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Association between sleep parameters and physical activity in runners during the COVID-19 pandemic

Associação entre parâmetros do sono e atividade física em corredores durante a pandemia de COVID-19

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ABSTRACT
To determine the association between sleep quality (SQ), excessive daytime sleepiness (EDS) and physical activity (PA) in amateur street runners during the COVID-19 pandemic. Eighty-six volunteers were evaluated, and the analyzed variables were: SQ (By Pittsburgh Sleep Quality Index), EDS (By Epworth Sleepiness Scale), and PA (By the Google Fit® app). The data was collected remotely, via email, using Google Forms. Pearson correlation test or Spearman correlation test was used for data correlation. Simple linear regression analysis was performed between variables that showed correlation. P values < 0.05 were considered significant. There was a correlation between EDS and step count [r (p) = 0.219 (0.042)], and only an association between PA and EDS was observed. Based on the results, an association was found between EDS and PA. However, no association was found between SQ and PA.

Keywords: Excessive daytime sleepiness. Sleep quality. Physical activity. COVID-19.

RESUMO
Determinar associação entre qualidade do sono (QS), sonolência diurna excessiva (SDE) e a atividade física (AF) em corredores de rua durante a pandemia de COVID-19. Em 86 voluntários, as seguintes variáveis foram avaliadas: QS (pelo Índice de Qualidade do Sono de Pittsburgh, ESE (pela Escala de Sonolência de Epworth) e a AF (pelo aplicativo Google Fit®). Utilizou-se o teste de correlação de Pearson ou teste de correlação de Spearman. A análise de regressão linear simples foi realizada entre as variáveis que apresentaram correlação. Consideraram-se significantes os valores de $p < 0,05$. Houve correlação entre a SDE e a contagem de passos, bem como entre a SDE e a AF. Verificou-se associação entre a SDE e a AF, mas não entre a QS e a AF.

Palavras-chave: Sonolência diurna excessiva. Qualidade do sono. Atividade física. COVID-19.

INTRODUCTION

The coronavirus disease (COVID-19) quickly emerged in Wuhan city, China, in December 2019 as a typical pneumonia of an unknown cause[1]. Due to its uncontrolled disease, the situation was defined as pandemic according to the World Health Organization (WHO) on

March 11, 2020[3]. Although the world has made a significant investment to try-out several types of drugs to treat COVID-19 and also to develop vaccines, the most effective measures to contain the outbreak until the vast majority of the population is vaccinated are still physical/social isolation and use of face mask[3].

It is possible to prevent the health system overload reducing the COVID-19 transmission rates with social distancing[4]. Although these restrictions help to reduce the virus dissemination, these constraints have negative effects, limiting normal daily activities and reducing the access to many forms of exercise[5]. Due to social isolation measures, usual places for physical exercise, such as gyms and parks for outdoor recreation, became inaccessible. Consequently, the practice of recreational street running, which had been gaining a large number of followers over the last 10 years, was one of the exercise practices that suffered the most consequences with isolation measures[6].

Such restrictions created a burden to the population's health by compromising physical fitness[5] Social isolation strategies cause drastic reductions in physical activity levels, as well as major increases in sedentary behavior[7]. In addition, the inability to reach sleep with good quality was also one of the consequences caused by the COVID-19 pandemic[8]. Recently, researchers have emphasized a strong relationship between physical activity and sleep, in addition, the researchers also have pointed out that levels of physical activity can be reduced when adequate sleep cannot be obtained. It is known that physical activity is considered a significant factor for the absence of sleepiness in the population alongside with body mass index (BMI) control and other covariates[9]. Thus, regular exercise is a non-pharmacological treatment option for disorders such as drowsiness and poor sleep quality[10].

In this context, sleep disorders may be related to physical inactivity, and it also may be worsened during the COVID-19 pandemic period. Therefore, the aim of this study was to determine the association between sleep quality, excessive daytime sleepiness, and physical activity in amateur street runners during the COVID-19 pandemic.

METHODS

This research is a cross-sectional survey with the approval of the Human Research Ethics Committee of the Health Sciences Center (CCS) of the Federal University of Pernambuco (UFPE) (protocol number: 4,301,713).

Subjects of both sexes, aged between 18 and 65 years old. Study participants were required to have prior experience in street running and to continue engaging in it during the pandemic period, or to have started practicing it at least three months prior to the data collection start and not to have experienced any type of injury in the last month preceding the evaluation. Subjects who presented comorbidities such as uncontrolled hypertension and diabetes, orthopedic and neurological alterations, infectious-contagious disease, emergence of an acute episode in established chronic disease or any cardiovascular or respiratory disease that prevented the tests from being performed were excluded. The volunteers were runners who participated in running groups in the state of Pernambuco or runners who practiced the modality independently, with a total of 86 individuals being evaluated.

The sample size calculation to perform regression analysis was performed according to a formula developed by Tabacknhick and Fidell[11]. The calculation can be described by $n > 50 + 8m$, where "m" is equal to the number of independent variables that, in this current study, were step counting, calories, displaced distance and minute count in motion, resulting in n = 82 volunteers.

The sample for this study was conducted through publicity in street racing groups in the state of Pernambuco, to inform the research objectives and select volunteers who fit in with the proposed sample. The data was collected online through electronic mail and guided audio-visual platforms, respecting all criteria of social distance.

On the first day scheduled, the volunteers were informed about all the proposed procedures and were invited to participate in the survey using Google Forms platform under the Free Informed Consent Term (FICT), pursuant to resolution 466/2012 of the National Health Council. After this first stage, the individuals underwent an assessment, which consisted of collection of personal information, assessment of excessive daytime sleepiness, sleep quality and level of physical activity.

INITIAL EVALUATION

Initially, the evaluation form was filled out, in which the participants were interviewed about their personal and clinical information, lifestyle, associated comorbidities, surgical history and data on physical activities before and after the pandemic and direct questions related to the number of days and the duration of regular physical exercise practice before and after the pandemic. The evaluation form and the questionnaires were filled out through Google Forms platform and the subjects received guidance through audiovisual platforms, respecting the rights of privacy and confidentiality of the data collected. Then, the volunteers answered questions related to excessive daytime sleepiness, sleep quality.

EXCESSIVE DAYTIME SLEEPINESS ASSESMENT

The excessive daytime sleepiness evaluation was performed using the Epworth Sleepiness Scale (ESS)[12]. The ESS is a scale which checks the existence of daytime sleepiness through eight daily situations, enabling a self-assessment taken by each volunteer about the possibility of napping when performing these situations. The score applied to ESS ranges from 0 to 3 for each item, with 0 being no chance of napping; 1 being a small chance; 2 being moderate chance; and, finally, 3 being high chance. If the total sum of items exceeds the value of 10 indicates excessive daytime sleepiness and a score greater than 16 is related to severe sleepiness. The maximum attainable final score is 24 points.

SLEEP QUALITY ASSESMENT

To evaluate the sleep quality parameter, the Pittsburg Sleep Quality Index (PSQI) was used[13]. It consists of a questionnaire, which assesses the sleep quality and possible disorders that occurred in the month prior to the time of assessment. It consists of four subjective questions and twenty objective questions, fifteen of which are self-administered (answered by the volunteer) and five of them are to be questioned to the roommate (relating to clinical information). The total sum of the scores produces an overall score ranging from 0 to 21, being the higher the score, the worse the sleep quality. Scores from 0 to 5 indicate good sleep quality and above 5 indicates poor sleep quality.

PHYSICAL ACTIVITY ASSESMENT

Google Fit was used to evaluate physical activity. This application is available for mobile devices and allows the user to measure, monitor and store the fitness information. It is easy to use and read by the user, and the application is available for any cell phone with Android or iOS technology[14]. Before each use, the application is calibrated by providing the user's personal data, such as sex, body mass in kilograms (kg) and height in centimeters (cm). All volunteers were monitored by the app for 7 consecutive days and were duly instructed to keep their cell phones throughout the evaluation period. If any activity without the device was performed, the volunteer was also instructed to add the type of activity, the time it was performed and the duration, as well as to charge the cell phone during sleep. Through these measures, it is possible to assess the number of steps taken, the displaced distance, the burned energy, in calories, and, finally, the number of minutes in motion.

STATISTICAL ANALYSIS

Statistical procedures were analyzed using the Statistical Package for Social Sciences (SPSS) software, version 20.0, using descriptive and inferential statistical techniques. For statistical analysis of the results, a significance level of 95% ($p < 0.05$) was assigned. The normality of the data distribution was assessed using the Kolmogorov-Smirnov test and the equality of variances was verified by Levene's F test. Data were expressed as mean ± standard deviation, percentile, median and interquartile range. Categorical variables were expressed as number of cases and frequency. Correlation analysis between sleep parameters and physical activity variables were performed using Spearman's or Pearson's tests, according to the normality distribution of the data. To compare physical activity and self-reported sleep hours on weekends and weekdays, the Wilcoxon test was used. Sleep quality and excessive daytime sleepiness according to physical activity were compared with Student's t-test or Mann-Whitney test. Simple linear regression analysis was performed between excessive daytime sleepiness and the independent variables that showed a significant correlation.

RESULTS

Figure 1 shows the flowchart for gathering and monitoring the volunteers. Eighty-six amateur street runners completed the survey.

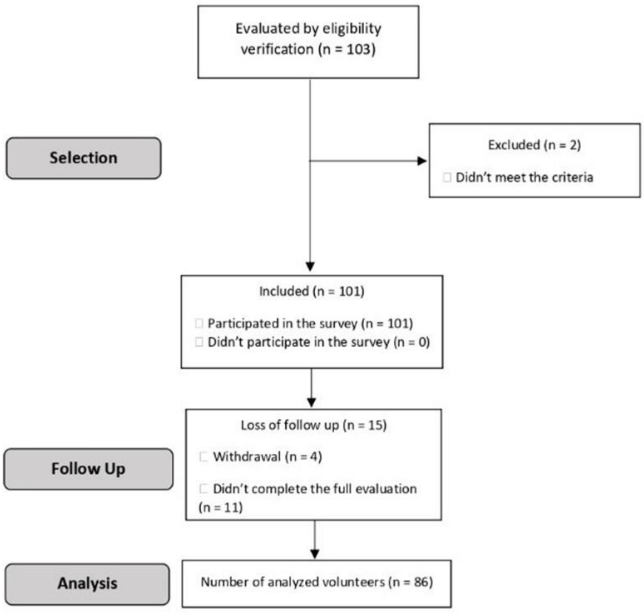

Figure 1. Flowchart for gathering and monitoring the volunteers.

A total of 103 runners were chosen according to the eligibility criteria, with 86 of them being recruited and analyzed. The overall characteristics of the sample are shown in table 1. The sample consisted of volunteers of both sexes (70.93% male) and was characterized as overweight (BMI: 25.49 ± 3.59 kg/m^2). The majority of research participants tested negative for COVID-19 (60.5%), reported poor sleep quality (96.5%), and only 23.3% of the sample showed excessive daytime sleepiness. Regarding the level of physical activity, it was observed that the sample had a low level of physical activity, based on the number of steps per day, of which only 14% were considered a little active, 7% active and 7% very active. The analyzed sample performed physical exercise more days per week before the pandemic when compared to practice during the pandemic period (p = 0.006). It was also observed that exercise lasted longer before the pandemic when compared to exercise duration during the pandemic period (p = 0.002).

Table 1. General characteristics of the sample

Variables	Total (n = 86)
Sex	
Male (n%)	70.93%
Age group (years)	
Total (n = 86)	34.37 ± 8.81
19 to 29 y.o.	24.44 ± 2.86
30 to 39 y.o.	34.05 ± 2.48
40 to 58 y.o.	46.23 ± 5.35
BMI (kg/m^2)	25.49 ± 3.59

Positive results for COVID	
Yes (n%)	11 (12.8%)
No (n%)	52 (60.5%)
Doesn't know (n%)	23 (26.7%)
Days per week of physical activity before the pandemic	4.35 ± 1.59*
None (n%)	3 (4.5%)
1 to 3 (n%)	23 (26.7%)
4 to 5 (n%)	41 (47.7%)
6 to 7 (n%)	19 (22.1%)
Duration of exercise practise before the pandemic (min)	78.26 ± 43.15*
Less than 60 minutes (n%)	12 (14.0%)
60 minutes (n%)	33 (38.4%)
More than 60 minutes (n%)	38 (44.2%)
Days per week of physical activity during the pandemic	3.66 ± 1.87
None (n%)	7 (8.1%)
1 to 3 (n%)	32 (37.2%)
4 to 5 (n%)	36 (41.9%)
6 to 7 (n%)	11 (12.9%)
Duration of exercise practice during the pandemic (min)	63.37 ± 36.09
Less than 60 minutes (n%)	31 (36.0%)
60 minutes (n%)	30 (34.9%)
More than 60 minutes (n%)	25 (29.1%)
Total ESS score	7.34 ± 4.00
No daytime sleepiness (n%)	66 (76.7%)
Excessive daytime sleepiness (n%)	20 (23.3%)
Total PSQI Score	8.60 ± 2.77
Good sleep quality (n%)	3 (3.5%)
Poor sleep quality (n%)	83 (96.5%)
Level of Physical Activity (steps/day)	6368.51 ± 3692.34
Sedentary	33 (38.4%)
Less sedentary	29 (33.7%)
Less active	12 (14.0%)
Active	6 (7.0%)
Highly Active	6 (7.0%)

Data expressed in number (%) for categorical variables and mean ± standard deviation or median (interquartile range) for continuous variables. *before vs after the pandemic; $p < 0.05$ (paired t-student test). BMI: Body mass index; min: minutes; ESS: Epworth Sleepiness Scale; PSQI: Pittsburgh Sleep Quality Index.

Regarding the objective evaluation of physical activity and self-reported hours of sleep, there were no differences in the behavior of these variables between weekdays and weekends ($p > 0.05$) (Table 2).

Table 2. Comparison of self-reported sleep hours and physical activity evaluated for Google Fit during weekdays and weekends in amateur street runners

Google Fit Variable	**During weekdays** Mean ± SD	**During weekends** Mean ± SD	***p-Value***
Sleep Hours	7.15 ± 1.88	6.89 ± 1.49	$p^{(1)} = 0.440$
Calories (kcal)	1863.3 ± 384.4	1833.76 ± 393.68	$p^{(1)} = 0.172$
Step counting	6551.0 ± 4108.0	5912.20 ± 4321.39	$p^{(1)} = 0.149$

Dislocated distance (m)	5401.63 ± 7861.08	4878.00 ± 6216.38	$p^{(1)} = 0.229$
Movement counting (min)	80.00 ± 43.35	74.33 ± 60.43	$p^{(1)} = 0.067$

Data expressed as mean ± standard deviation and median (interquartile range) for continuous variables, confidence interval of 95%. P: percentile; kcal: kilocalorie. (1) Paired Wilcoxon test.

In the assessment of self-reported sleep hours and objective evaluation of physical activity, no differences were observed between individuals with good and poor sleep quality (p > 0.05) (Table 3). The analysis of self-reported sleep hours and objectively evaluated physical activity in individuals with excessive daytime sleepiness and without excessive daytime sleepiness was demonstrated (Table 3). The group with excessive daytime sleepiness had a higher number of steps/day compared to the group without daytime sleepiness (p = 0.019). Regarding distance covered, the group with excessive daytime sleepiness showed a greater distance covered than the group without sleepiness (p = 0.011). No differences were found between the groups in the variables of sleep hours (p = 0.717), calories (p = 0.622), and count of minutes in movement (p = 0.085) (Table 3).

Table 3. Comparison of self-reported sleep hours and physical activity during the 7 days of the week among groups with good and poor sleep quality, and among groups with presence and absence of excessive daytime sleepiness

	Pittsburgh Sleep Quality Index			**Epworth Sleepiness Scale**		
	Good sleep quality (n=3)	**Poor sleep quality (n=83)**		**No excessive daytime sleepiness (n = 66)**	**With excessive sleepiness (n = 20)**	
Variables	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
			p-Value			***p-Value***
Sleep hours	8.03 ± 2.28	7.04 ± 1.42	$p^{(1)} = 0.556$	7.12 ± 1.55	6.92 ± 1.08	$p^{(1)} = 0.717$
Calories (kcal)	1844.0 ± 636.0	1855.2 ± 352.5	$p^{(1)} = 0.560$	1865.4 ± 328.3	1819.8 ± 456.7	$p^{(2)} = 0.622$
Step counting	7909.2 ± 6650.1	6312.8 ± 3600.5	$p^{(1)} = 0.929$	5692.5 ± 2934.4	8599.4 ± 4970.6	$p^{(1)} = 0.019$*
Dislocated distance (m)	3410.9 ± 1753.2	5318.6 ± 6406.2	$p^{(1)} = 0.656$	3889.0 ± 2303.9	9749.9 ± 11492.9	$p^{(1)} = 0.011$*
Movement counting (min)	79.0 ± 46.2	78.3 ± 43.4	$p^{(1)} = 0.982$	73.7 ± 39.4	93.8 ± 52.1	$p^{(1)} = 0.085$

Data expressed as mean ± standard deviation and median (interquartile range) for continuous variables, confidence interval of 95%. kcal: kilocalorie. (1) Mann-Whitney Test.

A correlation was found between excessive daytime sleepiness and step count [r(p) = 0.219 (0.042)]. However, there was no correlation between sleep quality and variables related to physical activity (Table 4).

Table 4. Correlation between physical activity, excessive daytime sleepiness and quality of sleep in street runners

Variables	EPWORTH r (p)	PSQI r (p)
Calories (kcal)	0.007 (0.946)	0.018 (0.870)
Step counting	0.219 (0.042)*	0.035 (0.749)
Dislocated distance (m)	0.193 (0.075)	0.089 (0.414)
Movement counting (min)	0.202 (0.062)	-0.072 (0.512)

(*) $p < 0.05$; kcal: kilocalorie.

Through simple linear regression analysis, it was found that physical activity, as measured by step count, is associated with and serves as a predictor for excessive daytime sleepiness ($\beta = 0.275$, $t = 2.622$, $p = 0.010$). However, no associations were established between physical activity and sleep quality.

DISCUSSION

This study aimed to determine the association between sleep quality, excessive daytime sleepiness, and physical activity in amateur street runners during the COVID-19 pandemic period. In the present research, a high prevalence of individuals with poor sleep quality was observed. Most of the volunteers had a low level of physical activity when evaluated by the weekly step counting. It was possible to verify an association between excessive daytime sleepiness and physical activity, however, no association was found between physical activity and sleep quality.

In the present study, no difference was observed when comparing physical activity and self-reported sleep between weekdays and weekends. These results were similar to Drenowatz et al.[15], who also found no differences in the amount of low, moderate, or vigorous physical activity intensity between weekdays and weekends in healthy young adults, evaluated over the course of a year before the pandemic.

This behavior can be explained by the lockdown, which a large part of the population was led to during the pandemic, with the disorder in their daily routines and work schedules, in addition to the reduction in daily commuting[16]. Individuals who could present higher levels of physical activity, by commuting to work and performing other activities during the week, became confined and, consequently, reduced daily physical activity. Likewise, typically active individuals who frequented parks and clubs during off hours and on weekends also reduced the frequency and duration of physical exercise[17].

This could be checked in this study, since the number of days and the number of hours of physical exercise were smaller during the pandemic when compared to the moment right before the pandemic. Activities performed during the lockdown generally involved low intensity, such as housework. In addition, there was a reduction in the level of physical activity and an increase in sedentary behavior in individuals previously considered active[18].

The sample analyzed in this current work had a large number of individuals with poor sleep quality. However, in the self-reported sleep evaluation, the volunteers stated 7-8 hours of sleep per night, compatible with the number of hours of sleep recommended for adults[19]. These findings are aligned with Trabelsi et al[18], who reported a significant increase in overall PSQI scores during lockdown compared to before the COVID-19 pandemic period, suggesting an increased prevalence of poor sleep quality. In addition, during the lockdown, there was also an increase in sleep duration when compared to before the COVID-19 pandemic period[20]. It is noteworthy that poor sleep quality may be associated with the high level of stress and anxiety caused by the pandemic[21]. Furthermore, the increase of negative emotions and the decrease of life quality in healthy individuals have been related to poor sleep quality[22]. It is known that sleep is a complex behavior that can be affected by several conditions, and physical exercise is a factor that acts in the regulation of circadian rhythms in the body, therefore, activity levels reduced by the quarantine period can damage the biological clock and affect the sleep quality regardless of the number of hours slept[23].

In this work, no differences were found between physical activity and self-reported sleep between individuals with good and poor sleep quality. On the other hand, Trabelsi et al.[24] found an association between the levels of physical activity and the sleep quality in individuals in an online survey with 5,056 adults. However, this study used a subjective method of physical activity evaluation, differing from the method used in the present research. It is noteworthy that the sample used in this paper, despite being composed of amateur street runners, had a significant number of inactive (38.4%) or slightly sedentary (33.7%) individuals. The physical activity levels reduction during the pandemic was also observed in a report carried out with more than 30 million users by FitBitR, which identified a daily reduction in step counting of 38% in European countries and 15% in South and North American countries[25]. The decrease in physical activity can be explained by restrictions imposed during the pandemic, with reductions in daily, recreational, or incidental activities, such as cycling or walking.

In a pre-pandemic assessment, Potter et al.[26] reported that low levels of physical activity throughout the day can directly interfere with sleep parameters. Similar findings were indicated by Bonnet & Arand[27], as these authors found an association between the level of physical activity and the regulation of physiological indicators that influence sleep parameters. However, the results described in this paper demonstrate that individuals with daytime sleepiness had a better level of physical activity when compared to individuals who had no sleepiness.

Irregular sleep schedules and the stress caused by the uncertainty of the pandemic have increased the prevalence of sleep disorders such as insomnia and abnormalities in circadian rhythm[28], factors associated with excessive daytime sleepiness. Thus, these changes, along with shifts in lifestyle habits, have led people to spend more time at home, engaging in low-intensity activities such as household chores[29]. In the present study, although the group with excessive daytime sleepiness showed a higher level of physical activity, both groups were identified as having a low level of physical activity, with a daily step count below 10,000 steps/day, a value proposed by Tudor-Locke et al.[30] as a reference to classify individuals as active.

Only one variable showed a correlation in association with excessive daytime sleepiness. However, no association was found between physical activity and sleep quality. Due to the lockdown and changes in lifestyle habits, these findings should be analyzed with caution since the subjects evaluated could be stressed and this may have affected the evaluation of excessive daytime sleepiness and the assessment of sleep quality carried out through questionnaires from the subjective perception.

In the present paper, it was observed that step counting is a predictor of excessive daytime sleepiness. The results are aligned with previous research that found an association between excessive daytime sleepiness and physical activity. In this study, it was also observed that the association of physical activity with daytime sleepiness is more consistent than with sleep duration[28]. These results indicate that changes in lifestyle habits may have influenced excessive daytime sleepiness, such as the reduction in social and leisure participation in physical activity during this lockdown at home, and a return to these activities may represent an improvement in this situation.

This article has limitations. From a methodological point of view, as this is observational research, the cross-sectional design limited the establishment of causal relationships. Another limitation was the subjective assessment of sleep parameters, as polysomnography is considered the gold standard method for sleep evaluation. However, the method used to assess sleep parameters was questionnaires translated and validated for Portuguese and they present a good correlation with the gold standard method.

CONCLUSIONS

According to the results of the present paper, the sample showed a high prevalence of poor sleep quality. Excessive daytime sleepiness was associated to physical activity, however no association was found between physical activity and sleep quality. Furthermore, even though street runners are a typically active population, a low level of physical activity was found during the pandemic. It is suggested that future longitudinal studies, with a larger sample size, be carried out in order to elucidate causal relationships and assess sleep parameters and physical activity levels in the population of street runners during and after the pandemic period.

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