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Workplace physical exercises, obesity anthropometric indexes, blood pressure and static muscle strength

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ABSTRACT. Current analysis compares anthropometric indexes of obesity, blood pressure and static muscle strength among workers who exercised or did not exercise themselves on the workplace. Three hundred and fifty-four workers, of whom 178 did not perform any physical exercises and 176 who did, were evaluated by means of a query on their participation in workplace exercises during the last 30 days. Their systolic (SBP) and diastolic blood pressure (DBP) was measured; height, body mass and waist circumference (WC) were taken; four static muscle strength tests (right and left handgrip strength, scapular strength and lumbar strength) were performed. The Shapiro Wilk test revealed asymmetry in the data presented as median and interquartile variance. Mann-Whitney test was used to compare data between the two groups. Results did not reveal any difference for body mass index (BMI), WC, SBP, DBP and mean blood pressure (MBP) between the groups. However, greater performance was an asset for all participants in workplace exercises for all static strength tests. There is evidence that workers who performed workplace exercises may increase muscle strength without any changes in BMI, WC and blood pressure.

Keywords: occupational health, gymnastics, blood pressure, worksite physical activity, muscle strength.

Ginástica laboral, indicadores antropométricos de obesidade, pressão arterial e força muscular estática

RESUMO. O objetivo desta pesquisa foi comparar indicadores antropométricos de obesidade, pressão arterial sistêmica e força muscular estática entre trabalhadores que realizam e não realizam ginástica laboral. Trezentos e cinquenta e quatro trabalhadores, dos quais 178 praticavam e 176 não praticavam ginástica laboral, foram submetidos a uma avaliação que constituiu de uma pergunta sobre a participação no programa de ginástica laboral nos últimos 30 dias, verificação das pressões sistólica (PAS) e diastólica (PAD), medidas de estatura, massa corporal, circunferência da cintura (CC) e da realização de quatro testes de força muscular estática (preensão manual direita e esquerda, força escapular e força lombar). O teste de *Shapiro Wilk* revelou assimetria nos dados que foram apresentados como mediana e variância interquartil e, comparados entre os grupos por meio do teste de *Mann-Whitney*. Os resultados não revelaram diferenças para o índice de massa corporal (IMC), CC, PAS, PAD e pressão arterial média (PAM) entre os grupos. Por sua vez, foi verificado maior desempenho, favorecendo os participantes de ginástica laboral, em todos os testes de força estática. Há evidências que os trabalhadores que realizam ginástica laboral podem aumentar a força muscular, porém sem alterar o IMC, a CC e a pressão arterial.

Palavras-chave: saúde do trabalhador, ginástica, pressão arterial, atividade física no local de trabalho, força muscular.

Introduction

Home tasks, transport, professional work and other activities for recreation and free time comprise the modern individual's daily physical activities (AINSWORTH et al., 2011). A drastic decrease in required energetic demands for daily physical activities has been observed during the last decades in developing countries, including Brazil (HALLAL et al., 2003; MATSUDO et al., 2002). Further, a quantitative reduction in physical activity is proportional to the increase in chronic and degenerative diseases such as obesity, type 2 diabetes, hypertension and heart conditions (BOOTH et al., 2008).

Decrease in energy spending within the workplace is mainly due to the substitution of manual work by machines and by an increase in digitalized tasks. Bone-muscle-articulations disorders, which have followed such changes, comprise a complex network of interactions in which physical activity, albeit insufficient and repetitive, is an integral part (VIOLANTE et al., 2007; BONFIGLIOLI et al.,

2007). The one-sidedness of the tasks, the constant pressure to improve product quality, the maintenance of static and anti-natural positions kept for hours on end, the shape of furniture and ergonomically unfavorable equipments and an excessively intense rhythm influence, in the long run, the organic balance. Pain, stress, dissatisfaction and annoyance are the result (QUEIROGA, 2000). Such conditions coupled to repetitive movements (ex.: keyboarding), aging and low physical capacities are the precursors of repetition-caused injuries (OLIVEIRA, 2007; LECLERC et al., 2004; MACKEY et al., 2007).

Increasing concern on workers' health triggered great interest in the practice of physical activities on the workplace. Programs of occupational physical activities are undertaken during working hours (HOWLEY, 2001) and are known as workplace exercises. workplace exercises aim at preparing the workers for the execution of their daily tasks (OLIVEIRA, 2007; DELBIN; MORAES, 2005), interrupt production routine, reduce intramuscular pressure through stretching exercises, activate and prepare antagonist muscular groups through localized muscular resistance exercises, prevent the accumulation of metabolites by the increase in blood flow and prepare specific muscular groups for habitual work activities (QUEIROGA, 2000). In addition, provide information on healthy behavior which include physical activities outside the workplace through counseling (QUEIROGA, 2000; SAMPAIO; OLIVEIRA, 2008).

In spite of the great difficulties to develop controlled studies within the workplace environment (PROPER et al., 2003), specialized literature confirms that workplace exercises are highly beneficial to the workers' health (MARTINS; DUARTE, 2000; MARTINS; BARRETO, 2007; CARVALHO; MORENO, 2007; SILVEIRA et al., 2007). However, information is lacking on morphofunctional effects of workplace exercises, such as obesity, blood pressure and muscle strength. Current analysis is based on the hypothesis that workers practicing workplace exercises feature differences in morphofunctional components when compared to workers who do not practice workplace exercises. Current assay compares anthropometric indexes of obesity, blood pressure and static muscle strength among workers who practice and who do not practice workplace exercises.

Material and methods

Three hundred and fifty-four voluntary workers (246 males and 108 females), aged between 16 and 60 years, working in a sweets factory in Rio Claro SP Brazil, participated in current scientific investigation. The company has approximately 1300 workers with tasks involving security, packing, transport of manufactures and administration, in day, evening and night shifts. Every year a percentage of the workers are clinically evaluated during the Accident Prevent Week in the firm's clinic, with two nurses and a physician. Coupled to general clinical procedures carried out by the physician, a test battery was performed to evaluate the physical aptitude components of the workers' health (anthropometric measurements and static muscle strength). Workers from all sectors and from all shifts were evaluated and a questionnaire was applied with regard to identification data and the practice of physical activities on the workplace, blood pressure, four static muscle strength tests (right and left handgrip strength, scapular strength and lumbar strength) and anthropometric measurements (height, body mass and waist circumference).

Current assay was approved by the Ethics Committee in Research of the Bio-sciences Institute of the Universidade Estadual Paulista (UNESP), Rio Claro, São Paulo State, Brazil (Protocol 1916), following ethical recommendations by Resolution 196/1996 of the Brazilian Health Council. The participants signed a free-consent term after being informed on tests' risks and procedures.

After identification, the workers were asked a standard question: "Did you participate in workplace exercises sessions during the last thirty days?" It should be highlighted that the firm has introduced workplace exercises for the last five years and that the program was monitored by the SESC Sports Department in Rio Claro SP Brazil. Its initial aim comprised only production workers but it was extended to workers in the administration sections during the last two years. The non-professional intervention was carried out by facilitators, or rather, a voluntary worker from each shift was trained so that he could monitor two series of six to eight exercises involving stretching, localized muscular resistance and short displacements. Exercises consisted of daily activities prior to the start of the work, with a duration of approximately 15 minutes The exercises, at which the workers were not under any obligation to participate, were updated every fortnight through a visit by a SESC teacher.

Blood pressure (BP) was taken by a mercury column sphygmomanometer (Mercurial®). Means of two measurements, with a 10 minutes interval and in a sitting position, were verified immediately after the workers arrived at the laboratory. Brazilian Guidelines for Arterial Hypertension were adopted

to diagnose hypertension (MION JR. et al., 2004). Workers with systolic (SBP) and diastolic (DBP) pressure ≥ 140 and 90 mm Hg respectively were considered hypertensive. Regardless of collection rates, workers who had been diagnosed by a physician or who were under anti-hypertensive care were considered hypertensive. Mean blood pressure (MBP) was estimated from systolic and diastolic pressure rates, following the formula MBP = [SBP + (2DBP)] / 3 (BASTOS et al., 1992).

Body mass was verified by a 100 g precision anthropometric scale (Welmy®) and height was obtained by a 0.1 cm scale wooden stadiometer (GORDON et al., 1991). BMI was calculated by body mass and height measurements. Waist circumference (WC) was measured by an unstretchable measuring tape (Mabis® Japan), in duplicate, at the mid-point between the last ribs and iliac crest. Regardless of gender, the participants were classified as normal weight (≤ 24.9 kg m^{-2}), excessive weight/overweight (25 to 29,9 kg m^{-2}) and obese, when BMI was ≥ 30 kg m^{-2}. WC rates equal to or higher than 88 and 102 cm defined abdominal obesity for females and males respectively (LEAN et al., 1995). WC and BMI are often used as fat indexes and indirectly represent abdominal fat and total body fat respectively (DOLL et al., 2002; RANKINEN et al., 1999).

Static strength tests were undertaken by specially developed dynamometers (Crown®) to assess handgrip strength (manual dynamometer), muscle strength of the scapular region (scapular dynamometer) and the muscle strength of the lumbar column (lumbar dynamometer). Participants were instructed prior to tests on the mechanisms of all equipments and on the procedures to perform the measurement protocol. Two or three attempts at sub-maximum forces were provided so that the participants could be at ease with the equipments. Two maximum attempts, with approximately 1 minute interval for recovery, were also provided for each test. Tests were performed in the order above and the interval corresponded to the time necessary (approximately 5 minutes) to explain procedures and to become familiarized with the apparatuses.

In the case of handgrip test, the evaluated worker remained standing, held the dynamometer with one hand and extended his arm along the body. Grip adjustment was individualized and only the last four distal phalanges put pressure on the traction bar. The worker was guided to perform maximum contraction as from that position. After measuring, the dynamometer was placed in the other hand and the same procedure was carried out.

Static strength test of scapular muscles was also undertaken while standing. The participant held the dynamometer at breast height, with elbows in line with the ground and looking forward. The participant was then guided to undertake maximum contraction with the two arms (shoulder extension movement) on the horizontal line.

Static strength test of the lumbar muscle was undertaken with the worker's trunk in a semi-flexioned situation and legs and arms extended. The worker held the bar and at a signal performed maximum contraction, exerting force as from the lumbar muscle. The above-mentioned test was not applied when participants complained of lumbar column pain.

Statistical analysis was performed with SPSS 15.0 for Windows (SPSS, 2006) at the significance level of $p < 0.05$. Shapiro Wilk test revealed that data were asymmetrical and were presented in a descriptive manner by means of median and interquartile variance. On the other hand, comparison between groups was done (for workplace exercises participants or not) by Mann-Whitney test.

Results

Table 1 shows the anthropometric characteristics and arterial pressure indexes of total participants and of participants, divided into workplace exercises practisers and non-practisers. Workplace exercises practitioners did not present significantly different rates with regard to these variables when compared to those of non-practitioners. When divided by gender, males and males differed in body mass and height variables (data not given).

Table 1. Median and interquartile variance (P75-25) of workers' anthropometric characteristics and arterial pressure.

	All (n=354)	Practisers (n=178)	Non-practisers (n=176)
Age (years)	33.0 (15)	33.5 (15)	33.0 (15)
Body Mass (kg)	73.5 (19)	75.1 (20)	70.3 (21)
Height (cm)	169.2 (13)	170.2 (11)	166.9 (16)
BMI (kg m^{-2})	25.5 (5.1)	25.5 (4.7)	25.5 (5.4)
WC (cm)	85.5 (16)	85 (15)	86 (16)
SBP (mmHg)	120 (20)	120 (19)	120 (19)
DBP (mmHg)	80 (13)	80 (15)	77.5 (10)
MBP (mmHg)	93.3 (13.55)	93.3 (12.3)	90.4 (13.4)

BMI: body mass index; WC: waist circumference; SBP: systolic blood pressure; DBP: diastolic blood pressure; MBP: mean arterial pressure.

Table 2 shows performance rates in static strength tests for right and left handgrip and for lumbar and scapular strength. Since no intra-gender differences existed, comparison on Table 1 was maintained. However, workers who participated in workplace exercises programs had a significantly better performance in static strength tests when compared to those by workers who did not participate in workplace exercises.

Table 2. Median and interquartile variance (P75-25) of performance rates in workers' static strength tests.

	All	Practisers	Non-practisers
Left hand strength (kg)	46.4 (20)	48.6 (17)*	47 (24)
Right hand strength (kg)	50 (20)	46.4 (20)*	44.2 (22)
Lumbar strength (kg)	115 (64)	120 (57)*	109.5 (74)
Scapular strength (kg)	27 (14)	29 (12)*	25 (14)

*$p < 0.05$ between conditions, practisers and non-practisers of workplace exercises.

Discussion

Current assay investigates the differences between anthropometric indexes for obesity, arterial pressure and static muscle strength of workers who practices workplace exercises.

Results retrieved from anthropometric indexes (body mass, BMI and WC) and arterial pressure (SBP, DBP, MBP) in current research showed no significant differences between workers who were or were not engaged in workplace exercises. According to the above, workplace exercises programs, as such, failed to cause any alterations in body composition and in BP indexes. In fact, greater effects require engagement in aerobic exercises programs with more extensive periods and more intensity than those developed in workplace exercises sessions (NAKAO et al., 1995). Besides being questioned on the type, duration and intensity of physical exercises, the workers were asked on their participation in the program organized by the firm during the last 30 days, considered insufficient to reduce obesity and BP indexes. A study comprising participation in 15 minutes workplace exercises sessions twice a week during four months showed BP changes of the people engaged (MARTINS; DUARTE, 2000). However, it should be highlighted that researchers also included guidelines for a health way of life in the workplace exercises program through lectures and health cues. Guidelines and exercise session may have jointly contributed towards the positive results.

With regard to static strength tests (right handgrip; left handgrip; lumbar strength; scapular strength), workers who participated in workplace exercises sessions revealed significantly higher performance than those who failed to participate. In fact, exercises that comprised strength capacity and muscle resistance caused neural and structural adaptations in the neuro-muscular system (ENOKA, 1997; HAKKINEN, 1994; McCOMAS, 1994). However, a performance increase of muscular strength at the start of the program is dependent more on neural adaptations than on anatomic ones (CARROLL et al., 2001). In other words, strength increases regardless of structural changes in muscle size and volume (hypertrophy), albeit not without the occurrence of neural adaptations (ENOKA, 1997; CARROLL et al., 2001; McCOMAS, 1994).

On the other hand, workplace exercises programs developed in firms comprise exercises muscular-skeleton warming up, localized muscular resistance, stretching and relaxing. Consequently, workers' engagement in workplace exercises programs three times a week during 15 minutes may provide changes in muscular strength as from neural adaptations within a relatively reduced period, as found in the situation under analysis. Muscular strength is a determining physical capacity for the person's life quality and is recommended as a component of health-related physical activity programs (NELSON et al., 2007). The increase or conservation of adequate conditions in muscular strength and resistance is highly important for the person's health especially for the good functioning of the heart-respiration system (KELL et al., 2001), increase in functional ability, falls and sarcopenia prevention (VISSER; SCHAAP, 2011).

There is a special interest in the increase and maintenance of muscular strength in workers. Repetitive Strain Injury, as muscle and skeleton dysfunctions, is one of the main causes of absenteeism on work (ANDRADE et al., 2008; SILVA; MARZIALE, 2003), coupled to complaints and early retirements, or rather, an important component in occupational diseases in Brazil (BRASIL, 2012). Such illnesses are closely associated to inadequate body positions, repetition of movements and muscular weakening. A decrease in body pain complaints has been reported as from the introduction of workplace exercises (SAMPAIO; OLIVEIRA, 2008). All kinds of initiatives to promote activities for the improvement of the workers' life quality may decrease costs in medical assistance, absenteeism and complaints, with a resulting increase in the firm's productivity (BATTISTI et al., 2005; DINUBILE; SHERMAN, 1999). Additionally, it was observed that a program of physical activity in the workplace reduced muscle and joint pain (PEREIRA; LÓPEZ; VILARTA, 2013; MACEDO et al., 2011). Specific strength training (20 min three times per week) at the workplace can lead to significant long-term reductions in spinal and upper extremity pain and disability of the arm, shoulder and hand (PEDERSEN et al., 2013; ANDERSEN et al., 2010).

Results are highly relevant from the point of view of prevention and from the economic and social stance. Certain limitations should however be emphasized. There is a lack of information on the work functions performed by each worker (administrative; caretaker) and on the control on the practice of physical activities outside working hours. Workers who are physically active in other situations (they generally exercise themselves more) are more prone to integrate workplace exercises programs offered by firms than

people who are insufficiently active. In other words, since some functions in the firm demand more physical strength or are due to the workers' behavior to occupy their free time in physical activities, they may have contributed towards a better performance in strength tests. However, the presuppositions that foreground this justification are very flimsy and more investigations are required since they involve the complex relationship between labor and physical activity during free time (WU; PORELL, 2000). Further, it is highly interesting to note that information on workplace exercises by workers was collected for the last 30 days, although the program had been offered for approximately five years.

Besides the good effects emphasized by the literature on physical exercises on the workplace (MARTINS; DUARTE, 2000; NAKAO et al., 1995; POHJONEN; RANTA, 2001; PEDERSEN et al., 2013; ANDERSEN et al., 2010; PEREIRA; LÓPEZ; VILARTA, 2013; MACEDO et al., 2011) and the possibility of contributing towards an increase in strength performance, workplace exercises programs should be an asset in the promotion of a physically active life style. Better labor conditions, medical care and the firms' initiative in promoting lectures and activities related to the health promotion should be useful strategies to decrease the exposure of workers to health risks and dangers (DINUBILE; SHERMAN, 1999; QUEIROGA et al., 2009).

Conclusion

The workers who participated in workplace exercises program and who were the object of current study showed a significantly higher performance in static muscular strength when compared to results of workers who failed to exercise themselves. No difference, however, existed in their BMI, WC and BP.

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