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# Association between Objective and Subjective Sleep Parameters with Postural Control Responses among Brazilian Schoolteachers

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## Abstract

**Objective** To investigate the impact of sleep quality on postural control in teachers.
**Methods** Cross-sectional study with 41 schoolteachers (mean age $45.7 \pm 10.4$ years). Sleep quality was assessed in two ways: objectively (through actigraphy), and subjectively (through the Pittsburgh Sleep Quality Index). Postural control was assessed in an upright posture during 3 trials of 30s (bipedal and semitandem stances in rigid and foam surfaces with eyes open) with a period of rest across trials, on a force platform, based in the center of pressure measurements in the anteroposterior and mediolateral directions.
**Results** The prevalence of poor sleep quality in this study sample was 53.7% ($n = 22$). No differences were found between Poor and Good sleep in the posturographic parameters ($p > 0.05$). Although, there was moderate correlation between postural control in the semitandem stance and subjective sleep efficiency for center of pressure area (rs = -0.424; $p = 0.006$) and amplitude in anteroposterior direction (rs = -0.386; $p = 0.013$).
**Discussion** There is correlation between poor sleep quality and postural control in schoolteachers, as sleep efficiency decreases, postural sway increases. Poor sleep quality and postural control were investigated in other populations, but not in teachers. Several factors such as work overload, insufficient time for physical activities, among others, can contribute to a worse perception of sleep quality, as well as deterioration in postural control. Further studies with larger populations are needed to confirm these findings.

**Keywords**
► postural balance
► sleep
► school teachers

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## Introduction

Schoolteaching is an occupation associated with physical and mental health conditions (e.g., back and neck musculoskeletal pain, stress and anxiety)[1–3] that impact their professional performance.[2] In the last years, some studies have reported that occupational risk factors are responsible for causing or worsening sleep disorders.[4–6] These risk factors are related to educational reforms, changes in the teachers' work process,[6] excessive bureaucracy, and difficulties coping with daily pressures and challenges because of difficult social contexts and overwork.[5]

Sleep-related problems occur worldwide. About 70 million Americans suffer from chronic sleep disorders. Sleeplessness is also associated with chronic diseases, such as hypertension, type 2 diabetes, mental illnesses, and poor quality of life and well-being.[7] In Brazil, the prevalence of sleep disorders ranges from 32% to 46.7%.[8,9] Regarding schoolteachers, a Brazilian study evaluated 959 of these professionals and found among them a 52.3% prevalence of poor sleep quality.[10]

Moreover, poor sleep quality can influence postural control in adults.[11,12] Balance is provided by the postural control system, which integrates the three sensorimotor subsystems – visual, proprioceptive, and vestibular –, in combination with the central nervous system (CNS), which processes, integrates, plans, and generates motor responses of adequate postural adjustment through the neuromuscular system.[13] Individuals with poor sleep quality have reportedly shown increased postural sway in upright postures.[12,14] Poor sleep quality results from the association of one or more factors that affects wakefulness, information integration, reasoning, and motor control, including postural control.[11] This relationship has already been studied in healthy adults,[11] cadet pilots,[15] and older adults,[16] but not in teachers. In addition, the social welfare reform approved in Brazil last year[17] increased the age and time of retirement contribution. Hence, increasingly more older teachers will keep on working, so both the effects of sleep quality and postural control should be evaluated in this population.

Given its complexity, the interrelationship between sleep and postural control information integration in the CNS – including sleep quality and postural control in teachers – needs to be better understood. Thus, the objective of this study was to investigate the impact of objectively and subjectively measured sleep quality on postural control responses in schoolteachers. This research is based on the hypothesis that individuals with objectively and subjectively measured poor sleep quality may also present worse balance assessment results.

## Material and Methods

This was a cross-sectional study, with data collected from August 2014 to March 2015. It is part of the second phase of a research project entitled PRÓ-MESTRE – Health, Lifestyle, and Work of Public-School teachers of Londrina, which aimed to evaluate health, lifestyle and work aspects of public-school-teachers"[18]. The Human Research Ethics Committee of the State University of State University of Londrina (protocol no. 33857114.4.0000.5231) approved the project. All patients were then informed about the objectives and procedures to be performed and signed an informed consent form.

The inclusion criteria were as follows: middle or high school teachers, responsible for a school subject, who had been actively teaching for more than 12 months, and who had not taken more than 30-day leave from work in the previous 12 months. Exclusion criteria were as follows: having physical and/or sensory limitations – such as inability to understand and respond to simple verbal commands and/or take requested stances – that hindered dizziness verification and balance test performance; having severely impaired visual and/or hearing acuity; being unable to perform activities of daily living; having orthopedic disorders, limited movements, or lower limb prostheses; self-reported central vestibular dysfunction; self-reported consumption of alcohol 24 hour before the evaluation, or of drugs with an effect on the central nervous system (such as tranquilizers and antidepressants) or vestibular system 48 hour before the evaluation; having undergone vestibular rehabilitation after medical discharge.

The sample size was based on two published articles with similar methodology, which evaluated sleep quality and postural control in 20[12] and 30[11] healthy adults. Hence, it included 41 teachers that completed the sleep quality and postural control assessments. The sample's statistical power was calculated from a post hoc test with GPower 3.1.7 software, using A-COP (area of the center of pressure) mean values and standard deviation in semitandem stance and considering the difference between the mean rigid and foam surface values for G1 ($n = 19$ participants; $2.2 \pm 1.6\,cm^2$) and G2 ($n = 22$ participants; $4 \pm 3.5\,cm^2$). This study's sample size is like that of previous studies, with similar experimental designs previously published by other authors (references [11 and 12]).

### Clinical Information

The patients' clinical information necessary for the research was obtained with a routine audiological assessment conducted at the Department of Audiology at the Speech-Language-Hearing Clinic, (Pitagoras-UNOPAR), based on Miller's medical history protocol, encompassing questions on age, gender, dizziness, tinnitus, and so forth.[19] Some questions specifically investigated whether the sensation of dizziness was present, in which ear, how often, time of symptom onset, and type of dizziness. The Brazilian version of the Dizziness Handicap Inventory (DHI)[20] was applied to those who reported dizziness. The DHI is a 25-item self-assessment scale designed to quantify the functional, emotional, and physical effects of dizziness and unsteadiness.[21] The Brazilian version of the International Physical Activity Questionnaire – short version (IPAQ)[22] was applied to assess the participants' level of physical activity, which was classified as low, moderate, or high, according to reference [23].

### Sleep Quality Assessment: Actigraphy

Participants wore an Actiwatch 2™ (Respironics Inc., Phillips) device on the wrist for 7 consecutive days and filled out a daily sleep diary. They received both oral and written information on how to use it. They were asked to press the event marker button when they turned off the lights to sleep. Actiwatch 2 was configured to collect data in 15-second logging intervals. Data were downloaded with Actiware software (version 6.0.5, Philips/Respironics). Sleep parameters were obtained according to Actiware predefined algorithms and supplemented by the event marker.[24] The sleep parameters extracted for this study were the length of time it took until sleep onset (sleep latency [LAT]), total sleep time (TST), total time in bed (TIB), and sleep efficiency – which was calculated by dividing TST by the number of minutes in the rest interval.[24] To calculate sleep efficiency, the software includes data on TIB, TST, and post-sleep onset waking.[24] Only nighttime sleep parameters were considered for the present study.

### Pittsburgh Sleep Quality Index (PSQI)

Sleep quality assessment was obtained from interviews with the participating teachers, using the Brazilian version of the PSQI[25,26]–whose questionnaire is widely used in the literature.[27,28] The instrument comprises 19 self-report items, whose sum ranges from 0 to 21–the higher the score, the worse the sleep quality. Total scores $\leq 5$ were associated with good sleep quality, and those $> 5$, with poor sleep quality.[26,27] Besides categorical variables, continuous ones reported in the questionnaire were also extracted: Self-reported LAT – i.e., the time the person reported they take to fall asleep; TIB – the time the person stays in bed; self-reported TST – the time the individual reported having slept; sleep efficiency, given in percentage from dividing TST by TIB times 100, with due adjustments for TIB as proposed by Buysse (2005) – all variables were calculated according to Buysse's guidelines.[29]

### Postural Control Assessment

Postural control was assessed with vertical ground reaction force on a force platform (BIOMEC400, EMG System do Brasil, Ltda, SP), at 100 Hz. All force signals were filtered with a 35-Hz low-pass second-order Butterworth filter and converted into COP data using MATLAB routines (The MathWorks, Natick, MA, USA).[30] The following data on postural control parameters were extracted: 95% confidence elliptical area of the center of pressure (A-COP $cm^2$); velocity of COP (VEL) in both directions of movement (anteroposterior [AP] and mediolateral [ML]; -cm/s)[31]; total displacement (D-TOTAL; cm) and amplitude of displacement (AMP; cm) in both directions. The data were analyzed as described in references [32 and 33].

All participants took time familiarizing themselves with the equipment and protocol until they felt comfortable with the test. Balance was assessed with a standardized protocol: barefoot, arms by their sides (BP)[34]; also, semitandem stance (ST) on the platform with the front heel 2.5 cm away from the back hallux.[35] The stances (BP and ST) were assessed on a rigid and then a foam surface.

The test was performed with an eyes-open experimental protocol, requesting individuals to fix their eyes on a target (black cross, 14.5 cm high × 14.5 cm wide × 4 cm thick) on the wall, placed 2 m away at eye level.[35] Three 30-second trials were performed, with 30-second rests in between them.[32] The mean of the three measurements was used for subsequent analysis,[35] which was based on the difference between the means obtained on the foam and rigid surfaces, for both BP and ST stances.

### Statistical Analysis

The Statistical Package for the Social Sciences, version 20.0 (SPSS, UK) was used for statistical data analysis; the 95% CI and 5% significance level ($p < 0.05$) were used in all tests. The parametric distribution of the data was verified with the Shapiro-Wilk test; without the assumption of normality, the Mann-Whitney test was used for continuous variables. The Spearman correlation test was performed to analyze the correlation between COP variables and sleep parameters. The Spearman correlations were classified as follows: correlations below 0.4 were considered weak, and between 0.4 and 0.5 were considered moderate.[36] The Chi-square test was used to analyze the association between categorical variables.

## Results

In total, 50 teachers who attended the assessments were evaluated, of which 1 was excluded for self-reported alcohol consumption 24 hours before the assessment, 1 for severely reduced visual acuity (awaiting corneal transplant) and 7 for having been away from work for more time greater than 30 days in the previous year. Thus, 41 teachers were included for analysis.

The teachers had a mean age of 45.7 ± 10.4 years were assessed; 70.7% ($n = 29$) were females, and 29.3% ($n = 12$) were males. The PSQI classified 53.7% ($n = 22$) with "poor sleep quality"; 26.8% ($n = 11$) reported dizziness. Sleep efficiency was measured as 87.3% (28.5) assessed by the PSQI and 88.3% (5.5) assessed by Actigraphy. The sample's descriptive data are shown in ►**Table 1**.

There were no significant differences between the Poor-Sleep and Good-Sleep Groups and COP variables (Mann-Whitney test; $p > 0.05$; ►**Table 2**) in BP and ST stances. Likewise, there were no significant differences in the other continuous variables (age, weight, height, BMI) ($p > 0.05$). The Chi-square test did not show any association between categorical variables (aural fullness, dizziness, tinnitus, diabetes, hypertension, hearing loss, neck pain, and physical activity), as demonstrated in ►**Table 2**.

There was a moderate correlation between sleep efficiency measured with PSQI and postural control based on A-COP ($r_s = -0.424$; $p = 0.006$; ►**Table 3**) in ST stance, and between sleep efficiency measured with PSQI and AMP-AP ($r_s = -0.386$; $p = 0.013$). There were no other significant correlations.

Subgroups were analyzed regarding gender, age groups, dizziness, aural fullness, tinnitus, diabetes, hypertension, hearing loss, neck pain, and physical activity. However, no associations were found.

## Discussion

This study aimed to assess the impact of objectively and subjectively measured sleep quality on postural control

 

**Table 1** Sample's descriptive data ($N = 41$).

| General Characteristics | N (%) |
|---|---|
| Gender | |
| Female | N = 29 (70.7%) |
| Male | N = 12 (29.3%) |
| Weight (kg) | 68.5 [20.2] [a] |
| Height (cm) | 1.63 [0.1] |
| BMI | 25.4 [4.8] |
| Age range (years) | |
| 27–46 years | N = 18 (43.9%) |
| 47–65 years | N = 23 (56.1%) |
| Mean ± standard deviation | 45.7 ± 10.4 |
| Weekly workload (hours) | 40 [15] |
| Time of service (years) | 20 [17] |
| Aural Fullness | |
| Yes | N = 4 (9.8%) |
| No | N = 37 (90.2%) |
| Dizziness | |
| Yes | N = 11 (26.8%) |
| No | N = 30 (73.2%) |
| Tinnitus | |
| Yes | N = 6 (14.6%) |
| No | N = 35 (85.4%) |
| Diabetes mellitus | |
| Yes | N = 2 (4.9%) |
| No | N = 39 (95.1%) |
| Arterial Hypertension | |
| Yes | N = 9 (22%) |
| No | N = 32 (78%) |
| Hearing loss | |
| Yes | N = 7 (17.1%) |
| No | N = 34 (82.9%) |
| Neck pain | |
| Yes | N = 16 (39%) |
| No | N = 25 (61%) |
| Physical activity (IPAQ) | |
| Low | N = 23 (55.6%) |
| Moderate | N = 18 (44.4%) |
| Sleep quality parameters (PSQI) | |
| Good sleep quality | N = 19 (46.3%) |
| Poor sleep quality | N = 22 (53.7%) |
| LAT (min) | 15 [25] |
| TIB (min) | 395 [90] |
| TST (min) | 360 [60] |
| Sleep efficiency (%) | 87.3 [28.5] |
| Total score | 7 [5] |
| Sleep quality parameters (Actigraphy) | |
| LAT (min) | 7.8 [10.1] |
| TIB (min) | 414.5 [78.4] |
| TST (min) | 366.4 [80.3] |
| Sleep efficiency (%) | 88.3 [5.5] |

Abbreviations: BMI, Body Mass Index; IPAQ, International Physical Activity Questionnaire; LAT, Sleep Latency; PSQI, Pittsburgh Sleep Quality Index; TIB, Total Time in Bed; TST, Total Sleep Time.
[a]median and interquartile range.

responses in schoolteachers. Poor sleep quality occurred more often in this study (54%), but there were no differences between the groups. However, a correlation was found between subjective sleep efficiency and A-COP and AMP-AP, demonstrating that as sleep efficiency decreases, postural sway increases. Previous studies found similar results in acute sleep deprivation (24, 36, or more hours without sleep).[37–39] This study, as well as Furtado et al.[11] and Montesinos et al.,[12] reported effects of chronic sleep deprivation, which can harm to these professionals' health.

The data in this study partially agrees with Furtado et al. (2016),[11] who experimentally assessed the effects of decreased quality of sleep on postural control in 30 healthy adults (18 to 29 years old) with actigraphy, PSQI, and static and dynamic posturography. The authors found a difference in stability with eyes closed, while with eyes open it was demonstrated that chronic poor sleep quality negatively affects postural control. On the other hand, the results of this research agree with previous studies that found an association between COP parameters and sleep quality mainly in AP direction, due to acute sleep deprivation[40] rather than day-by-day poor sleep quality.[12] A study that assessed 13 healthy adults (aged 25 ± 2.7 years) in different sensory conditions and tasks[40] reported that, in no-task condition, regardless of visual condition, sleep deprivation increased COP values in AP direction.[40] The AP direction result found in this study may be related to the participants' age. Sleep deprivation affects young adults in the opposite direction, in contrast with older adults, in whom sleep deprivation affects in both directions. This may result from adductor and abductor muscle atrophy due to aging, making the muscles closer to the center of mass maintain an upright posture. Hence, sleep deprivation may change the biomechanics of postural control differently in young and older adults.[41] Thus, by destabilizing postural control, sleep debt may be a significant risk factor for falls – particularly, given the high incidence of fall-related accidents in the workplace.[40] These findings could also help change postural control. Therefore, it is especially important to assess these variables in schoolteachers.

Sleep quality can be subjectively and objectively measured. Both are valuable instruments and should be used according to the objective to be achieved. A study suggested

 

**Table 2** Comparative good/poor sleep (according to the PSQI) subgroups analysis and postural control variables (mean difference).

| Continuous Variables | | Good Sleep ($n = 19$) PSQI | 95% CI | Poor Sleep ($n = 22$) PSQI | 95% CI | p Mann-Whiney test |
|---|---|---|---|---|---|---|
| **Bipedal stance** | | | | | | |
| Age (years) | | 45 [23][a] | 37.3–53.8 | 46 [17.5] | 40.1–50.1 | $p = 0.855$ |
| A-COP ($cm^2$) | | 2.7 [2.2] | 1.5–3.8 | 3.1 [4.2] | (-10)-9.7 | $p = 0.583$ |
| VEL AP (cm/s) | | 0.3 [0.2] | 0.2–0.5 | 0.4 [0.4] | (-0.1)-0.5 | $p = 0.784$ |
| VEL ML (cm/s) | | 0.4 [0.5] | 0.2–0.6 | 0.5 [0.3] | 0.05–0.5 | $p = 1.000$ |
| D-TOTAL (cm) | | 19.2 [12.2] | 9.1–27.2 | 20.4 [16.1] | (-0.9)-25.1 | $p = 0.834$ |
| AMP-AP (cm) | | 0.8 [1.2] | 0.5–1.4 | 1.4 [1.2] | 0.2–2 | $p = 0.480$ |
| AMP-ML (cm) | | 1.1 [0.9] | 0.5–1.3 | 1.1 [0.8] | (-0.4)-1.8 | $p = 0.958$ |
| **Semitandem stance** | | | | | | |
| Age (years) | | 45 [23] | 37.3–53.8 | 46 [17.5] | 40.1–50.1 | $p = 0.855$ |
| A-COP ($cm^2$) | | 2.5 [3] | 1–3.3 | 3.1 [4] | 1.8–5.1 | $p = 0.100$ |
| VEL AP (cm/s) | | 0.1 [0.3] | (-0.06)-0.2 | 0.003 [0.3] | (-0.1)-0.1 | $p = 0.278$ |
| VEL ML (cm/s) | | 0.4 [0.2] | 0.2–0.5 | 0.3 [0.3] | 0.2–0.4 | $p = 0.464$ |
| D-TOTAL (cm) | | 13.8 [10.8] | 4.9–17.7 | 7.2 [14.7] | 2.2–12.3 | $p = 0.374$ |
| AMP-AP (cm) | | 0.6 [0.9] | 0.3–1.1 | 0.8 [1.4] | 0.4–1.5 | $p = 0.166$ |
| AMP-ML (cm) | | 0.2 [1.1] | (-0.2)-0.8 | 0.3 [0.7] | (-0.02)-0.7 | $p = 0.937$ |
| **Categorical Variables** | | Good Sleep ($N = 19$) N (%) | | Poor Sleep ($N = 22$) N (%) | | p Chi-square test |
| Gender | Female | 13 (44.8) | | 16 (55.2) | | $p = 1.000$ $X^2 = 0.000$ |
| | Male | 6 (50) | | 6 (50) | | |
| Age range (years) | 27–46 | 8 (44.4) | | 10 (55.6) | | $p = 1.000$ $X^2 = 0.000$ |
| | 47–65 | 11 (47.8) | | 12 (52.2) | | |
| Dizziness | Yes | 5 (45.5) | | 6 (54.5) | | $p = 1.000$ $X^2 = 0.000$ |
| | No | 14 (46.7) | | 16 (53.3) | | |
| Tinnitus | Yes | 4 (66.7) | | 2 (33.3) | | $p = 0.524$ $X^2 = 0.406$ |
| | No | 15 (42.9) | | 20 (57.1) | | |
| Aural Fullness | Yes | 2 (50) | | 2 (50) | | $p = 1.000$ $X^2 = 0.000$ |
| | No | 17 (45.9) | | 20 (54.1) | | |
| Hearing loss | Yes | 4 (57.1) | | 3 (42.9) | | $p = 0.685$ $X^2 = 0.396$ |
| | No | 15 (44.1) | | 19 (55.9) | | |
| Diabetes | Yes | 1 (50) | | 1 (50) | | $p = 1.000$ $X^2 = 0.000$ |
| | No | 18 (46.2) | | 21 (53.8) | | |
| SAH | Yes | 3 (33.3) | | 6 (66.7) | | $p = 0.466$ $X^2 = 0.785$ |
| | No | 16 (50) | | 16 (50) | | |
| Neck pain | Yes | 7 (43.8) | | 9 (56.2) | | $p = 1.000$ $X^2 = 0.000$ |
| | No | 12 (48) | | 13 (52) | | |
| Physical Activity | Low | 6 (40) | | 9 (60) | | $p = 0.707$ $X^2 = 0.270$ |
| | Moderate | 6 (50) | | 6 (50) | | |

Abbreviations: A-COP, center of pressure area; AMP-AP, amplitude in the anterior posterior direction; AMP-ML, amplitude in the mediolateral direction; D-TOTAL, total displacement; SAH, systemic arterial hypertension; VEL AP, velocity in the anterior posterior direction; VEL ML, velocity in the mediolateral direction.
[a]median and interquartile range.

 

**Table 3** Spearman correlation between sleep parameters and postural control variables ($n=41$).

| | Actigraphy[a] $r_s$; p[c] | | | | PSQI[b] $r_s$; p[c] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | LAT[a] | TIB[a] | TST[a] | EFIC[a] | LAT[b] | TIB[b] | TST[b] | EFIC[b] | T-SCORE[b] |
| **Bipedal stance** | | | | | | | | | |
| A-COP | -0.144; 0.370 | 0.011; 0.944 | -0.082; 0.612 | -0.160; 0.317 | 0.098; 0.544 | -0.005; 0.975 | -0.005; 0.973 | 0.063; 0.694 | -0.118; 0.464 |
| VEL AP | -0.206; 0.197 | -0.082; 0.610 | 0.015; 0.925 | 0.219; 0.169 | -0.160; 0.318 | 0.002; 0.990 | 0.027; 0.865 | 0.055; 0.733 | -0.167; 0.297 |
| VEL ML | -0.049; 0.762 | 0.004; 0.978 | -0.044; 0.786 | -0.006; 0.969 | -0.053; 0.743 | 0.037; 0.817 | -0.040; 0.806 | -0.020; 0.903 | -0.041; 0.372 |
| D-TOTAL | -0.158; 0.324 | -0.017; 0.915 | 0.027; 0.867 | 0.159; 0.322 | -0.111; 0.491 | 0.028; 0.863 | -0.007; 0.965 | 0.004; 0.979 | -0.166; 0.299 |
| AMP-AP | -0.126; 0.433 | 0.154; 0.337 | 0.101; 0.529 | -0.105; 0.513 | 0.195; 0.222 | 0.179; 0.262 | -0.035; 0.826 | -0.275; 0.082 | 0.154; 0.335 |
| AMP-ML | -0.265; 0.094 | -0.049; 0.760 | -0.096; 0.551 | -0.030; 0.854 | -0.014; 0.928 | -0.112; 0.484 | -0.085; 0.596 | -0.070; 0.664 | 0.040; 0.804 |
| **Semi tandem stance** | **LAT[a]** | **TIB[a]** | **TST[a]** | **EFIC[a]** | **LAT[b]** | **TIB[b]** | **TST[b]** | **EFIC[b]** | **T-SCORE[b]** |
| A-COP | 0.169; 0.291 | -0.157; 0.328 | -0.155; 0.333 | -0.077; 0.633 | 0.250; 0.115 | 0.222; 0.163 | -0.211; 0.186 | **-0.424; 0.006**** | 0.198; 0.214 |
| VEL AP | -0.018; 0.911 | -0.109; 0.497 | -0.026; 0.874 | 0.053; 0.744 | -0.208; 0.191 | -0.038; 0.814 | 0.085; 0.599 | 0.106; 0.511 | -0.221; 0.164 |
| VEL ML | 0.119; 0.460 | -0.124; 0.440 | -0.110; 0.494 | -0.037; 0.820 | -0.345; 0.227 | -0.241; 0.130 | 0.033; 0.840 | 0.229; 0.149 | -0.321; 0.340 |
| D-TOTAL | -0.015; 0.927 | -0.165; 0.304 | -0.094; 0.557 | 0.053; 0.742 | -0.296; 0.060 | -0.161; 0.314 | 0.040; 0.806 | 0.180; 0.260 | -0.294; 0.062 |
| AMP-AP | -0.086; 0.591 | -0.143; 0.372 | -0.087; 0.590 | 0.050; 0.756 | 0.210; 0.187 | 0.296; 0.061 | -0.196; 0.218 | **-0.386; 0.013**** | 0.181; 0.256 |
| AMP-ML | 0.272; 0.085 | 0.015; 0.927 | -0.019; 0.907 | -0.174; 0.277 | -0.063; 0.696 | -0.057; 0.723 | 0.027; 0.866 | -0.003; 0.986 | -0.161; 0.315 |

Abbreviations: A-COP, center of pressure area; AMP-AP, amplitude in the anterior posterior direction; AMP-ML, amplitude in the mediolateral direction; D-TOTAL, total displacement; EFIC, Sleep efficiency; LAT, Sleep Latency; PSQI, Pittsburgh Sleep Quality Index; TIB, Total Time in Bed; T-SCORE, total score; TST, Total Sleep Time; VEL AP, velocity in the anterior posterior direction; VEL ML, velocity in the mediolateral direction.

[a]Actigraphy data.

[b]PSQI data.

[c]$r_s$ = Spearman correlation value; p = statistical difference.

**(statistically significant difference).

 

that perceived sleep quality is quite different from objective reality, at least for adults 55 years or more; this difference is unrelated to age, gender, educational attainment, or cognitive status (assessed using standard screens).[27] This may be an explanation for the absence of other findings between groups. Another possibility is that actigraphy sleep efficiency calculation includes post-sleep onset waking data – which cannot be inferred from the questionnaire. However, there were no differences or correlations for post-sleep onset waking data (data not shown in the tables).

Subgroup analyses were made regarding gender, age groups, dizziness, aural fullness, tinnitus, diabetes, hypertension, hearing loss, neck pain, and physical activity. The sample comprised mostly women, which was to be expected, agreeing with previous studies.[42] Nonetheless, there were no differences or associations between the variables analyzed.

Lastly, this study has several strengths, including the assessment of a specific population with similar occupations (schoolteachers), with objectively and subjectively measured sleep quality, and objectively assessed postural control. However, some limitations should be considered. Postural control was assessed with eyes open in BP and ST stances; it would be interesting to assess it in other sensory conditions, as different results may be found. Bipedal stance is relatively easy to perform and may not have been discriminatory. Nevertheless, the foam surface and the semitandem stance proved to efficiently challenge the participants' postural control and show results. In addition, the teachers were middle-aged adults, so these results, though discrete, are important because, with advancing age, the problems studied here may worsen. Another limitation of the study was that it did not address other variables – such as stress, fatigue, daytime sleepiness, and so on – that may significantly affect schoolteachers' sleep and postural control.

## Conclusion

There were associations between subjective sleep efficiency and A-COP and AMP-AP – as sleep efficiency decreases, postural sway increases. Thus, sleep quality can affect postural control responses. Further studies with larger samples are needed to better generalize these findings to other populations with sleep disorders.

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