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Weekly time spent in the standing position is independently related to a better quality of life in postmenopausal women

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ABSTRACT

Objectives: To analyze the relationship between standing, sitting and reclining behaviors and quality of life in postmenopausal women.
Study design: Cross-sectional study composed of forty postmenopausal women (aged 59.58 ± 5.32) who do not practice regular physical exercise. Body composition was measured using Dual-energy X-ray absorptiometry and quality of life by the Short Form 36 Health Survey (SF-36). Physical activity level was assessed using an accelerometer (Actigraph GTX3x) and is reported as minutes per week of moderate-to-vigorous physical activity (MVPA). Inclinometer analysis was also measured using this accelerometer model and reported as a weekly percentage of time spent standing, sitting and reclining. All analyses were performed using SPSS 17.0 software with the significance level set at 5%.
Results: The percentage of time in the standing position was lower among women with poor quality of life ($p < 0.05$). Adjusted analysis (age, years since menopause, percentage of fat mass, MVPA and occupation status) was used to evaluate the relationship between quality of life and accelerometer inclinometer measures. The relationship between time standing and general health status ($\beta = 0.353$; 95%CI = 0.017; 0.377), social function ($\beta = 0.429$; 95%CI = 0.060; 0.396) and overall score ($\beta = 0.336$; 95%CI = 0.015; 0.442) were statistically significant. The relationship between the reclining position and both overall score ($\beta = -0.320$; 95%CI = −0.492; 0.006) and emotional aspects ($\beta = -0.337$; 95%CI = −0.191; 0.001) showed a tendency to present statistical significance.
Conclusion: In summary, our results suggest that postmenopausal women who spend more time in the standing position have a better overall quality of life regardless of confounders.

Introduction

The *American College of Sport Medicine* (ACSM) recommends at least 30 min of moderate-to-vigorous physical activity (MVPA) five days per week, or 20 min of vigorous activity three times a week for health benefits [1]. However, less than 15% of middle-aged adults in Brazil currently meet this international recommendation for physical activity in their leisure time [2].

Postmenopausal women undergo critical physiological changes, such as an increase in fat mass [3], a decrease in lean mass [4] and lipid and glycemic profile disorders [5–7], resulting in an increase in the likelihood of presenting a risk for cardiovascular diseases and, probably, a lower quality of life. In addition to these changes, a recent study showed that older postmenopausal women (≥60 years) practice less MVPA per week, when compared with their younger postmenopausal peers (≤59 years) [8]. Moreover, Lovejoy et al. [9] found that there is a decrease in the quantity of physical activity (PA)

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during the menopausal transition, without significant changes in diet, indicating that PA needs to be tracked in this period.

It is well established that being physically active results in a better general health status, including among postmenopausal women [6,8,10,11]. In contrast, epidemiological studies have shown that sedentary behavior increases the likelihood of developing chronic diseases, and thus, impairing quality of life [12,13]. Daily activities such as watching TV and computer usage usually correspond to low energy consumption and impede physical activities, even light ones, during waking hours. This condition favors a positive balance of energy and, consequently, weight gain [14]. However, sedentary behavior, such as time spent lying down, is often not taken into account. Otherwise, the time spent on MVPA represents a low portion of daily time and only exerts a protective health factor in individuals who have low levels of sedentary behavior [15].

In this way, recent epidemiological studies have focused on the amount of time people spend on sedentary behavior and observed that remaining in such behavior for several hours is associated with chronic diseases such as hypertension, diabetes and hypercholesterolemia, as well as weight gain and, consequently, increases all causes of mortality [16,17]. In postmenopausal women, high sedentary behavior was linearly associated with higher mortality from all causes and this risk was high even when confounders, such as physical activity, physical function and chronic disease were controlled, after a long-term follow-up [18].

Taken together, these outcomes suggest a detrimental effect of sedentary behavior and, likewise, a positive effect of being physically active, which can influence quality of life. However, to the best of our knowledge there are no studies regarding time spent in the standing position (active position), nor did we find research categorizing sedentary behavior in terms of both sitting and reclining.

Therefore, the main objective of this study was to analyze the relationship between standing, sitting and reclining behaviors and quality of life among postmenopausal women. We hypothesized that, independent of MVPA, time spent reclining would present a negative relationship with quality of life and that time spent standing would present the opposite outcome.

Materials and methods

Sample

To determine the sample size, we performed a power analysis for the design of this study based on the observation from a previous study that verified a relationship between physical activity, measured using an accelerometer, and health-related quality of life in elderly women and observed a correlation between PA (counts/hour) and pain perception ($r = -0.502$, $p < 0.01$) [19]. We used a power of 0.80 and a type I error of 0.05 and according to Miot [20], it was estimated that we would need 30 subjects. Considering a dropout rate (due to incomplete accelerometer data), we over-recruited the number of subjects ($n = 49$).

Therefore, 49 women were evaluated, of which nine were excluded due to incomplete accelerometer data. Thus, the study sample was composed of 40 postmenopausal women aged 50–75 years (average 59.58 ± 5.32 years), who underwent an Ação and Saúde program, carried out at the Science and Technology Department of the Sao Paulo State University (FCT/UNESP), Presidente Prudente campus – SP, Brazil, a city with about 210,000 inhabitants and a Human Development Index (HDI) of 0.86, located in southeastern Brazil [21].

To be eligible the women had to meet the following inclusion criteria: (i) be postmenopausal (not having had a menstrual cycle for at least one year and FSH > 30 IU/L) [22,23]; (ii) be older than 50 years of age on the date of the assessment, aiming to ensure the postmenopausal period [24]; (iii) not having been engaged in regular exercise for a period of 6 months prior to the evaluation date; (iv) not be bedridden; (v) not be receiving hormone replacement treatment; (vi) not be using drugs such as beta-blockers, statins, etc. and (vii) have signed the written informed consent form for study participation.

Excepting the criterion for FSH values, which were analyzed in a private laboratory, the other criteria were measured using self-reporting in interviews conducted by an experienced PhD student. In addition, the occupation status was also reported in the interviews.

All participants gave written informed consent and the study protocol was reviewed and approved by the Ethical Research Committee of UNESP (number 64/2011).

Data collection

Anthropometry and body composition

Height was measured in the upright position to the nearest 0.1 cm (without shoes) using a wall-mounted stadiometer (Sanny, São Bernardo do Campo, São Paulo, Brazil). Body mass was measured with a calibrated electronic scale (Filizola, model Personal Line, São Paulo, Brazil) with a precision of 0.1 kg. These evaluations were used to calculate body mass index (BMI). The participants were barefoot and wore light clothing so as not to interfere with the measurement.

The percentage of total body (BF%), trunk (kg) and android fat (kg) were estimated using a DXA scanner, version 4.7 (General Electric Healthcare, Lunar DPX-NT; England). The participants were positioned in a supine position and remained immobile throughout the examination. All measurements were carried out at the university laboratory in a temperature-controlled room. Each morning, before the beginning of the measurements, the equipment was calibrated by the same researcher, according to the manufacturer's instructions.

Quality of life

A Brazilian version of the Short Form 36 Health Survey (SF-36) was used to evaluate general quality of life [25]. This version has an average intra-observer correlation coefficient of 0.67 (range from 0.44 to 0.85). The questionnaire is divided into eight domains (physical aspects, emotional aspects, physical function, pain, general health status, vitality, social function and mental health). Each SF-36 domain is scored on a scale that ranges from 0 to 100, of which 0 is a worse quality of life and 100 is a better quality of life [26,27]. The overall score was calculated using the average of the eight domains. The 50th percentile [58.33] determined a great or poor score.

Physical activity

Engaging in regular physical activity was measured using accelerometers (ActiGraph GT3X, Pensacola, FL), which can be used to objectively measure the duration and intensity of physical activity in free-living conditions. The devices are small ($3.8\ cm \times 3.7\ cm \times 1.8\ cm$ in size) and lightweight (27 g), and designed to record movements in the anteroposterior, mediolateral, and vertical orthogonal planes. The ActiGraph GT3X measures and records changes in acceleration from approximately 0.05–2.5 g ($g = 9.8\ m/s^2$) within a frequency range of 0.25–2.5 Hz and is digitized by an Analog–Digital 12 bit converter at a rate of 30 times per second (30 Hz). The sampling interval was set at 60 s (epoch). For this study population we chose this epoch period since the

pattern of physical activity is related to low intensity and long duration [28].

Each accelerometer was attached to an elastic belt and was securely positioned near the right iliac crest. The participants used the equipment for seven days consecutively and were instructed to wear the accelerometer while awake, and to remove it for water activities.

Initially, specific software (*The ActiLife5 Data Analysis Software by Actigraph*) was used to analyze the data, and only full days of monitoring were included in the database. Secondly, zero-hour consecutive counts were excluded from the analysis, as they were considered to be periods when the participants were not wearing the device, and days containing less than ten hours of monitoring, as these would have had the power to increase the variability [29]. Finally, each participant wore the accelerometer for at least five full days [28].

Intensity levels were analyzed according to the recommendation established by Sasaki et al. [30] for a tri-axis accelerometer. Moderate-to-vigorous physical activity (MVPA) was defined as greater than 2690 counts per minute (cpm) (>3.0 METs) [30]. Practice of physical activity was expressed in minutes per week of MVPA.

Inclinometer analysis

Time spent in the standing, sitting, and reclining positions was assessed using the ActiGraph GT3X tri-axis accelerometer. With the GT3X device worn on the hip, the inbuilt inclinometer function detected time spent in standing, sitting, and reclining positions through posture position (i.e., in vertical, horizontal, and lateral [axes 1, 2, and 3]). The ActiGraph algorithm classifies counts above 100–1951 cpm as standing. If the counts are below 100 cpm, the inclination angles from the axes are used to classify whether the participant is sitting or reclining or the device is "off". Time spent standing, sitting and reclining was reported as a weekly time percentage in these positions. Time reclining did not include sleep time, since subjects were instructed to wear the device only while awake.

Statistical analysis

For statistical analysis, the Shapiro–Wilk test was used to test the normality of the data set. All data were considered to have parametric distribution and are presented as mean, standard-deviation and 95% confidence interval (95%CI). In addition, the Levene's test was performed to verify the homogeneity of variance. The independent *t*-test was used to compare the great and poor quality of life groups (Table 1). Pearson's correlation was used to verify the relationship between anatomical positions and SF-36 domains (Table 2). In addition, linear regression was performed to analyze the magnitude of the independent relationship between anatomical positions and SF-36 domains. The regression analyses were adjusted for age, years since menopause, fat mass (%), MVPA and occupation status (Table 3). All analyses were performed using SPSS statistical software (version 13.0). The level of significance was set at 5%.

Table 1
Descriptive statistics of the sample dichotomized by SF-36 overall score.

	Great quality of life $n=20$ (upper median)	Poor quality of life $n=20$ (lower median)	*p*-Value
Age (years)	59.98 (4.78)	58.21 (6.90)	0.350
Body mass index ($kg\,cm^{-2}$)	28.13 (4.49)	28.41 (3.54)	0.829
Retired (%)[a]	60% ($n=12$)	65% ($n=13$)	0.799
Years since menopause (years)	11.08 (3.85)	11.64 (6.77)	0.748
FSH (IU/L)	51.27 (25.00)	53.05 (16.24)	0.792
Body fat (%)	44.80 (5.21)	46.63 (5.66)	0.294
Trunk fat (kg)	16.09 (4.18)	17.41 (4.07)	0.317
Android fat (kg)	2.66 (0.85)	2.83 (0.91)	0.542
Time standing (%)	47.26 (8.95)	39.84 (13.49)	**0.047**
Time sitting (%)	39.59 (7.59)	40.23 (10.17)	0.822
Time lying (%)	13.15 (7.19)	19.93 (16.90)	0.107

FSH, follicle-stimulating hormone
[a] Mann–Whitney test.

Table 2
Pearson's correlations between time standing, sitting and lying to SF-36 domains.

SF-36 domains	Inclinometer measures		
	Time standing (%)	Time sitting (%)	Time lying (%)
Physical functioning	0.148	0.075	−0.183
Pain	0.232	−0.169	−0.096
General health status	**0.423****	−0.116	−0.302
Vitality	0.241	−0.084	−0.160
Mental health	**0.343***	−0.030	−0.288
Social functioning	**0.412****	0.011	**−0.377***
Physical aspects	0.225	0.017	−0.213
Emotional aspects	0.214	0.124	−0.275
Overall score	**0.394***	0.006	**−0.357***

* $p<0.05$.
** $p<0.01$.

Results

Table 1 presents the comparison between the great and poor quality of life groups. Overall, 62.5% of the sample were retired and time since retirement was on average 7.0 ± 8.5 years. The percentage of time in the standing position was lower among women with poor quality of life ($p < 0.05$). Moreover, the mean body fat (%) was higher than 35% in both poor and great qualities of life; however, no differences in body composition were found between the groups. On average, participants wore the accelerometer for 6.60 ± 0.59 days.

The relationship between standing, sitting and reclining time and quality of life is shown in Table 2. A positive correlation was observed between time standing and the subscales of general health status ($r = 0.422$; p-value = 0.007), mental health ($r = 0.343$; p-value = 0.030), social function ($r = 0.412$; p-value = 0.008) and overall score (rho = 0.394; p-value = 0.012). Time spent in the reclining position was negatively correlated with social functioning ($r = -0.377$; p-value = 0.016) and overall score ($r = -0.357$; p-value = 0.024). Sitting time did not present any statistically significant correlations.

When adjusted analysis was used (age, years since menopause, percentage of fat mass, MVPA and occupation status), the relationship between time standing and general health status ($\beta = 0.353$; 95%CI = 0.017; 0.377), social function ($\beta = 0.429$; 95%CI = 0.060; 0.396) and overall score ($\beta = 0.336$; 95%CI = 0.015; 0.442) was statistically significant. The relationship between the reclining position and both overall score ($\beta = -0.320$; 95%CI = −0.492; 0.006) and emotional aspects ($\beta = -0.337$; 95%CI−0.191; 0.001), showed a tendency to present statistical significance (Table 3).

Discussion

The novelty of this study is the investigation of anatomical positions and quality of life in postmenopausal women. We demonstrated that (1) regarding potential confounders, time spent in the standing position was related to better general health status, social function and overall quality of life, and (2) spending more time in the reclining position seems to be detrimental to emotional aspects and overall quality of life in postmenopausal women.

Table 3
Adjusted relationship between time standing, sitting and lying to SF-36 domains.

SF-36 domains	Inclinometer measures {β (95%CI)}		
	Time standing (%)	Time sitting (%)	Time lying (%)
Physical functioning	0.156 (−0.107; 0.279) $p = 0.370$	0.093 (−0.113; 0.190) $p = 0.608$	−0.202 (−0.346; 0.096) $p = 0.259$
Pain	0.235 (−0.056; 0.335) $p = 0.155$	−0.257 (−0.265; 0.037) $p = 0.136$	−0.039 (−0.258; 0.206) $p = 0.821$
General health status	**0.353 (0.017; 0.377)** **p = 0.033**	−0.126 (−0.201; 0.097) $p = 0.480$	−0.233 (−0.361; 0.072) $p = 0.185$
Vitality	0.244 (−0.068; 0.434) $p = 0.148$	−0.143 (−0.279; 0.120) $p = 0.442$	−0.123 (−0.400; 0.194) $p = 0.485$
Mental health	0.337 (−0.023; 0.5593) $p = 0.068$	−0.013 (−0.260; 0.244) $p = 0.949$	−0.294 (−0.637; 0.083) $p = 0.127$
Social functioning	**0.429 (0.060; 0.396)** **p = 0.009**	−0.087 (−0.179; 0.110) $p = 0.630$	−0.327 (−0.397; 0.010) $p = 0.062$
Physical aspects	0.54 (−0.048; 0.129) $p = 0.362$	0.112 (−0.048; 0.091) $p = 0.528$	−0.212 (−0.163; 0.039) $p = 0.221$
Emotional aspects	0.222 (−0.030; 0.142) $p = 0.195$	0.207 (−0.028; 0.106) $p = 0.248$	−0.337 (−0.191; 0.001) $p = 0.053$
Overall Score	**0.336 (0.015; 0.442)** **p = 0.036**	0.028 (−0.163; 0.192) $p = 0.869$	−0.320 (-0.492; 0.006) $p = 0.055$

Adjusted by age, years since menopause, body fat (%), minutes per week spent in moderate-to-vigorous physical activity and occupation status. 95%CI: 95% confidence interval.

Previous studies have demonstrated that sedentary behavior plays a central role in the development of several chronic diseases [31,32], and, on the other hand, engaging in sufficient MVPA is recommended to avoid these outcomes [1]. Recently, our group demonstrated that engaging in sufficient MVPA could result in positive outcomes for body composition [8,11], glucose homeostasis [10] and inflammation markers [6]. Indeed, being moderately active implies a 26% and 27% less chance of premature death from chronic disease in overweight and obese people, respectively [33].

In addition to the effects of physical activity on the metabolic profile, active behavior is also related to a better quality of life for a range of the population [19,34–37], including postmenopausal women [13,38,39]. Carvalho et al. [38], using a questionnaire to evaluate both physical activity and quality of life, found that the practice of regular exercise, but not physical activity, increased the odds of presenting a better quality of life in general by 4.8. Furthermore, women who engaged in regular exercise also presented higher sensorial ability, autonomy, social interaction and intimacy when compared to their sedentary peers [38]. In a population-based cross-sectional study, Mansikkamäki et al. [39] found that women who were physically inactive, as measured through a questionnaire, demonstrated a greater likelihood of presenting anxiety/depressed mood, decreased well-being and somatic and vasomotor symptoms. In contrast, women who engaged in the recommended amount of physical activity had a higher self-perceived health level and better relative health and improved global quality of life. Longitudinally, (using questionnaires), Moilanen et al. [13] observed that postmenopausal women who increased or maintained their physical activity levels had a 1.49 chance of improving their general quality of life than women who decreased their physical activity levels.

Although the positive relationship between physical activity and quality of life is well established, as mentioned previously, most studies use self-reporting to evaluate physical activity and in postmenopausal women this can be a limitation [40]. Furthermore, to our knowledge this is the first study to evaluate physical activity behaviors via an accelerometer and inclinometer. Briefly, we found that the standing position was related to better general health status, mental health and social function even after controlling for confounders; while time reclining (excluding time sleeping) seemed to be related with worse social functioning, emotional aspects and overall quality of life.

Recent studies have aimed to investigate the positive effects of prolonged standing time [41,42]. Remaining in the standing position for a few minutes results in a total accumulated knee-joint load and recruited muscle fibers similar to walking, which can together increase energy expenditure [42]. Chaput et al. [41] found that workers who spend more time in the standing position presented normal glucose tolerance and less type-2 diabetes than their "sitting work" peers. A short-term intervention demonstrated that increased sitting-to-standing transitions increased physical activity levels and decreased sedentary behavior [43]. Indeed, standing time presented a dose-response association with all-causes of mortality.

Surprisingly, although several studies have shown an inverse relationship between sitting time and health outcomes [44–46], this outcome was not seen in the present study. However, Chau et al. [47] pointed out that although total sitting time is associated with all-causes of cardiometabolic disease-related mortality, prolonged sitting in specific contexts, such as watching TV, reading books, or at work, do not adversely influence health in the same framework.

The positive relationship between prolonged standing and quality of life can be explained by its effect on health outcomes. For example, postmenopausal women who engage in recommended amounts of physical activity present lower body fat values [8,48], higher lean and mass values [11,48] and a better immunometabolic profile [6,10]. Furthermore, moderate-to-vigorous physical activity is inversely related to several pro-inflammatory cytokines, such as interleukin-6 and 1β, C-reactive protein and tumor necrosis factor-α, and positively related to adiponectin, one of the most anti-inflammatory cytokines [49–51]. Accordingly, these favorable metabolic profiles resulting from physical activity can increase self-perceived well-being in various domains.

Despite the significance of our findings, it is important to mention some limitations. The small sample size would suggest a need for caution in extrapolating the results. The cross-sectional design does not allow for any longitudinal consideration and thus does not allow causal inferences. Moreover, the depression status of the participants was not evaluated. On the other hand, the positive aspects of this study should be highlighted. Perhaps the most notable of these is the objective measurement of physical

activity and anatomical positions through triaxial accelerometer, providing a reliable measurement of habitual physical activity and avoiding any possible mistakes presented in the subjective self-reported physical activity questionnaires.

In summary, our results suggest that postmenopausal women who spend more time in the standing position have a better overall quality of life regardless of confounders. Therefore, steps should be taken to encourage an increase in physically active lifestyles, together with an increased awareness of the harmful effects of sedentary behavior.

Competing interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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