89 - EVALUATION OF THE PHYSICS LABOR LOAD OF CONSTRUCTION'S WORKERS – CASE STUDY

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1. INTRODUCTION

The field in which the man exercises his work, as a productive activity of social utility, can be defined by the application point of the activity and its determinants, generically named of work situation (IIDA, 1990). A work situation contains basically two central components: the work's demands and its goals and the ways through the worker respond to the demands. The fact that every worker is a work process operator, makes him submitted to the work's load, which is exactly the demands' product with the conditions for achieving (VERDE, 2003).

The Taylorist organization pattern presented during the work's industrialization of man affected directly the worker's health and had as a consequence the beginning of the scientifically studies that provide solutions and improvements in human working conditions. It is big the number of studies related between work and disease leading to the perception of an increasingly number of the worker's health aggravation (VERDE, 2003).

Many scientific articles tried to assess the physics labor load with the goal of improving the working conditions of the workers and in the illness prevention, such as, the musculoskeletal disorders related to work (DORT) (FIELDLER, VENTUROLI, 2002). In that case, the acquisition of physiological data respect to the neuromuscular and cardiopulmonary system is necessary (PHILLIPS, 2002). These physiological data situation and the application of these quantitative relations represents a model of physiological state of human work.

The finding that the physics labor demanding in the work environment has direct influence over the workers' health leads to the importance of using physiological indexes with the goal of determine the worker's physic capacity's limit. In this perspective, trying to measure the physics labor load, Apud (1997), the actual study proposed a methodology through the monitoring of the heart rate variation (HR) during the workday. Following this model proposed by Apud (1997), the actual study aimed to determine the physics labor load of 20 workers from Construction in the city of Ponta Grossa, Parana.

2. EVALUATION OF THE PHYSICS LABOR LOAD THROUGH THE HEART RATE

Through bibliographic review in current scientific studies about evaluation of the physics labor load, some researchers such as Seixas and Marquesini (2001); Fieldler and Venturoli (2002); Guimarães et al.(2003); Miranda (2004); Lopes et al. (2006), used the heart rate (HR) (number of heart beats that the cardiac muscle executes in a determine space of time) (LOPES, et al., 2006), as a tool to identify the levels of physics load of work. The essays related the HR to the appearance of diseases and the excess of physic effort in several work ramifications.

Moore, Lee, Greenisen and Bishop (1997), validated the use of the HR monitoring by the use of the frequency counter, considering it a precise method and reliable in the study of HR during work. Vitalis, Pournaras, Jeffrey, Tsagarakis, Monastiriotis and Kavvadias (1994) concluded that the measuring method of HR is considerably advantageous by the practicality and acceptability by people (VERDE, 2003.)

The method proposed by Apud (1997) suggests the survey of the workers' HR using a heart rate monitor. The measurement is realized using a frequency counter composed by a pectoral belt. Depends on the equipament's brand or the decoding way, the informations obtained about the heart beats are transmitted from the belt to a clock or an interface, and after, downloaded and processed in computer program.

The limit of maximum work load can be calculated indirectly, based in the work HR (WHR) or by the cardiovascular load (CVL). The CVL corresponds to the work HR percentage (HRW) related to the maximum useful HR (MHR) which should not surpass 40% of the WHR (APUD, 1989). To determine the CVL, we use the following equation:

$$CVL = \frac{WHR - RHR}{MHR - RHR} \times 100$$

Being: CVL – Cardiovascular load (%); WHR – Work heart rate; MHR – Maximum heart rate (220 – age); RHR – Resting heart rate. Source: Apud (1997)

Following, the CVL is compared to the cardiovascular capacity of 40% of individual limit, suggested for Apud (1989), it was got as a result of the cardiac frequency of limit.

$$CFL = 0{,}40 \times (MCF - CRF) + CFR$$

Source: Apud (1997).

When the cardiovascular load exceeds 40% (above CFL), it is suggested to reorganize the work. One of the changes that may be done is to determine the time of the recovery (rest), obtained by the following expression:

$$RT = \frac{WT \times (CFW - CFL)}{CFW - CFR}$$

Being: RT- Rest time (minutes); WT- Work time (minutes). Source: Apud (1997)

It is also suggested that the physical load of work in each activity sets the acceptable limits to keep a good performance of work. When necessary, it is the case to establish the duration of the working day, and the duration and frequency of the breaks according to the physical ability of the worker. Finally, the working load proposed by Apud (1997), is classified.

3. MATERIALS AND METHODS

A group of 20 male volunteers, between 20 to 60 years old (medium: 37,1 + - 10,2), workers of a site office from the city of Ponta Grossa, Paraná took a part in this case study, of applied nature with a quantitative and qualitative approach. The experiment was carried out during the phase of concreting of the second slab of a residential building.

It was used a heart rate monitor of Polar OY brand in order to measure the CF. The CF started being recorded right after the monitor captured the first heartbeat of the worker. The monitoring of CF began at seven o'clock in the morning remained to the end of the working day, at 6:00 o'clock. The values were stored in 15 seconds intervals during the whole period of time. After measured and stored, the data were transferred to a microcomputer and worked through a specific program of cardiac frequency analysis.

During the phase of concreting the following activities were fulfilled by the volunteers:

a.support of the tube of concreting;
b.carrying buckets of cement;
c.thickening of concrete with immersion vibrator;
d.levelness of the concreted surface;
e.finishes;
f.exchange of the tube of concreting;
g.handling of the hose of irrigation.

The results got by the sample were tested by the descriptive statistical method, emphasizing their medium values and standard deviation.

4. RESULTS AND DISCUSSION

During the concreting process or in any other phase of the construction, it is rare for the workman to keep carrying out the same kind of activity all the time. It happens due to the huge quantity of activities that are fulfilled in a site office. However, it can be noticed that the most of the workmen carried out a certain task for a longer period of time. From this premise, it was set the main activity realized for each worker during a working day.

The main parameter of analysis adopted has been the cardiac frequency of work (CFW), defined as the medium frequency obtained during the working day. According to Apud (1997), 125 bpm would be the limit for a continuous work of 8 hours, to be used as reference of the men.

In Table 1, the classification of physical load of work and the respective tracks of cardiac frequency of work (CFW), proposed for Apud (1997).

Table 1. Classification of the physical load of work through the CFT.

Physical load of work	Cardiac frequency of work (CFW)
Very light work	< 75
Moderately heavy work	75 – 100
Heavy work	100 – 125
Extremely heavy work	125 – 150
Very heavy work	150 – 175
Extremely heavy work	> 175

Source: Apud (1997).

The Table 2 summarizes the data of the evaluation of the physical work on main tasks, showing the results of the physiological evaluation with all the twenty workers. The results are exposed in medium more standard deviation that provided the acquisition of classification of the load of complete work and for type of task.

Table 2. Classification of the physical load of work obtained by CVL and CFL of the workers

Activity	n	Age	CFR (Bpm)	CFW (Bpm)	MCF (Bpm)	CVL (%)	CFL (Bpm)	Classification of work
All activities	20	35±12.2	66±7.7	95±11	185±12.2	24±7.2	114±5.6	Moderately heavy
Concreting	8	35±14.4	65±9.8	92±14.5	185±14.4	23±9.9	113±3.8	Moderately heavy
Thickening	4	48±3.5	65±8.6	93±9.1	172±3.5	26±5.4	108±6.3	Moderately heavy
Finishing	4	29±5.8	71±5.2	98±9.1	192±5.8	23±5.9	119±5.2	Moderately heavy
Levelness	2	31±5.7	65±7.1	96±6.6	189±5.7	25±2.1	115±2	Moderately heavy
Supporting	2	23±4.2	65±2.8	103±5.7	197±4.2	29±4.9	118±0	Heavy

Source: Data of research (2009)

It was realized that the physical load of general work on the various activities of concreting was quite near among the 20 workmen. All the values of CFW remained below the maximum acceptable limit (<125 bpm). The rates vary among 72 to 114 bpm. The most of the workers (65%) have had their activities considered as moderately heavy. 5% of the activities got the classification as “very light” and 30% got the classification as “heavy”.

The task of supporting of the tube concreting carried out for two workers presented the higher levels of CFW (99 and 107bpm). Providing the higher physical load of work among the activities. High physical loads can cause muscle-skeleton disease, for, since, according to Viikari-Juntura (1997), there is an association between the intensity of physical load of work and

the happening of muscle-skeleton disease in several body segments, such as the spine (back), neck, shoulders, elbows, wrists and hands. This task of supporting was the unique where there was not rotation on function. At the activity of concreting, for instance, eight workmen took turn between throwing the concrete with the tube (two at a time) and throwing with buckets (six at a time). The two ones who supported the tubes were beginner workmen.

Figure 1 shows the graphic made from compiled data of CF at work of one of the workers tested that fulfilled the task of supporting.

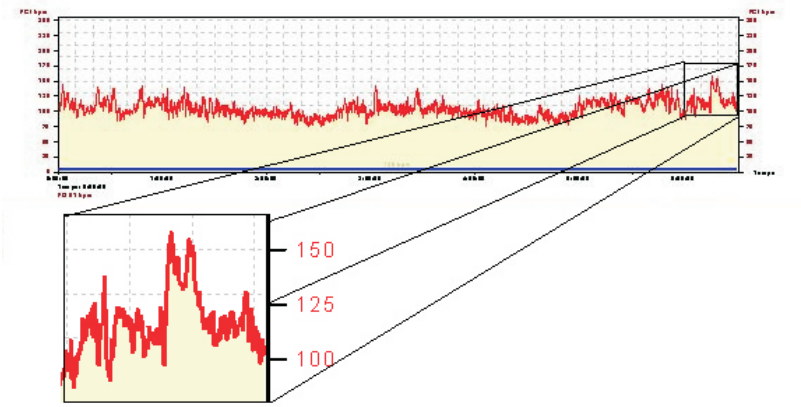

FIGURE 1 – Monitoring graphic of cardiac frequency of the individual 08.
Source: data of research (2009).

This individual has reached the highest peak of CF during the working day (158 bpm). However the CFW was below CFL, There being no physical overload on this employee during the working day, according to Apud (1997).

5. FINAL CONSIDERATIONS

At the conditions of development of this work and based on the theories that involve the use of CF, on the evaluation of physical load of work and after the analysis and discussion of the results, the present research has allowed to get to the following conclusions:

- In what involves the study of case, the activities encased at the concreting showed, in general, low physical demanding and were classified as moderately heavy and heavy, according to the classification proposed by Apud (1997).

- The values of the cardiovascular load did not exceed the maximum limit of 40%, not having been physical overload to the workers, hence it is not necessary ergonomic measures. However, after an informal conversation with the workers and through the differentiated values obtained by the cardiovascular load, it is recommended the use of lighter tools and with ergonomic cables, and the introduction of rotation among functions, in order to prevent back pain and physical wear on workers. The physical conditions of men in activities, where occur the use of tools with few technological resources and mechanization will directly influence the health of the workman and the capacity of production.

- The differentiated values got from the cardiovascular load also collaborate so that the hired company takes or requests, periodically, medical and physical examinations of the employees, in order to diagnose possible risks to health before starting work.

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EVALUATION OF THE PHYSICS LABOR LOAD OF CONSTRUCTION'S WORKERS – CASE STUDY

ABSTRACT

The finding that the physics labor demanding in the work environment has direct influence over the workers' health leads to the importance of using physiological indexes with the goal of determine the worker's physic capacity's limit. With this proposal, the present study aimed to measure the physics labor load from Construction workers. 20 volunteers participate of the research, with ages varying between 20 and 60 years old (average: 37,1 ±10,2). The data collect was realized in a construction site in Ponta Grossa city, Parana. The main tasks performed by the workers during their workday were identify and described in the study. The data were obtained by the survey of the heart rate at work (WHR), with the use of a monitor from Polar Oy brand. The work's rating followed the methodology proposed by Apud (1997). The results are showed in table and describe the averages plus standard deviation of the workers and by activity. All the HRW values was below the maximum acceptable limit (<125 bpm). The indexes ranged between 72 to 114 bpm. Most of the workers (65%) had their activities considered as “averagely heavy). 5% had the rating “very light) and 30% had the rating “heavy”. None of the activities surpassed the maximum limit of 40%, and therefore, being unnecessary the introduction of ergonomic ways. However, due to the different values of cardiovascular load obtained among the individuals, it recommends the use of lighter tools and with ergonomics cables and the introduction of a rotation between the functions, in a way to prevent LBP's and physics' wastage in the workers.

KEY WORDS: physics labor load, heart rate, workers.

ÉVALUATION DE LA CHARGE PHYSIQUE DE TRAVAIL DES OUVRIERS DE LA CONSTRUCTION CIVILE. L'ÉTUDE DE CAS

RESUME

La constatation dont les exigences physiques dans l'ambiance du travail a l'influence directe sur la santé des ouvriers conduit l'importance d'utiliser des indices physiologiques , avec l'objectif de déterminer la capacité physique de l'ouvrier. Avec cette proposition, la présente étude a eu comme objectif mesurer la charge physique de travail des ouvriers de la construction civile. 20 volontaires ont participé de la recherche, avec des âges en variant entre 20 et 60 ans (moyenne : 37,1 + 10,2). La collecte des données a été réalisée dans un marbrier des oeuvres dans la ville de Ponta Grossa , Paraná. Les principales tâches réalisées par les ouvriers durant la journée de travail ont été identifiées et décrites dans l´étude. Les données ont été obtenues par le moyen d'élévation de la fréquence cardiaque dans le travail (FCT), avec l'utilisation d'un moniteur de la marque Polar Oy. La classification du travail a suivi la méthodologie proposée par Apud (1997). Les résultats sont montrés en tableau et décrivent les moyennes plus le détour étalon total des travailleurs et par l'activité. Toutes les valeurs de FCT sont restées en bas de la limite maximum acceptable (< 125 bpm) . Les indices ont variés entre 72 à 114 bpm. La plupart des travailleurs (65%) a eu leurs activités considérées comme « moyennement lourdes ». 5% ont obtenu la classification « très légères » et 30% ont obtenu la classification « lourde ». Aucune activité a dépassé la limite maximum de 40%, en étant, donc, dispensable l'adoption de mesures ergonomiques. Pourtant, dû aux valeurs diférencées de charge cardiovasculaire obtenues entre les individus, on recommende l'utilisation d' outils plus légers et avec des poignées ergonomiques et l'introduction de roulettes entre les fonctions de manière à prévenir des lombalgies et des usures physiques chez les travailleurs.

MOTS CLEFS: charge physique de travail ; fréquence cardiaque ; travailleurs.

EVALUACIÓN DE LA CARGA FÍSICA DE TRABAJO DE OBREROS DE LA CONSTRUCCIÓN CIVIL. ESTUDIO DE CASO

RESUMEN

La constatación de que las exigencias físicas en el ambiente laboral tienen influencia directa sobre la salud de los trabajadores conduce la importancia de utilizarse índices fisiológicos con el objetivo de determinar el límite de la capacidad física del trabajador. Con esta propuesta, el presente estudio objetiva medir la carga física de trabajo de obreros de la construcción civil. 20 voluntarios participaron de la encuesta, con edades variando entre 20 y 60 años (media: 37,1 ±10,2). La colecta de los datos fue realizada en un cantero de obras en la ciudad de Ponta Grossa, Paraná. Las principales tareas realizadas por los trabajadores durante la jornada de trabajo fueron identificadas y descriptas en el estudio. Los datos fueron obtenidos por medio del levantamiento de la frecuencia cardiaca en el trabajo (FCT), con uso de un monitor de la marca Polar Oy. La clasificación del trabajo siguió la metodología propuesta por Apud (1997). Los resultados son mostrados en tabla y describen las medias, más desvío-estándar total de los trabajadores y por actividad. Todos los valores de FCT se quedaron abajo del límite máximo aceptable (<125 bpm). Los índices variaron entre 72 a 114 bpm. La mayoría de los trabajadores (65%) tuvo sus actividades consideradas como “medianamente pesada”. 5% obtuvieron la clasificación “muy leve” y 30% obtuvieron la clasificación “pesada”. Ninguna actividad ultrapasó el límite máximo de 40%, siendo, por lo tanto, desnecesaria a adopción de medidas ergonómicas. Entretanto, debido a los valores diferenciados de carga cardiovascular obtenidos entre los individuos, se recomienda el uso de herramientas más leves y con cables ergonómicos y la introducción de rotación entre funciones, de manera a prevenir lumbalgias y desgastes físicos en los trabajadores.

PALABRAS-CLAVE: Carga física de trabajo; Frecuencia cardiaca; Trabajadores.

AVALIAÇÃO DA CARGA FÍSCA DE TRABALHO DE OPERÁRIOS DA CONSTRUÇÃO CIVIL. ESTUDO DE CASO

RESUMO

A constatação de que as exigências físicas no ambiente laboral têm influência direta sobre a saúde dos trabalhadores conduz a importância de se utilizar índices fisiológicos com o objetivo de determinar o limite da capacidade física do trabalhador. Com esta proposta, o presente estudo objetivou medir a carga física de trabalho de operários da construção civil. 20 voluntários participaram da pesquisa, com idades variando entre 20 e 60 anos (média: 37,1 ±10,2). A coleta dos dados foi realizada em um canteiro de obras na cidade de Ponta Grossa, Paraná. As principais tarefas realizadas pelos trabalhadores durante a jornada de trabalho foram identificadas e descritas no estudo. Os dados foram obtidos por meio do levantamento da frequência cardíaca no trabalho (FCT), com uso de um monitor da marca Polar Oy. A classificação do trabalho seguiu a metodologia proposta por Apud (1997). Os resultados são mostrados em tabela e descrevem as médias mais desvio-padrão total dos trabalhadores e por atividade. Todos os valores de FCT ficaram abaixo do limite máximo aceitável (<125 bpm). Os índices variaram entre 72 a 114 bpm. A maioria dos trabalhadores (65%) teve suas atividades consideradas como “medianamente pesada”. 5% obtiveram a classificação “muito leve” e 30% obtiveram a classificação “pesada". Nenhuma atividade ultrapassou o limite máximo de 40%, sendo, portanto, desnecessária a adoção de medidas ergonômicas. Entretanto, devido aos valores diferenciados de carga cardiovascular obtidos entre os indivíduos, recomenda-se o uso de ferramentas mais leves e com cabos ergonômicos e a introdução de rodízios entre funções, de forma a prevenir lombalgias e desgastes físicos nos trabalhadores.

PALAVRAS-CHAVE: Carga física de trabalho; Frequência cardíaca; Trabalhadores.