Correlation between standing posture during work and low back and lower limb pain among cleaners and caregivers of older adults

Correlação entre a postura em pé durante o trabalho e dor na coluna lombar e nos membros inferiores em trabalhadoras da limpeza e cuidadoras de idosos

Correlación entre la postura de trabajo de pie y el dolor en la columna lumbar y los miembros inferiores en trabajadores de limpieza y cuidadores de ancianos

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ABSTRACT | Maintaining a standing posture during work has been associated with musculoskeletal symptoms. Few studies, however, assess the standing time using objective measures. Thus, this study aimed to verify whether standing time at work is associated with lower back and lower limb pain in the last seven days and last 12 months in caregivers of older adults and cleaners. This is a cross-sectional study. Standing time at work was quantified using inclinometers attached to the workers' thigh and spine. Musculoskeletal symptoms were assessed using the Nordic Musculoskeletal Questionnaire. Data were analyzed using the point-biserial correlation coefficient (r_{pb}) between standing time at work and the presence of musculoskeletal symptoms. The analyses were performed using the SPSS software, adopting 5% significance level. Workers spend most of their time standing still (41.3%) or walking (39.3%). The presence of symptoms in the lower back was positively correlated with standing time (r_{pb}=0.52; p<0.05). Walking time was negatively correlated with symptoms at the hip in the last 12 months (r_{pb}=−0.53; p<0.05) and running time with symptoms at the hip, in the last seven days, (r_{pb}=−0.43; p<0.05) and the lower back (r_{pb}=−0.43; p<0.05). Longer standing time was correlated with the presence of symptoms in the lower back. Meanwhile, less time walking and running were correlated with the presence of musculoskeletal symptoms in the hips and lower back.

Keywords | Occupational Exposure; Ergonomics; Cumulative Trauma Disorders; Posture; Physical Therapy Specialty.

RESUMO | A postura em pé durante o trabalho tem sido associada a sintomas musculoesqueléticos. Entretanto, há poucos estudos que avaliam o tempo em pé utilizando medidas objetivas. Assim, o objetivo deste estudo foi verificar se o tempo em pé no trabalho está associado com dor na coluna lombar e nos membros inferiores nos últimos sete dias e 12 meses em cuidadoras de idosos e trabalhadoras da limpeza. Trata-se de estudo transversal, em que o tempo em pé no trabalho foi quantificado por meio de inclinômetros fixados na coxa e na coluna vertebral, e os sintomas musculoesqueléticos foram avaliados por meio do Questionário Nórdico de Sintomas Osteomusculares. Os dados foram analisados por meio da correlação ponto bisserial (r_{pb}) entre o tempo em pé no trabalho e a presença de sintomas musculoesqueléticos. As análises foram realizadas por meio do software SPSS e o nível de significância adotado foi de 5%. Verificou-se que as trabalhadoras passam a maior parte do tempo em pé paradas (41,3%) ou andando (39,3%). Houve correlação

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positiva entre a presença de sintoma na lombar e o tempo em pé (r_{pb}=0,52; p<0,05) e correlação negativa entre o tempo andando e sintomas no quadril (r_{pb}=−0,53; p<0,05) nos últimos 12 meses e o tempo correndo e sintomas no quadril (r_{pb}=−0,43; p<0,05) e na coluna lombar (r_{pb}=−0,43; p<0,05) nos últimos sete dias. O maior tempo em pé foi correlacionado com a presença de sintomas na lombar; enquanto o menor tempo andando e correndo foram correlacionados com a presença de sintomas no quadril e na coluna lombar.

Descritores | Exposição Ocupacional; Ergonomia; Transtornos Traumáticos Cumulativos; Postura; Fisioterapia.

RESUMEN | La postura de trabajo de pie está asociada con síntomas musculoesqueléticos. Sin embargo, hay pocos estudios que evalúan el tiempo prolongado en esta postura utilizando medidas objetivas. Por esto, el objetivo de este estudio fue verificar si el tiempo prolongado al trabajar de pie está asociado al dolor en la columna lumbar y en los miembros inferiores de los cuidadores de ancianos y los trabajadores de limpieza entre los últimos siete días y 12 meses de trabajo. Se trata de un estudio transversal, en el que se cuantificó el tiempo prolongado en el trabajo de pie por medio de inclinómetros fijados en el muslo y la columna vertebral, y los síntomas musculoesqueléticos fueron evaluados por el Cuestionario Nórdico de Síntomas Musculoesqueléticos. Para el análisis de datos se utilizó la correlación biserial puntual (rpb) entre el tiempo prolongado en el trabajo de pie y la presencia de síntomas musculoesqueléticos. Los análisis se realizaron con el software SPSS, y se adoptó el nivel de significación del 5%. Se constató que las trabajadoras pasaban la mayor parte del tiempo paradas (41,3%) o caminando (39,3%). Hubo una correlación positiva entre la presencia de síntomas en la región lumbar y el tiempo prolongado de pie (rpb=0,52; p<0,05) y una correlación negativa entre el tiempo al caminar y los síntomas en la cadera (rpb=−0,53; p<0,05) en los últimos 12 meses, y el tiempo al correr y los síntomas en la cadera (rpb=−0,43; p<0,05) y en la columna lumbar (rpb=−0,43; p<0,05) en los últimos siete días. El mayor tiempo prolongado de pie se correlacionó con la presencia de síntomas en la región lumbar, mientras que el menor tiempo al caminar y correr se correlacionó con la presencia de síntomas en la cadera y columna lumbar.

Palabras clave | Exposición Ocupacional; Ergonomía; Trastornos de Traumas Acumulados; Postura; Fisioterapia.

INTRODUCTION

Musculoskeletal symptoms in the lower limbs are common and can affect 8% to 32% of the population[1,2]; often found in workers who are required to stand for most of their work hours[3,4]. These symptoms decrease a worker's performance, which can lead to incapacity to work, periods of absence, and early retirement[5].

Maintaining a standing posture for a prolonged period is described as harmful to health[6-11], and standing for at least two hours makes individuals more susceptible to discomfort[10]. Symptoms in lower limbs induced by standing posture cause fatigue and decreased venous return[6,9].

Many workers perform most of their occupational activities while standing, such as health and cleaning professionals[3,12]. In these sectors, the characteristics of the environment or work organization commonly increase the chance of workers complaining of pain in various regions of the body[5-7]. The main risk factors mentioned in the literature are inadequate footwear, lack of places to sit during breaks, long walking distances, lack of rest breaks, and maintaining certain postures for prolonged periods[5,13,14].

Although the prevalence of symptoms in the spine—18.5% in Brazil[15] and 19.1% in the world[5]—and in the lower limbs is high in workers who remain standing, studies show inconclusive results regarding the association between maintaining a standing posture for prolonged time at work and the development of musculoskeletal symptoms[16,17]. In addition to the standing posture, musculoskeletal symptoms in the lumbar spine may be associated with other risk factors, such as cargo handling and unfavorable postures[18].

Notably, few studies evaluate—using objective measures—the time of exposure to standing posture in correlation with musculoskeletal symptoms. A study conducted with accelerometers to evaluate the time of exposure to standing posture in health professionals and construction workers found no association between low back pain and time standing at work[19]. Another study observed positive associations between time standing at work (self-reported) and lower limb pain[20]. Also, a study identified a weak association between musculoskeletal symptoms in the lower limbs and standing posture, assessed by accelerometer[21]. A recent systematic review based on laboratory studies[22] found evidence for the association between long-term standing posture

and symptoms in the lumbar spine and lower limbs. No study, however, used objective measures to verify the association between standing time and the presence of symptoms in an evaluation of Brazilian workers in a work environment.

Therefore, this study aims to verify, using objective measures, whether the time of exposure to standing posture during work is associated with musculoskeletal symptoms in the lumbar spine and lower limbs in caregivers of older adults and cleaning workers in the last seven days and in the last 12 months. We hypothesize a correlation between the time in standing posture and the symptoms in the evaluated regions.

METHODOLOGY

This is a study that involves caregivers of long-term care institutions for older adults and cleaning service workers from a third-party company hired by a higher education institution. The data analyzed in the study were obtained from two primary studies conducted by the same research group in the municipality of São Carlos, in the state of São Paulo, from August 2016 to July 2018. The researchers underwent previous training, and the sample was constituted by inviting all workers from each institution. All individuals who consented to the research procedures were evaluated on previously scheduled days and times, preserving the privacy of volunteers.

Both studies were conducted only with daytime workers. For the group of caregivers, data collection was performed during a complete work shift (12 hours); whereas the cleaning workers were evaluated for half the work shift (4 hours).

The sample size was estimated with the G*Power program, considering the application of the point-biserial correlation test, effect size of 0.722[23] in the two-tailed test, 5% significance level, and 95% power. The minimum sample size was estimated at 16 participants.

The inclusion criteria for the study were: workers aged 18–60 years, with a work shift of, at least, four hours a day and five times a week. Exclusion criteria were: being pregnant, having diseases or disorders that affect mobility, being allergic to adhesive tapes, and working for less than 12 months in the company. Additionally, technical problems during data recording that would make data analysis unfeasible were also considered an exclusion criterion. The inclusion criteria resulted in a group of 25 workers, all females, with two being excluded due to technical problems, totaling 23 workers in the final sample.

A sociodemographic questionnaire was used to obtain data on age, schooling level, body mass index (BMI), and physical activity. The Nordic Musculoskeletal Questionnaire (NMQ) was applied to assess musculoskeletal symptoms. For this study, the Brazilian version of the NMQ was used, focusing on questions about the prevalence of symptoms in the lumbar spine, hip/thigh, knee, and ankle/foot in the last 12 months and the last seven days[24,25]. In addition to these regions, the variable "lower limb" was created by grouping hip/thigh, knee, and ankle/foot.

Exposure time in standing posture was quantified from two triaxial inclinometer sensors and a data acquisition unit (Logger Teknologi, Sweden). The sampling frequency was 20Hz. The sensors were fixed in the middle third of the right thigh and in the spine, at the level of the C7/T1 (Figure 1). After fixing the sensors, the reference position was recorded with the worker standing still, in upright position, for 30 seconds. Then, the worker was instructed to start her usual work activities in the most natural way possible. The records had a total duration ranging from 3 to 12 hours. After registry, the data were exported to a computer using the program developed by Lund University, Sweden[26]. The raw file went through a signal treatment process and was then analyzed by a routine developed in the MATLAB software.

The routine was developed based on pilot studies conducted in the laboratory. As a result of these tests, the 65° of hip flexion was established as cutoff point to distinguish between sitting and standing position. This value was used to identify the time of exposure to standing posture during the workday[27]. The tests also helped differentiating static and dynamic postures, having as reference a study on the validation of accelerometers to differentiate the standing still, standing while moving, sitting, walking, running, and pedaling postures[28].

The standing posture was identified based on the energy of the frequency components of the column and thigh movement signals, obtained by the fast Fourier transform, combined with the observation of the limit values of the angles for each sensor. The routine differentiated the activities, such as standing, sitting, walking slowly, and running/walking fast (Table 1). The total time of exposure to standing posture was normalized by the total time of registry, disregarding the lunch break.
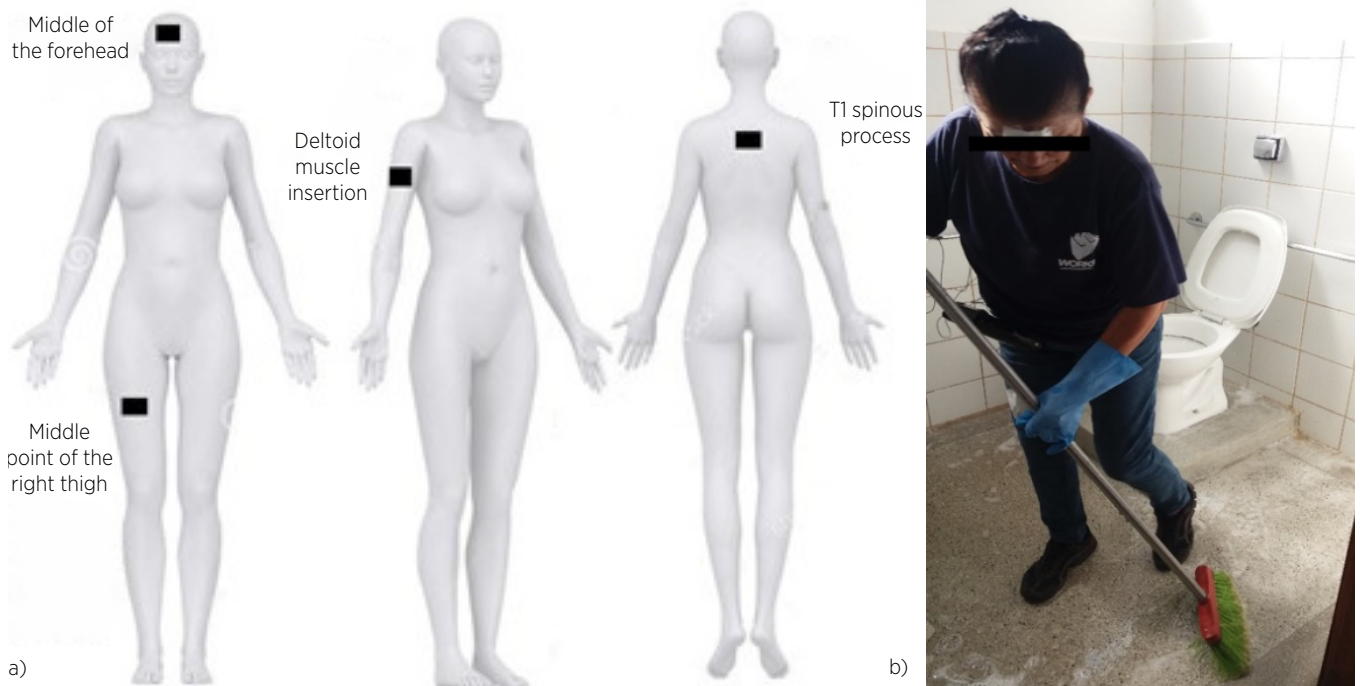
Figure 1. (a) placement of the sensors; (b) volunteer working with the sensors attached

Table 1. Criteria used to classify postures and activities

Posture	Threshold
Sitting	Mean thigh/hip flexion angle ≥65° Thigh energy ≤40
Standing	Mean thigh/hip flexion angle <65° Thigh energy ≤50
Walking slowly + moving	Mean thigh/hip flexion angle <65° Mean cervical flexion angle ≥0° Thigh energy >50 Thigh energy ≤249
Walking fast + running	Mean thigh/hip flexion angle <65° Thigh energy >249

The data were analyzed in the SPSS software (version 23.0) with descriptive analysis of the variables and correlation of the point-biserial (r_{pb}) between the percentage of time in each posture and the symptoms in the last seven days and in the last 12 months in the regions: lumbar spine, hip/thigh, knee, ankle/foot, and lower limb. A 5% significance level was adopted.

RESULTS

All participants had some schooling level, approximately 60% were overweight or obese (Table 2).

Table 2. Sociodemographic and occupational characteristics of workers (n=23)

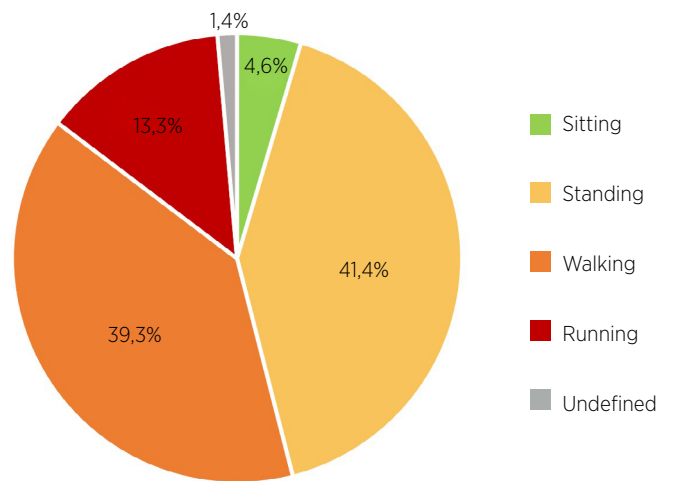| Characteristic	Mean	Standard Deviation
Age (years)	42.0	12.7
Weekly workload (hours)	42.1	3.6
Time in the current company (months)	17.1	17.5
Collection duration (hours)	4.8	3.0
BMI (kg/m²)	27.6	7.2
BMI classification	N	%
Normal	7	30.4
Overweight	7	30.4
Obesity	9	39.1
Physical activity in leisure context	6	26.1
Occupation		
Older adults' caregiver	7	30.4
Cleaning	16	69.6
Schooling level		
Incomplete primary education	5	21.7
Complete primary education	5	21.7
Incomplete secondary education	1	4.3
Complete secondary education	5	21.7
Technical course	7	30.4

BMI: body mass index.

The most affected regions in the 12 months were the lower limbs; and in the last seven days were the lower limbs and lumbar spine (Table 3).

Table 3. Presence of musculoskeletal symptoms by body region

Symptom	In the last 12 months		In the last 7 days	
	n	%	n	%
Lumbar spine	6	26.1	5	21.7
Hip	3	13.0	4	17.4
Knee	6	26.1	3	13.0
Ankle/Foot	6	26.1	6	26.1
Lower limbs	10	43.5	10	43.5

Figure 2 shows the postures adopted at work. Note that, most of the time the workers remain "on foot," that is, they remain standing, walking, or running 94.0% of the time.

Figure 2. Time distribution in each posture adopted at work (n=23)

The presence of symptoms in the lumbar spine showed a significant positive correlation with standing time. Also, walking (12 months) and running postures (7 days) showed a significant negative correlation with symptoms in the hip and lumbar spine. Table 4 shows that the correlations were not significant for the other regions.

Table 4. Correlation between the percentage of time in each posture and the presence of symptoms in the last 12 months and seven days for regions of the lumbar spine and lower limbs

Posture	Symptoms in the last 12 months					Symptoms in the last 7 days				
	Lumbar	Hip	Knee	Ankle/Foot	LL	Lumbar	Hip	Knee	Ankle/Foot	LL
Standing	**0.52***	0.34	0.11	0.05	0.02	**0.43***	0.40	−0.11	0.11	0.30
Walking	−0.53	**−0.53***	−0.19	−0.04	−0.12	**−0.43***	−0.38	0.27	−0.19	−0.29
Running	−0.33	−0.19	−0.09	0.04	−0.10	−0.55	**−0.43***	−0.05	−0.09	−0.28
"On foot"	−0.22	−0.41	−0.21	0.09	−0.27	−0.49	−0.32	0.16	−0.21	−0.20

LL: lower limbs; On foot: time in standing position regardless of whether they were moving or not.
* $p<0.05$.

DISCUSSION

This study aims to verify whether the time of exposure to standing posture during work correlates with musculoskeletal symptoms in the lumbar spine and lower limbs. We partially confirmed the hypothesis that there would be a correlation between the time in standing posture and the presence of symptoms in the evaluated regions.

Studies evaluating the association between standing posture and musculoskeletal symptoms showed varied results[19-22]. Regarding symptoms in the lumbar spine, a moderate correlation was found with maintaining a standing posture. Considering that lumbar symptoms have a multifactorial origin, including manual handling of loads, morbidities, obesity, and unfavorable postures[18], a relevant correlation was found with standing posture.

Still regarding the lumbar spine, long walking periods have already been associated with lower intensity of low back pain in blue-collar workers[29], similarly to our outcomes.

Considering the evaluated populations, our results corroborate the literature. A systematic review on risk factors for musculoskeletal disorders in nurses identified that symptoms in the lower limbs were associated with remaining in the static standing position, alongside elevated BMI, patient handling, and walking or standing on cold or wet surfaces for long periods[11]. As for cleaning professionals, the literature indicates a high prevalence of symptoms in knees and ankles/feet significantly associated with self-assessment of health, burnout, and BMI[30]. The use of safety shoes at work has also been associated with symptoms in the ankles/feet, since these increase plantar pressure, reduce comfort, and increase fatigue and muscle activation[31,32].

The association between hip symptoms and shorter walking and running time can be explained by fear that physical activity will worsen the pain or cause injuries; thus, instigating a downward cycle of pain, avoidance, hypervigilance, depression, and disuse[33]. Furthermore, evidence of the effect of gait on patients with chronic musculoskeletal pain suggests that this activity significantly improves symptoms[34], indicating that workers who move more present less pain. Since this is a cross-sectional study, the possibility of reverse causality cannot be excluded.

The time spent in standing posture for workers with highly physical demands (blue-collar) seems to be associated with symptoms in the lower limbs, while short periods of standing at work and leisure were associated with an increase in the intensity of pain in the knee and hip[35]. Moreover, prolonged periods standing up were positively associated with hip pain. These associations, although weak, suggest that standing periods can have a detrimental effect on the lower limbs.

One of the limitations of this study is its cross-sectional design, which makes it impossible to establish a causal relationship between the variables. Other limitations were the reduced and poorly heterogeneous sample size, both in the characteristics of the workers and in the variability regarding the time they remained standing. Although the sample size calculation was performed before the sampling, the size of the effect for the correlation between the variables was overestimated (r_{pb}=0.7). Considering the results obtained in this study (r_{pb} ranging from 0.06 to 0.44), the estimated sample size could vary from 57 to 3,599 participants. Moreover, we suggest for future studies to evaluate the level of fatigue and intensity of symptoms during the work shift and to further detail the tasks performed and the type of footwear used.

Nevertheless, it is worth mentioning that this study was developed with an accurate methodology for measuring time and posture, bringing valuable results, such as the adopted postures and the exposure time, which can contribute to the implementation of interventions mainly focused on preventing and controlling pain in the lumbar spine and lower limbs of workers who remain standing for a long time.

CONCLUSION

Longer standing time is correlated with the presence of musculoskeletal symptoms in the lumbar spine. Whereas shorter walking and running periods are related to the presence of symptoms in the lumbar and hip/thigh.

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