared by authors.

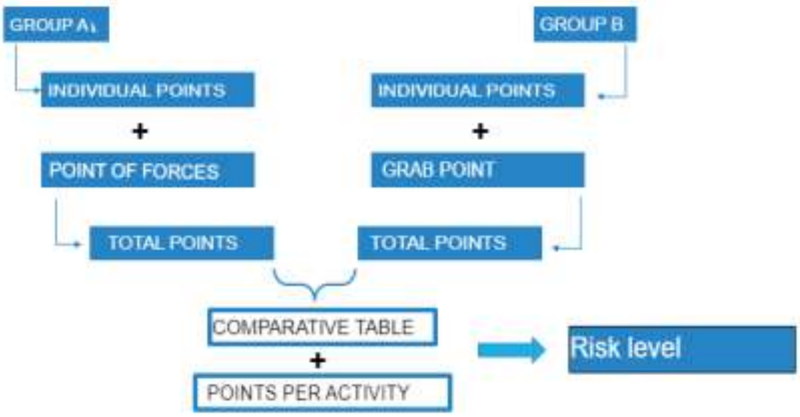

Figure 2. Scheme to obtain risk level in REBA.

The method allows the evaluation of both static and dynamic postures and the reporting of sudden changes in posture is new. By crossing the scores obtained in the first two groups, a pre-established final result is reached. Depending on the number obtained, it is possible to determine whether the position presents a high risk of injuries or not, providing guidance on the need for corrective actions for certain postures.

The REBA method is divided into 15 levels. The first level presents no risk, however, between the eighth and fifteenth, the risks are high, requiring action and modification of the workplace.

2.4 Owako Working Posture Analysing System (OWAS)

Finnish researchers Karu, Kansi and Kuorinka, in 1977 (Luiz, 2013 apud KARHU et al., 1997) developed a method that could identify and evaluate inadequate postures where, together with the Finnish Institute of Occupational Health, they created an ergonomic method that allowed discover, during the execution of the task, worker postures that can cause various muscular/skeletal problems.

As this is an assessment of the worker's posture, it is necessary to carry out observations during periods of work. This observation can be made through complete cycles or during at least thirty seconds of activity. To record these activities, photographs, filming or notes are taken. Once the observation is complete, it is possible to identify the worker's position and obtain one of the standardized positions for each posture. These postures have scores, which will be treated as codes and used to prepare the OWAS method code model.

Unlike other methods, in OWAS a code model is created that distributes the assessments carried out by posture, shown in figure 3. In the following image, you can see the arrangement and order of these codes. Comparing these values, the risk level obtained by the OWAS method will be obtained.

Source 3. Model prepared by authors.

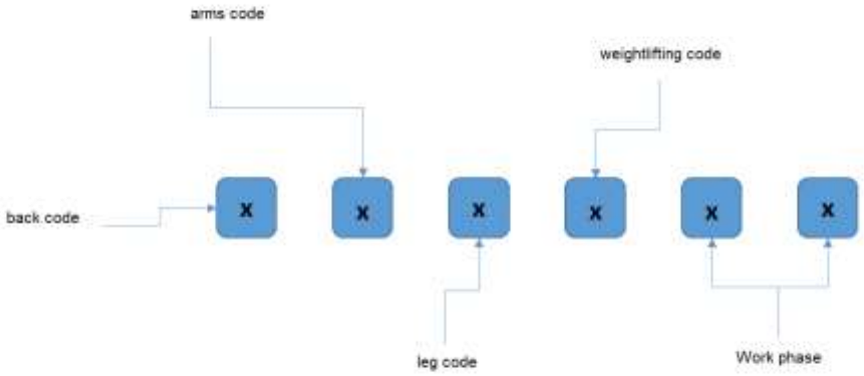

Figure 3. Code model for OWAS.

Once the verification is complete, a table of action levels is used according to the posture obtained. This table crosses all the values and, in return, provides a score from 1 to 4. The lowest number symbolizes that no corrective measures are necessary for the task at the moment, while the highest number implies immediate corrections.

2.4 *National Institute of Safety and Healthy* (NIOSH)

In 1980, according to Rego (1987), the creation of a method that would determine the maximum manual load in a work activity was sponsored in the United States, under the initiative of the National Institute for Occupational Safety and Health, called NIOSH.

The method used established that, for any work situation, when manually lifting loads, there is a Recommended Weight Limit (L.P.R.). The calculation formula is described below:

$$LPR = 23 \times FDH \times FAV \times FDVP \times FFL \times FLRT \times FQPC$$

Where the value 23 corresponds to the ideal limit weight (being constant) and each variable corresponds to a multiplication factor presented below:

FDH – Horizontal Distance Factor in relation to the load;

FAV – Vertical Height Factor in relation to the ground;

FDVP – Vertical Distance Factor in the action interval;

FFL – Survey Frequency Factor;

FRLT – Trunk Lateral Rotation Factor;

FQPC – Cargo Handle Quality Factor.

Once calculated, compare the L.P.R. with the actual load lifted, thus obtaining the Lift Index (IL). The Lifting Index (LI) of the NIOSH method determines whether an activity presents a risk of musculoskeletal injury, quantifying this risk. The interpretation of the results demonstrates that, if the index is less than 1, the condition is safe and, if greater than 1, the condition is unsafe.

2.5 Occupational Repetitive Actions (OCRA)

The OCRA method was developed by Drs. Daniela Colombini, Enrico Occhipinti and Michele Fanti at the request of the International Ergonomics Association (IEA) in 1996. The objective of developing the method was to prevent musculoskeletal disorders of the upper limbs, through the assessment of ergonomic risks associated with a particular activity. This assessment takes place using a calculation model, which will determine an exposure index based on the comparison between the variables found in reality and in theory.

The method uses several questions and, through them, the values of Observed Technical Actions (ATO) and Recommended Technical Actions (ATR) are generated, arriving at the exposure index, which is compared with the determined risk levels, identifying the degree of risks to which that activity is exposed (PAVANI, 2007).

Table 1. Classification of OCRA risk levels.

AREA	OCRA VALUES	RISK LEVEL	ACTIONS
Green	Up to 2,2	Acceptable	None
Yellow	Between 2.3 and 3.5	Very low risk	Check and implement improvements
Red	Biggest 3.5	Present risk	Redesign the workstation and assess staff health

Source 4. Colombini et.al. (1996)

The risk classification, in the OCRA model, is analogous to the colors of the traffic light, as shown in table 1. The OCRA Values column is related to the number found in the IE (Exposure Index).

2.6 Space, environment, furniture, equipment, task and activity (EAMETA)

The Space, Environment, Furniture, Equipment, Task and Activity tool – EAMETA – is a system created based on NR 17 that is concerned with topics such as space, environment, furniture and equipment, with a combination of two themes that repeatedly appears in these analyses: task and activity. EAMETA can have several objectives in evaluating the work system, from separating the interviews carried out by content and themes to prioritizing and focusing on more specific problems.

The application of this tool is divided into two stages, according to Másculo & Vidal (2011). The first consists of filling out a table with ten aspects that the observer and the worker must evaluate, related to the items in NR 17 (space, environment, furniture and equipment). In the second stage, referring to the task and activity, three questions are asked, separately, to the area leader and the operator, preferably in that order. The area leader is asked the following questions: 1) What is done here?, 2) Who takes care of what? and 3) What is expected of each person? For the operator, the questions are: 1) What can you do?, 2) What is your job? And 3) What tasks do you perform?

After completing these two steps, the table that guides the preparation of a final table must be completed, for subsequent interpretation of results from the EAMETA tool.

2.7 Strain Index (SI)

Developed in 1995, the SI aims to assess the risk of work-related musculoskeletal injuries of the upper limb. Measures six task variables: Intensity of effort, Duration of effort, Number of efforts per minutes, Hand posture, Speed of execution and Duration of task per day.

After establishing each variant, the final formula can be used to find the risk of the assessed activity, and thus define three risk levels.

$$SI = IE \times DE \times EM \times PM \times VE \times DD$$

In the formula described above, the acronyms correspond to six distinct variables:

IE – Intensity of Effort

DE – Duration of Effort
EM – Number of Efforts per minute
PM – Hand Posture
VE – Execution Speed
DD – Task Duration per Day

After applying the method, the risks are comprehensively assessed, using a pre-established score. The interpretation of the results occurs with the lowest number being associated with the lowest risk of accidents and muscle injuries.

3. Results

When the employee performs his activities daily, he may assume different body positions or perform repetitive movements throughout the work cycle. According to Pavani (2007), instruments for analyzing postural risks are divided into three classifications: checklists, semi-quantitative and quantitative methods.

Checklists correspond to a set of questions that will be interpreted at the end of the application as a risk involving a scale. This is the case of EAMETA. Semi-quantitative methods use observations (direct/indirect) and the data are converted to numerical scales. This classification includes RULA, OWAS and REBA. The qualitative ones propose the use of formulas to define the load lifted, as is the case of NIOSH, OCRA and SI.

In table 2 (prepared by the authors) an attempt was made to systematize the advantages and disadvantages of each method researched.

Table 2. Advantages and Disadvantages of Ergonomic Methods.

METHOD	ADVANTAGE	DISADVANTAGE
RULA	Quick and practical analysis of a large number of workers and general ergonomics.	Too many positions to evaluate, based on the authors' analysis.
REBA	General ergonomic analysis along with movement analysis with sudden change.	Too many positions to evaluate, based on the authors' analysis.
OWAS	Assess the entire body and the handling of heavy loads.	At least 100 samples are required – according to the authors – observations to ensure reliability in the final result.
NIOSH	Ideal for evaluating manual lifting of loads.	Too many variables to be studied.
OCRA	Upper limbs and complementary factors are evaluated.	Excessive variables and formulas.
SI	Upper limbs are evaluated with fewer variables.	There is a great disparity between the final result numbers, leaving room for error.
EAMETA	Make a comparison between what the operator of the function thinks and the sector leader.	Only the worker's view regarding their attitudes, since the leader is not questioned about this.

Source 5. Summary prepared by the authors

Unlike the other methods seen, the EAMETA tool is used for ergonomic assessment focused on the environment. This method will make a comparison between what the operator thinks and the leader in this sector, and will also have evaluations from the observer. Therefore, the advantages brought by this method are broad assessments of the entire workplace and what is used to perform the function. Its disadvantage, in addition to its scope, is that only the worker views their postures, with no theoretical comparison or level of risk to be considered.

The RULA method is an easy-to-apply instrument, allowing the assessment of overload of the upper limbs and neck, mainly, in addition to also evaluating the lower limbs and trunk. Thus, it considers fast movements, but does not take into account vibration or extreme temperatures. The great advantage brought by the RULA method is, as already mentioned, a quick and practical analysis of a large number of workers. However, an excess of tables and positions can be a problem when applying this method.

The OWAS method is important for evaluating the entire body and handling heavy loads, in addition to helping to solve problems related to accidents due to poor posture. To analyze postures, detailed observation of the task is necessary, however, in this method, samples are taken at intervals, requiring at least 100 – according to the authors – observations to provide reliability in the final result.

The REBA method is mainly aimed at analyzing the upper limbs – in addition to the neck, trunk and lower limbs – and work that uses repetitive movements. Its differential is the analysis of movements with sudden changes.

The NIOSH method has the advantage of evaluating manual lifting of loads, which nowadays is one of the biggest causes of muscle dysfunction in workers. However, according to Franceschi (2013), it does not consider the potential risk associated with repetitive surveys.

The OCRA method is used to evaluate musculoskeletal injuries in the upper limbs with the difference of carrying out an analysis of the complementary factors involved in the production system, such as extreme temperatures and vibrations.

The Strain Index is mainly used to evaluate musculoskeletal injuries in the upper limbs, but it does not evaluate factors that are not related to hand posture. If there are short movements over time at the workplace, the use of the method is not recommended, which is its main disadvantage.

4. Conclusion

Through ergonomics, it is possible to adapt work to human beings through various methods, such as postural analysis. By offering better working conditions, ergonomics reduces fatigue and stress and, consequently, promotes increased well-being and productivity for workers.

It can be seen that for the assessment of upper limbs only, the most suitable methods are SI and OCRA, which have the advantage of evaluating the work environment together with posture. When a general ergonomic assessment is required, methods such as RULA and REBA are the most suitable. Through them, it is possible to evaluate upper and lower postures, as well as aspects such as “handling” the load and unpredictable movements.

Methods like NIOSH are useful when you want to know the ideal hand load. The OWAS method is recommended when seeking to understand the workplace cycles that cause poor posture. The EAMETA tool is best suited for combined assessments of the work environment and worker's thinking, taking into account the conversation and questionnaires carried out during the interview.

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