Chapter 30
Exceeding the Recommended Energy Limits Due to Age and Gender in Occupational Aerobic Workloads

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ABSTRACT

The purpose of this chapter is to analyze the physical aerobic work in terms of the metabolic expenditure and compare it with the recommended boundaries of energy found in literature, proposing an alternative to the potential work overload through a compensatory equation introduced in the standard time of the workstation. To support the study, information considering the estimated metabolic expenditure in workers was applied to a novel procedure to reduce the metabolic demand of the task according to age and gender. Results of the study indicated that women older than 30 years exceeded the energy limits from moderate to very heavy load activities, and men older than 40 years exceeded the energy limits in heavy and very heavy workloads. The proposal of compensatory equation statistically reduced the energy loads below the recommended limits of energy. The aerobic workload is a sensitive factor for age and gender groups and can be potential risks for developing cardiovascular diseases as well as some musculoskeletal disorders.

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INTRODUCTION

Accurate methods are required to measure and control the efficiency of the industrial processes. Time and motion studies (TMS) provide the necessary information to establish proper time standards and obtain balanced workloads that allow workers to reach production rates. Because of the importance of the manufacturing companies to maintain appropriate productivity levels, standard time (ST) is considered as a key activity to control most of the production processes through the calculation of the work rate. In this respect, an increased work rate can expose operators to an elevated risk of musculoskeletal injury (Gooyers & Stevenson, 2012), and considering the aerobic physical capacity, ST might be inappropriate if it is performed by individuals who do not reach this capacity just because the age, gender or combination of both (Balderrama, Flores, & Maldonado, 2015).

Even though there is a fact of a significant difference to produce energy on individuals, just few evidence to consider age and gender was found in the calculation of predetermined times or some other systems used to determine the ST; Murrel (1965) proposed a fixed relationship to compute rest time considering an energy expenditure of 5 kcal/min for males and a 4.2 kcal/min for females no matter the age of the workers, and Mital and Shell (1984) proposed the use of an energy model to predict rest period as a percentage of working duration to compensate physiological fatigue, but without stablish the application of the rest. Regarding rest pauses and line balancing, some intents to consider individual energy production have been experimented; Ayabar, De la Riva, Sanchez & Balderrama (2015), developed a model to estimate de energy consumption trough heart rate using linear regression and determine ST in moderate workload stations. Unfortunately, the study did not consider age and gender in the calculations.

It is important to remark that gender differences are significant in physiological work; in a longitudinal study during 5 years taking indices of work content, health, work ability, functional capacity, and symptoms of stress in 129 employees, women showed less physically able as men for physical work (due for reasons as the musculoskeletal capacity), and the critical age for women in prolonged physical work resulted in less than 50 years (Ilmarinen, 1988). Job demands could be significate in relation with older employees; lower autonomy and higher job demands increased the association of an array of common chronic health problems with sickness absence. These results were obtained taking in consideration work factors, health and sickness absence, and relative excess risk on 8,984 employees (Leijten, Van den Heuvel, Ybema, Robroek, & Burdorf, 2013). Likewise, a study performed in 2007 with 4 year, and 11 year examinations of 612 men using ultrasonography and the association between five measures of energy expenditure, concluded that high energy expenditures at work are associated with an accelerated progression of atherosclerosis even after controlling virtually all known cardiovascular risk factors, especially among older workers and workers with preexisting ischemic heart disease or carotid artery stenosis (Krause, Brand, Kaplan, Kauhanen, Malla, & Tuomainen, 2007). Workloads are then, an important part in the physical development of the worker; a 16-year follow-up study based on assessments of musculoskeletal and cardiovascular load, resulted in the following conclusión: In general, and contrary to what one might think, aging workers with low workload had better physical capacity than the subjects with high workload (Savinainen, Nygård & Ilmarinen, 2004).

With age, some physiological factors tend to change, for example, a research considering 120 men aged from 23 to 60 years old observed in six different type of work, found that the variation in the relative aerobic strain (RAS) is shown to increase in work tasks and is demonstrated that this increment is mainly related to physical work and the exposure of workers to peak loads (Ilmarinen & Rutenfranz,