30 - EVALUATION OF PHYSICAL WORKLOAD OF EMPLOYEES CASTING THROUGH AN ANALYSIS OF ERGONOMIC WORK AND CHANGE IN HEART RATE

BRUNA ANGELA ANTONELLI (UTFPR)
PROF. DR. ANTONIO AUGUSTO DE PAULA XAVIER (UTFPR)
PROF. DR. TARCÍSIO F. ALVES DA SILVA (FADEP)
PROF. BELMAR RAMOS JUNIOR (FADEP)
LARISSA CRISTINE SKITTBERG (FADEP)
Programa de Pós-Graduação em Engenharia da Produção / Universidade Tecnológica Federal do Paraná
Campus Ponta Grossa - PR
bruna_antonelli@yahoo.com.br

1. INTRODUCTION

The relationship between man and his work was marked from the industrial revolution, which occurred between 1760-1830. During this period, a number of technological breakthroughs made an impact on human labor and production process in economic and social level. That prompted a restructuring in this process with increasing substitution of human labor by technology, changing work characteristics and having a deep impact on people's lives. (Deliberato, 2002) (Dejours, 1992).

The need for scientific answers regarding health at work has generated a search for the development of theories, concepts and methods in the work environment. Concerned about the harsh conditions of work environments in coal mines, smelters and other unhealthy conditions that researchers began to study the physiology of work eoe energy expenditure in an attempt to transfer to the territory practical knowledge generated in laboratories of physiology (Wunsch, 2004; Iida, 2005).

In Brazil, can be observed many workers involved in activities whose production processes are still rudimentary, with a minimal degree of technology. The existence of heavy, high energy consumption and physical overload is often found (WUNSCH, 2004). An example of heavy activity cited by Grandjean (1998) are the foundry industry, characterized by predominantly static postures of the spine and arms resulting from excessive handling and shipment weight.

In a heavy physical work, as Iida (2005) and Kirkendall & Garrett (2003), the need for muscle contraction is intense because the actual characteristics of this type of activity. The human body in this situation goes through many changes that affect the organs, tissues and bodily fluids, because the skeletal muscle produces large amounts of lactic acid which creates an increase in intra-and extracellular acidity. This causes an imbalance in the biological control systems of the body, causing a series of challenges to the control system of the organism.

According to McArdle & Katch, (2003), the heartbeat can be a flag, through which one can evaluate the body stress, but can also be used as a demonstration of physiological toll of work. In ergonomic studies to measure the physiological indices for the purpose of determining the amount of physical activity that an individual may exercise (Alves et al, 2000). The energetic cost of an activity as Kirkendall & Garrett (2002), can be understood as the rate of production of body energy. Since the workload is understood as a quantitative or qualitative measure of the level of motor activity, physiological and mental health necessary to perform a job.

Given this context, this study sought to evaluate the ergonomic point of view the activities performed by workers, analyzing the possible overload of the musculoskeletal body segments according to the work activities, observing the behavior of heart rate in order to identify the activity of major and less physical wear during work.

The study is justified because the foundry industries present with features of physical manual labor, lifting and handling of excessive loads at high temperatures (Iida, 2005; Bridges, 2005). Thus, the physical effort of individuals is intense, the ability to work well as health and welfare of the worker may be compromised. This scenario may have important effects on metabolic changes in the composition of body fluids and may contribute to the development of pathological processes caused by stress due to the activity (Garret & Kirkendall, 2002).

Thus to achieve the AET and assess the physical load of work by checking the heart rate is possible to establish strategies showing the existence of problems that can interfere directly in human performance production, since this relationship is fundamental to success in the environment work. If the result is negative, for example, the load is too high or too low, you should try to adjust working conditions or cargo in order to tailor the system for work-man's welfare and worker health (Kahil, 2003).

2. MATERIALS AND METHODS

The study was conducted in November 2009 in a molten state of Parana, consisting of 25 employees. The survey was conducted from a random sample intentionally, with a selection of 16 males, aged unknown, working in the foundry sector.

Were included in the study employees with at least one year of uninterrupted activity in the foundry sector and accepted to participate in the study after the interview and signing an informed consent. Exclusion criteria included employees who used continuous medication, had physician-diagnosed heart disease. To conduct the study we used the following materials: Heart Rate Monitors Polar S625 and S810 ® model; Digital Camera from Sony ®, Balance ® digital brand Britain and tape measure.

To obtain the resting heart rate has been called every worker individually, stressing that they were instructed not to smoke three hours before the test and not perform vigorous physical exercise. The time of verification took place between 7am to 8am before commencing work activities. To monitor heart rate during labor is necessary to insert the subject's individual characteristics (date of birth, height (cm), body mass (kg), sex. After entering the data, was placed with the transmitter strap on the chest, below pectoral muscles, following the guidelines for use.

Data were collected at the clinic of the company, which was only the individual and the evaluator during the test. Guided to take a stand that evaluated lying supine on the stretcher holding hands beside the body, and which avoided making moves, trying to relax so the same. By connecting the transmitter that detects heart rate displayed in beats per minute (bpm), and stores it in the file, and this is analyzed by Polar Precision Performance SW Performace, which generates in graphical form the variation in heart rate. To perform the ergonomic analysis was used a digital camera where it was recorded racy footage collaborator in the work situation.

The results were transferred to a computer for their own equipment ("interface") for analysis software developed by the manufacturer. In parallel, a time study by the method of continuous time, with the aim of analyzing the workload according to the activity.

3. ANALYSIS AND DISCUSSION OF RESULTS

The study was conducted with 16 male employees who work in the following activities: Molding manual and pneumatic, production assistant, and Polishing Shakeout. We evaluated 64% of workers involved in the casting process, where 50% were overweight according to Body Mass Index (BMI).

In relation to age, can be observed that both sectors had lower average were the manual molding and mold release, with 37.5 and 32 years respectively. The sectors of pneumatic molding, production assistant and polishing were aged over 40 years.

According to Hall (2005), age is an important factor that interferes with the muscular strength of an individual. Grandjean (1998) describes that men aged between 25 and 35, have the ultimate in strength and muscle are in the prime of their working capacity, so you must lead these employees to activities that require more muscular effort. Above 40 years the worker suffers a deficit of progressive muscular capacity due to decrease of muscle fibers and motor units, the same for the total strength of a muscle, this deficit is approximately 30% of total muscle strength (Hall 2005) .

All activities observed in this smelter identify themselves require intense muscular strength mainly from the lumbar spine, but the polishing industry is presented with more static postures of upper limbs, with less weight bearing, which may explain the presence of employees with age range.

It should be emphasized that the attitudes that employees take during activities are the result of the job characteristics and dimensions that make human performance disadvantage with the onset of fatigue or musculoskeletal pathologies.

It is considered that the activities examined, there is also high demand ergonomic lumbosacral spine, along with the physical work demands, such as poor posture, manual lifting weight and repeatability of these movements. Still, it is noteworthy that in addition to physical exertion activities found in the foundry environment presents some values of the temperature of solidification of metals such as iron in this case the temperature of 1535 ° C, this value could be higher depending on the volume of production. This interferes significantly in the temperature of the working environment and can give damage to workers' health because of increased fatigue due to heat exposure required for the activity. (Smith, 1996).

The heavy physical work performed in conditions of high temperature can cause second Iida (2002), two types of physiological demand. First the muscle demands more blood supply that can reach up to 25L/min, on the other hand, blood flow must flow to the skin surface to remove heat at a rate of 10L/min. Given this situation the cardiovascular system is highly required, due primarily to its ability to pump blood to be approximately 25L/min. The hard work observed in the foundry industries, as the same author generates additional heat during the metabolic processes, because the body receives an additional load of heat by convection and radiation, where work efficiency is reduced by up to 41% if held at temperatures at 28 ° C.

In ergonomic studies to measure the physiological indices for the purpose of determining the amount of physical activity that an individual may exercise (Alves et al, 2000). The maximum load at work can be calculated based on average heart rate of work (FCMT) or the cardiovascular load (CCV). The physical load of work classified according to the methodology proposed by E. Apud (1997) as shown in Table 1:

Table 1: Classification of work activities

Average heart rate	Job classification
Less than 75 bpm	Very light
Between 76 and 100 bpm	Moderately heavy
Between 101 and 125 bpm	Heavy
Between 126 and 150 bpm	Extremely heavy

Fonte: Apud E. (1997)

The maximum increase in heart rate during labor is acceptable for a "performance" solid, is 35 and 30 beats per minute (bpm) in men and women, respectively. This means that the limit is reached when the average worker's heart rate is 35 bpm above the mean resting heart rate (FCR) (Fiedler, 1998).

Table 3 shows the values found in this study regarding the resting heart rate (FCR), working (FCT), HR max (FCM), cardiovascular load (CCV) and classification of work during the workday.

Table 1 - FCR (resting heart rate); HRMax (maximum heart rate); FCMT (Average Heart Rate at Work), CCV (cardiac load) and work classification.

Activities	FC repouso (bpm)	FC Máx (bpm)	FCMT (bpm)	CCV %	Job classification
Molding Manual	67,5	182,5	110,25	61%	Pesado
Shakeout	71	188	119,5	64%	Pesado
Molding Pneumatics	62,4	179,2	102	57%	Pesado
Production assistant	56	178	125	70%	Pesado
Polish	65	176,5	95	54%	Medianamente leve

According Fronchetti (2006), the HR values at rest are commonly used as a reference to a functional condition of the body, influencing bands including the determination of exercise intensity, in general, lower resting HR values reflect a good functional status, whereas high values were apparently related to physiological disorders and predisposition to cardiovascular diseases. The activities under the job classification of Apud (2007), presented mostly as heavy, but the polishing industry which ranked as moderately low.

Through the activities analyzed it was observed that individuals perform the activities above the ideal limit, ie the cardiovascular load corresponds to the percentage of heart work, in relation to heart rate maximum usable, which should not exceed 40% of center cardiac work (Fiedler, 1998).

The activities analyzed vascular exceed the capacity, ie the optimal value of HR to exercise their individual activities, without exceeding its physical capacity. The human body in this situation goes through many changes that affect the organs, tissues and body fluids. The level of stress caused by heavy lifting increases the intensity of the responses of sweating and movement designed to dissipate heat, where the individual loses a large amount of body fluids.

Says Clark (1994) that during intense exercise, muscles can generate 20 times more heat than when the individual is at rest. Between 75% and 80% of the energy produced by the body is converted into heat and only 20 to 25% is used by muscles for energy to perform mechanical work (Garret & Kirkendall, 2003; Powers & Howley, 2006). This reality leads to major changes in the internal environment and are not easily overcome such possible changes, with consequent severe disturbances in the internal environment which causes fatigue and disruption in a particular instance of the activity.

As Bridger (1995), work that requires great physical demand is usually performed in places where temperatures and humidity are high, so energy expenditure is greater than 5 calories per minute, and heart rate ultrapassarm 100/125 bpm In these cases it is necessary to introduce a pause for rest breaks. Work with mild and moderate lactate and heart rate reaches a new stable level, with no fatigue quickly, but in heavy work, the CR reaches its maximum in a short time and need to stop work (Powers & Howley, 2006).

In the company studied, employees have an hour lunch and 10 minute intervals during the afternoon. For Barnes (1977), being officially allowed or not, the worker must rest largely on his work shift, and reports that, in strenuous activities, the men rested 5 to 25% of working time. It is already known that numerous factors affect the amount of daily tasks performed by the individual and, in consequence related fatigue.

Working conditions, adding to the appropriate equipment, will cause the worker to perform a number of activities per day, taking into account your skill and dexterity. Thus, fatigue resulting from the activity level will depend on factors such as hours worked in day and week, pillows, duration and location, environmental conditions and forms of execution of work.

FINAL

For the conditions under which the study was conducted, and based on these results, we can conclude that the sample of employees and activities in the foundry industry, the region with the highest load ostemomuscular is the lumbar spine and upper limbs due to static postures and repetition of movements. The cargo exceeds human capabilities and limitations, necessitating the need for design changes of this production system, setting the ceiling for manual handling. So you can increase the productive capacity and prevent loss in the process generated by ergonomic problems.

Through the values of heart rate achieved by the employees evaluated in all the activities that value exceeds the vascular capacity, or the optimal heart rate to exercise their individual activities, without exceeding its physical capacity. Thus we consider the need for distribution of breaks determined by the company itself, in agreement with the activity performed. The organization of work is an important point that should not be overlooked in any assessment of an activity. The organization contains important points, and directly affects the workers and the production itself. This can be observed in the activity of auxiliary production where an employee has to perform the activity, presenting the highest value of cardiovascular fitness (70%).

It is also suggested a training program for employees, with suggestions made by them, because during the study we noticed a great interest on the part of employees, conducting some training, particularly with regard to handling heavy, which are the main causes of aches and pains.

Regarding demographics, age, height, weight and body mass index of subjects studied, it appears that there are overweight by 50% of employees studied, a factor that influences performance, cardiorespiratory fitness and physical condition, thus suggest assessment and / or nutritional counseling in the diet of these workers, who perform heavy physical exercise, in which the energy replacement is a very important role. This replacement should not only give up the meals taken within the company, but also carried out on this.

Another important factor is medical care in this type of activity, because the health aspects are an important part of good performance. Finally, we stress the need for ergonomic interventions in seeking to understand the work environment and their ways of interaction with humans in order to reach a proper harmony of these aspects, it becomes crucial in improving the quality of life of workers.

The two tools used in this study, ergonomic work analysis and analysis of heart rate provided sufficient data to seek ways to prevent fatigue and establishing workload limits, which are important factors in preventing diseases osteomusculres linked with the job.

Ergonomics is essentially an interdisciplinary activity, which must be performed by a team of professionals from different areas, it is impossible that a professional be able to solve, the ergonomic shape, a situation, it is important to have a team work, integrating the different areas of knowledge, a common purpose, which is the improvement of working conditions.

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Autor principal: Bruna Angela Antonelli
Rua Brasilia, 156, apto 601
Email: bruna_antonelli@yahoo.com.br

EVALUATION OF PHYSICAL WORKLOAD OF EMPLOYEES CASTING THROUGH AN ANALYSIS OF ERGONOMIC WORK AND CHANGE IN HEART RATE

ABSTRACT

This study aimed to evaluate the physical workload of employees in a foundry by ergonomic analysis and heart rate variation. It was observed that the activities in the foundry sector, ostemomuscular great burden in the spine and upper limbs due to static postures and repetition of movements. The cargo exceeds human capabilities and limitations, necessitating the need for design changes of this production system, setting the ceiling for manual handling. Through the values of heart rate achieved by the employees evaluated in all the activities the value exceeds the physical capacity.

KEYWORDS: Ergonomics, heart rate, heavy work.

EVALUATION DE LA CHARGE DE TRAVAIL PHYSIQUE DES EMPLOYES COULEE PAR UNE ANALYSE DU TRAVAIL ERGONOMIQUE ET CHANGEMENT DU RYTHME CARDIAQUE.

RÉSUMÉ

Cette étude visait à évaluer la charge de travail physique des employés dans une fonderie par l'analyse ergonomique et variations du rythme cardiaque. Il a été observé que les activités dans le secteur de la fonderie, la charge ostemomuscular grande de la colonne vertébrale et des membres supérieurs en raison de postures statiques et de la répétition des mouvements. La cargaison dépasse les capacités humaines et les limites, ce qui nécessite de modifier la conception de ce système de production, la fixation du plafond pour la manutention manuelle. Par les valeurs de la fréquence cardiaque atteint par les employés évalués dans toutes les activités de la valeur dépasse la capacité physique.

MOTS-CLÉS: Ergonomie, le rythme cardiaque, des travaux lourds

EVALUACIÓN DE LA CARGA DE TRABAJO FÍSICO DE EMPLEADOS CASTING MEDIANTE UN ANÁLISIS DE TRABAJO ERGONÓMICO Y CAMBIO DE RITMO CARDIACO.

RESUMEN

Este estudio tuvo como objetivo evaluar la carga de trabajo física de los trabajadores en una fundición de análisis ergonómico y la variación de la frecuencia cardíaca. Se observó que las actividades en el sector de la fundición, la carga ostemomuscular grande en la columna vertebral y las extremidades superiores debido a las posturas estáticas y la repetición de movimientos. La carga supera las capacidades y limitaciones humanas, que requieren la necesidad de cambios en el diseño de este sistema de producción, fijando el límite máximo de la manipulación manual. A través de los valores de la frecuencia cardíaca alcanzado por los trabajadores evaluados en todas las actividades que el valor supere la capacidad física.

PALABRAS CLAVE: ergonomía, la frecuencia cardíaca, el trabajo pesado

AVALIAÇÃO DA CARGA DE TRABALHO FÍSICO DE COLABORADORES DE UMA FUNDIÇÃO ATRAVÉS DA ANÁLISE ERGONÔMICA DO TRABALHO E VARIAÇÃO DA FREQUÊNCIA CARDÍACA.

RESUMO

O presente estudo teve como objetivo avaliar a carga de trabalho físico de colaboradores de uma fundição através da análise ergonômica do trabalho e variação da frequência cardíaca. Foi observada que as atividades desenvolvidas no setor de fundição, geram maior carga ostemomuscular em coluna lombar e membros superiores devido as posturas estáticas e repetição dos movimentos. O transporte de carga excede as capacidades e limitações humanas, havendo a necessidade de mudanças do projeto desse sistema de produção, definindo o limite máximo para movimentação manual de cargas. Mediante os valores da freqüência cardíaca atingida pelos colaboradores avaliados, em todas as atividades o valor excede a capacidade física.

PALAVRAS-CHAVE: Ergonomia, Frequência Cardíaca, trabalho pesado.