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Article

How did poor sleep quality and working from home influence the prevalence of leisure-time physical inactivity during the Covid-19 pandemic? COVID-Inconfidentes

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Abstract: To examine the association of sleep quality and work from home with physical inactivity (PI) in leisure time during Covid-19 pandemic. A population-based household survey was conducted in two Brazilian municipalities from October to December 2020. Leisure-time physical activity (PA) was self-reported, and individuals who practiced less than 150 minutes of moderate PA or 75 minutes of vigorous PA weekly were classified as PI. Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI). WFH was assessed by: "Currently, how is your work routine regarding location? Associations were investigated using logistic regression and directed acyclic graphs (DAG) for the multivariate models. A total of 1,750 adults were interviewed, 69.1% were PI and 51.9% had poor sleep quality. Furthermore, 79.8% were not in WFH. In multivariate analysis, leisure PI was associated with poor sleep quality (OR:1.59: 95% CI: 1.02-2.48), and not being in WFH (OR:1.62: 95% CI: 1.05-2.50). When performing the combined analysis between these two factors, and who were not in WFH were four times more likely to be PI at leisure (OR=4.22;95%CI:2.05-8.65). The results indicate a high prevalence of PI, with poor quality sleep and non-WFH associated with leisure PI. These combined factors exacerbated the occurrence of PI.

Keywords: Physical inactivity; work from home; sleep; Covid-19 and public health.

1. Introduction

Physical activity (PA) has been a topic of recurrent discussion in recent years, as scientific evidence provides irrefutable information about its positive effects and implications for human quality of life [1, 2]. Its performance in promoting physical and mental health has been recognized in different spheres, whether individual, economic, political, or social [3]. International guidelines recommend a minimum weekly goal of 150 minutes of moderate PA, 75 minutes/week of vigorous PA, or a combination of both intensities [4, 5].

Although the benefits of regular PA are undeniable, an increase in leisure-time physical inactivity (PI) in the world's population has been observed [6]. Global estimates indicate that in 2016, 27.5% of adults [7] and 81% of adolescents [8] did not reach the recommended PA frequency. In Brazil, the data are even more alarming; our country is one of the countries with the highest prevalence of PI in the world since approximately 47% of Brazilian adults did not perform enough PA in 2016. Research also points to an increase of more than 15% in PI in the period between

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2001-2016 in Brazil, going against the global goal proposed by the World Health Organization (WHO) aiming at a relative reduction of 10% in PI by 2025)[7].

At the beginning of the Covid-19 pandemic [9], social restriction was one of the first and most important measures to contain the spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [10]. This decision brought about changes in the population's routine and health behaviors, highlighting an overall negative effect on PA practice; people were confined to their homes and could not exercise [11]. In addition, the pandemic may have led to reduced exposure to sunlight, causing dysregulation of the circadian cycle, accentuating sleep schedule fluctuations, and increasing the chances of poor quality sleep [12]. In addition, when infected with SARS-CoV-2, the individual may experience a disturbed sleep-wake cycle, leading to insomnia or poor sleep quality [13].

Another conduct encouraged by social restriction was work from home (WFH) in nonessential workers [14, 15], in which the employee began to perform his activities fully or partially remotely at home, without commuting to the workplace. Before the Covid-19 pandemic, this type of work was performed only for certain types of occupations, on an occasional basis, or because of the unique circumstances of employees [16]. However, it is believed that this new work format will continue to be encouraged, given the reduction in the cost of operating expenses of companies, as well as allowing for flexibility in working hours and promoting the balance between the professional and personal lives of workers [17].

Thus, this study seeks to investigate how the combination of work format (WFH) and poor sleep quality may affect PI. Aims: (1) to assess the association between poor sleep quality and leisure-time PI, and (2) to verify the joint association between poor sleep quality and no WFH with PI during the Covid-19 pandemic. As hypothesized, poor sleep quality is significantly associated with PI, and the joint association between poor sleep quality and no WFH is strongly associated with PI during the Covid-19 pandemic.

2. Materials and Methods

2.1. Study design and region

The present study is part of a larger project entitled "Epidemiological surveillance of Covid-19 in the Inconfidentes Region/MG," which is a population-based household seroepidemiological survey conducted between October and December 2020 in two Brazilian municipalities (Ouro Preto and Mariana), located in the state of Minas Gerais, in the Iron Quadrangle region, an area with one of the largest iron ore reserves in the world. Meireles et al. (2021) provided detailed information about the collection, methodology, and questionnaire used in the study [18].

2.2. Study population

From a probabilistic sample, permanent residents of the urban areas of the municipalities of Mariana and Ouro Preto, Minas Gerais, aged 18 years or older, were eligible for the study. The exclusion criteria were as follows: residents of social centers

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and long-stay institutions, individuals isolated due to a current diagnosis of coronavirus-2 infection (SARS-CoV-2), and individuals with cognitive impairment.

The sample size was calculated based on the population estimates for each city according to the 2010 population census. A confidence level of 95% was adopted, and the design effect was equal to 1.5. In addition, for each municipality, a recomposition percentage of 20% was added to the sample size, considering losses due to refusal, absence of the resident, or closed households, resulting in a total of 732 interviews for each municipality.

A stratified sampling process by conglomerate was adopted in three stages: census sector (selected for each stage, randomly and without replacement), households (selected by a systematic sampling process), and residents (one resident was randomly selected, using the application Sorteador de Nomes®). The sample weight of each selected unit was calculated to correlate with the 2019 population projection. Furthermore, the selection of census sectors was previously stratified considering the number of households and average income to ensure the representativeness of the different socioeconomic levels in the final sample. We interviewed 1,789 participants, excluding 27 individuals who did not complete the interview or who could not undergo venipuncture, and 12 were excluded due to the absence of data on PA, totaling 1,750 individuals included in this study.

2.3. Data Collection

The interviews were conducted by undergraduate and graduate students at the homes of the selected individuals using a structured questionnaire in electronic format through the Data Goal® application. The questionnaire contained questions on sociodemographic characteristics, lifestyle habits, health behaviors, and health conditions. In addition, blood samples were collected via venipuncture for laboratory testing for SARS-CoV-2 infection and other biochemical analyses. The activities were carried out on weekends (Friday, Saturday, and Sunday), aiming to enhance the participation of residents who worked during the week.

2.4. Outcome variable: Leisure-time physical activity practice

Leisure-time PA was assessed by weekly frequency, duration, and type of exercise performed. Moderate PA was defined as walking, treadmill walking, weight training, water aerobics, Pilates, volleyball, and dancing, and vigorous PA included running, cycling, swimming, treadmill running, aerobic gymnastics in general, wrestling, soccer/futsal, basketball, and tennis [19-22]. Then, the weekly frequency (0 to 7 days) was multiplied by the daily time (in minutes) to obtain the weekly volume of leisure-time PA in minutes. This volume was categorically evaluated. We adopted the cut-off points established by the WHO and the Physical Activity Guide for the Brazilian Population [5, 23], in which individuals were classified as physically active (≥150 min/week of moderate PA or ≥75 min/week of vigorous activity or a combination of both), or physically inactive (<150 min/week of moderate PA or <75 min/week of vigorous activity).

2.5. Explanatory variables

2.5.1. Sleep quality

Sleep quality was assessed by using the Pittsburgh Sleep Quality Index (IQSP). The Brazilian version of the IQSP has an overall reliability coefficient (Cronbach's α) of

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0.82, indicating a high degree of internal consistency [24]. This instrument comprises 19 questions categorized into seven components: subjective sleep quality (C1), sleep latency (C2), sleep duration (C3), habitual sleep efficiency (C4), sleep disturbances (C5), use of sleep medications (C6), and daytime dysfunction (C7). Each component is scored from 0 to 3, with the sum of the scores ranging from 0 to 21 [25]. In this study, sleep quality was classified as good when the IQSP score was less than or equal to 5 and poor when the IQSP was greater than 5.

2.5.2. Ways of working during the pandemic

Regarding the way of working, the question consisted of: 'Currently, how is your work routine regarding location?' (1) All work activities are being performed at my home; (2) Part of the activities are performed in the traditional work environment, that is, some days at home and others at the workplace; (3) All work activities are being performed in my work environment. They were categorized as not working from home (all activities at the workplace) or working from home (partial and/or full WFH).

2.5.3. Adjustment Variables

To reduce potential confounding effects, adjustment variables were selected based on the literature, and a theoretical causality model was based on a directed acyclic graph (DAG).

2.5.4. Sociodemographic information

The sociodemographic variables assessed were sex (female or male), age group (18-34 years; 35-59 years; ≥ 60 years), self-reported skin color (white; non-white: black, brown, yellow, and indigenous), marital status (single or married), and housing status (living alone or not living alone). Current income (≤ 2 minimum wages, >2 to ≤ 4 minimum wages, >4 minimum wages), education level (< 8 years; 9-11 years; ≥ 12 years of study), and family structure (number of residents at home and residents under 18 years of age) were also assessed.

2.5.5. Health conditions

The health conditions assessed were self-reported chronic diseases (high blood pressure, diabetes, asthma, lung disease, chronic kidney disease, depression, anxiety disorder, obstructive sleep apnea, cancer, heart disease, or thyroid disease), which were assessed separately, and dichotomized into the presence of morbidity (individuals who reported at least one disease) and absence of morbidity (no disease reported).

Body mass index (BMI) was calculated from self-reported current height (cm) and weight (kg) and classified as low weight (BMI < 18.5 kg/m^2 if < 60 years or BMI < 22 kg/m^2 if ≥ 60 years), eutrophic (BMI 18.5-24.9 kg/m^2 if < 60 years or BMI 22.0-27.0 0 kg/m^2 if ≥ 60 years), and overweight (BMI > 25.0 kg/m^2 if < 60 years or BMI > 27.0 kg/m^2 if ≥ 60 years) [26, 27].

Anxiety disorder symptoms were assessed using the General Anxiety Disorder-7 (GAD-7) scale [28]. Symptoms of depression were assessed using the Patient Health Questionnaire-9 (PHQ-9) scale [29]. For both scales, the categorization was dichotomous, with scores <10 being classified as having no symptoms of anxiety or

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depression disorder and scores ≥ 10 as having symptoms of anxiety or depression disorder [30, 31].

The subjects were asked about their smoking and drinking habits and were categorized as yes or no.

2.6 Statistical Analysis

Statistical analyses were performed considering the sampling and study design weighting factors, using the 'svy' package of Stata® software, version 15.0. Categorical variables are described as relative frequencies and 95% confidence intervals (95%CI). The relationship between descriptive variables and outcomes was estimated using Pearson's chi-square.

A theoretical causality model based on a directed acyclic graph (DAG) was developed according to exposure (sleep quality and WFH), outcome (leisure-time PI), and confounding variables using the online software Dagitty, version 3.2 [32]. Causal connections, represented by arrows, were established between the variables (Figure 1). Each variable in the DAG was represented by a rectangle, and the colors had different meanings: green was the exposure variable, blue circled by black was the outcome variable, possible confounding variables in blue were the antecedents of the outcome variable, and those in red were the antecedents of the outcome and exposure variables. To avoid unnecessary adjustments, spurious associations, and estimation errors, the backdoor criterion was used to select a minimum set of confounding variables to fit the analyses [33]. The model was fitted using the following minimum set of variables: sex, age, income, BMI, marital status, skin color, anxiety, and depression.

Multicollinearity between the covariates was tested by calculating the variance inflation factor using the "subsetByVIF" command in Stata software version 15.0, considering a maximum cutoff point of 10 (VIF < 10) [34].

Univariate and multivariate analyses were performed using logistic regression and are presented as odds ratios (OR) and their respective 95% confidence intervals (95%CI). Initially, WFH and sleep quality were evaluated separately, and then, to verify if there is a joint relationship between WFH and poor sleep quality on PI during leisure, a joint interaction analysis was conducted. Additive interaction evaluated two dichotomous exposures, that is, the effect of one risk factor on the outcome of another risk factor [35]. The effect of the two factors does not start from a multiplicative null but from an additive null [36]. A significance level of 5% was used for all analyses.

Figure 1. Directed acyclic graph (DAG) on work-from-home, sleep, and leisure-time physical inactivity (PI) in adults during the Covid-19 pandemic.

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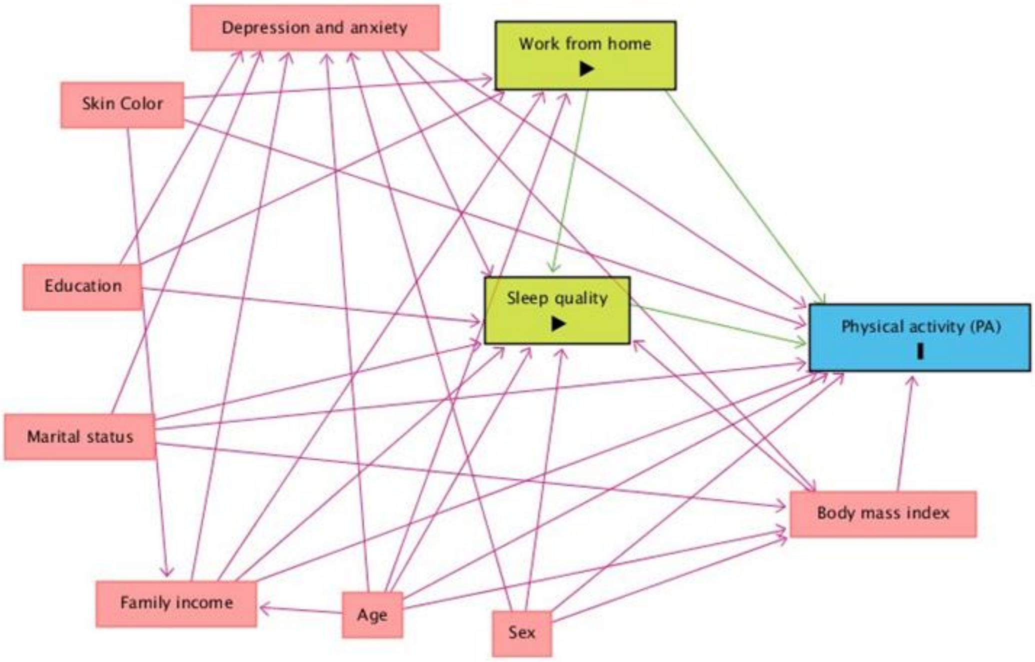

Note: The variables in green and with the symbol "►" inside the rectangle are explanatory; the blue variable and with the letter "I" inside the rectangle is the outcome variable; the variables in red are the antecedents of the outcome and exposure variables.

2.7 Ethical considerations

This project was approved by the Research Ethics Committee of the Federal University of Minas Gerais (Protocol No. 4.135.077). All procedures adopted in this study followed the recommendations of the Declaration of Helsinki and Brazilian guidelines and standards for research involving human subjects.

3. Results

The study evaluated 1,750 individuals, mostly females (52.4%; 95% CI:40.5-54.8), 35-59 years old (45.8%; 95% CI:41.2-50.5), non-white skin color (73.9%; 95% CI:68.4-78.8), with less than nine years of education (69.1%; 95% CI:64.3-73.6) and whose incomes were below two minimum wages (41.2%; 95% CI:35.6-47.1). PI was observed in 69.1% of participants, 51.9% had poor sleep quality, and 20.2% reported WFH (Figure 2).

Table 1: Univariate regression between physically active and inactive individuals according to demographic characteristics and health conditions, COVID-Inconfidentes, 2020.

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Variable	Total (%)	Physically active (%)	Physically inactive (%)	OR (CI95%)
		30.9 (26.2-35.7)	**69.1 (64.2-73.7)**	
Sociodemographic				
Sex				
Male	49.6 (40.5-54.7)	35.8 (27.0-45.6)	64.2 (54.3-73.0)	1.00
Female	52.4 (45.2-59.4)	26.23 (21.9-31.5)	73.7 (68.4-78.4)	1.56 (0.94-2.58)
Age group				
18-34 years	35.1 (30.7-39.7)	38.1 (27.1-50.5)	61.9 (49.5-72.9)	1.00
35-59 years	45.8 (41.2-50.4)	31.1 (26.0-36.8)	68.9 (63.1-74.0)	1.35 (0.78-2.35)
≥ 60 years	19.1 (15.6-22.9)	16.6 (11.0-24.1)	83.4 (75.8-88.9)	**3.09 (1.47-6.52)**
Race				
White	26.1 (21.2-31.6)	41.4 (31.7-51.9)	58.6 (48.1-68.3)	1.00
Not White	73.9 (68.4-78.8)	27.1 (22.2-32.5)	72.9 (67.5-77.8)	**1.90 (1.13-3.19)**
Marital Status				
Married	52.9 (46.8-58.8)	24.7 (18.0-32.8)	75.3 (67.1-82.0)	1.00
Not-married	47.1 (41.1-53.2)	37.7 (31.4-44.3)	62.3 (55.6-68.5)	**0.54 (0.31-0.92)**
Living status				
Alone	4.7 (3.4-6.5)	31.4 (19.2-46.8)	68.6 (531-80.7)	1.00
Not-alone	95.2 (93.4-96.5)	30.8 (25.8-36.2)	69.2 (637-74.2)	1.02 (0.47-2.25)
Education				
≥ 9 anos	69.1 (64.3-73.6)	37.4 (31.5-43.7)	62.6 (56.3-68.4)	1.00
< 9 anos	30.0 (26.4-35.7)	15.9 (10.7-23.1)	84.1 (76.9-89.3)	**3.16 (1.80-5.52)**
Family Income				
≤ 2MW	41.2 (35.6-47.0)	24.3 (18.5-31.2)	75.7 (68.7-81.4)	1.00
>2 a ≤ 4 MW	31.3 (26.3-36.9)	29.9 (22.0-39.2)	70.1 (60.7-77.9)	0.75 (0.41-1.35)
>4MW	27.4 (22.3-33.1)	42.8 (32.7-53.4)	57.2 (46.5-67.2)	0.43 (0.26-0.68)
Health conditions				
Chronic diseases[b]				
No	46.9 (40.4-53.5)	33.2 (24.6-43.1)	66.8 (56.8-75.4)	1.00
Yes	53.1 (46.4-59.5)	29.4 (23.4-36.4)	70.6 (63.7-73.7)	1.19 (0.69-2.05)
Nutritional status				
Eutrofic	43.5 (36.9-50.2)	40.8 (33.6-48.2)	59.2 (51.7-66.3)	1.00
Overweight	36.9 (29.4-45.1)	26.6 (18.2-37.0)	73.4 (62.9-81.7)	**1.90 (1.05-3.42)**
Obesity	19.6 (16.2-23.3)	24.9 (18.4-32.6)	75.1 (67.3-81.5)	**2.08 (1.25-3.44)**
Smoker				
No	85.0 (80.7-88.5)	29.7 (24.8-35.1)	70.3 (64.8-75.1)	1.00
Yes	15.0 (11.4-19.2)	37.1 (23.1-53.4)	62.9 (46.5-76.8)	0.71 (0.34-1.51)
Alcohol				
No	41.2 (35.4-47.1)	26.5 (21.2-32.5)	73.5 (67.4-78.7)	1.00
Yes	58.8 (52.8-64.5)	33.9 (26.6-42.0)	66.1 (57.9-73.4)	0.70 (0.43-1.12)

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Depressão				
No	84.4 980.9-87.3)	30.9 (25.8-36.4)	69.1 (63.6-74.1)	1.00
Yes	15.6 (12.7-19.0)	30.4 (18.8-45.1)	69.6 (54.8-81.1)	1.02 (0.50-2.05)
Ansiedadde				
No	76.8 (72.7-80.5)	31.4 (26.7-36.4)	68.6 (63.6-73.3)	1.00
Yes	23.2 (19.5-27.3)	29.0 (20.0-39.9)	71.0 (60.1-79.9)	1.11 (0.68-1.83)
Sleep				
Good Quality	48.1 (44.1-52.2)	35.0 (28.1-42.5)	65.0 (57.5-71.8)	1.00
Poor Quality	51.9 (47.8-55.9)	26.9 (21.2-33.5)	73.1 (66.5-78.9)	1.47 (0.94-2.29)
Work routine during social restriction				
Work from home	20.2 (16.7-24.8)	45.5 (36.5-54.5)	54.5 (45.2-63.5)	1.00
Not working from home	79.8 (75.2-83.7)	27.1 (22.2-32.6)	72.9 (67.4-77.8)	**2.24 (1.41-3.58)**

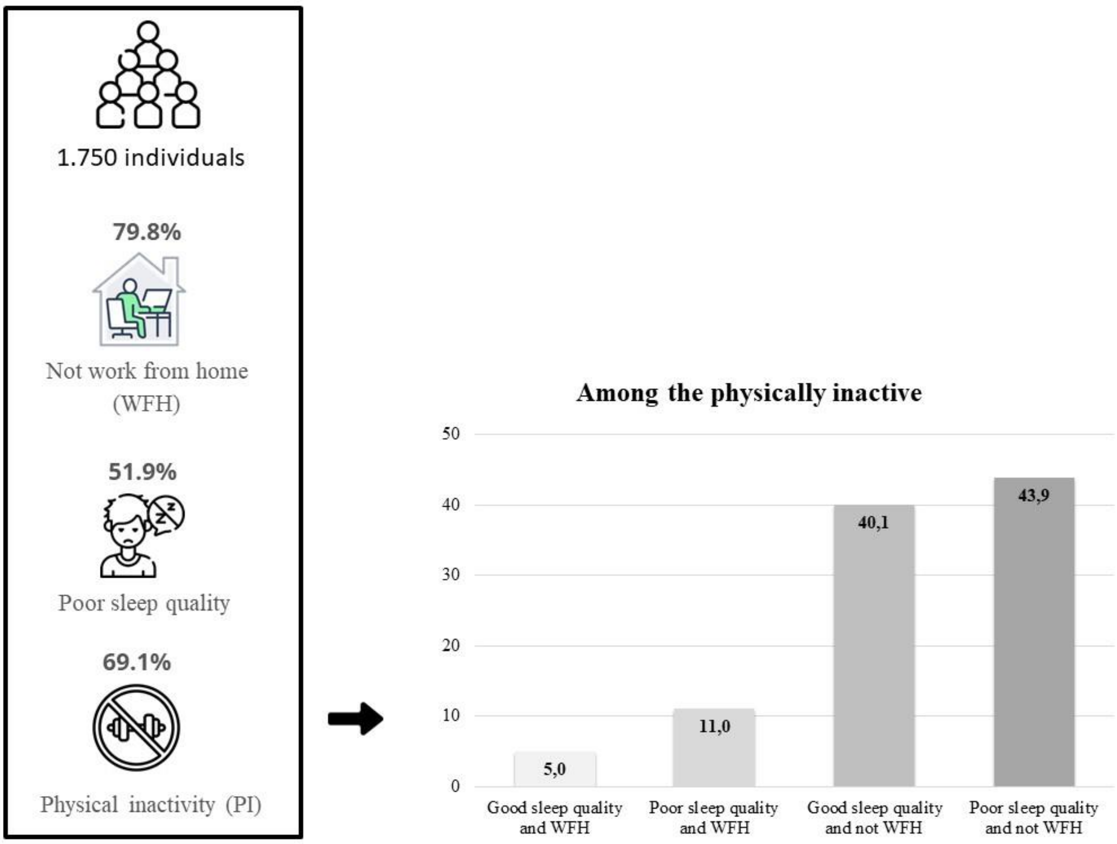
Differences (active physically and inactive physically) were assessed using univariate regression.

Odds ratios (OR)

Confidence intervals 95% (95%CI)

N= 1.750.

Figure 2. Prevalence of Physical Inactivity, Work Routine during Social Restriction and Sleep. COVID-Inconfidentes.



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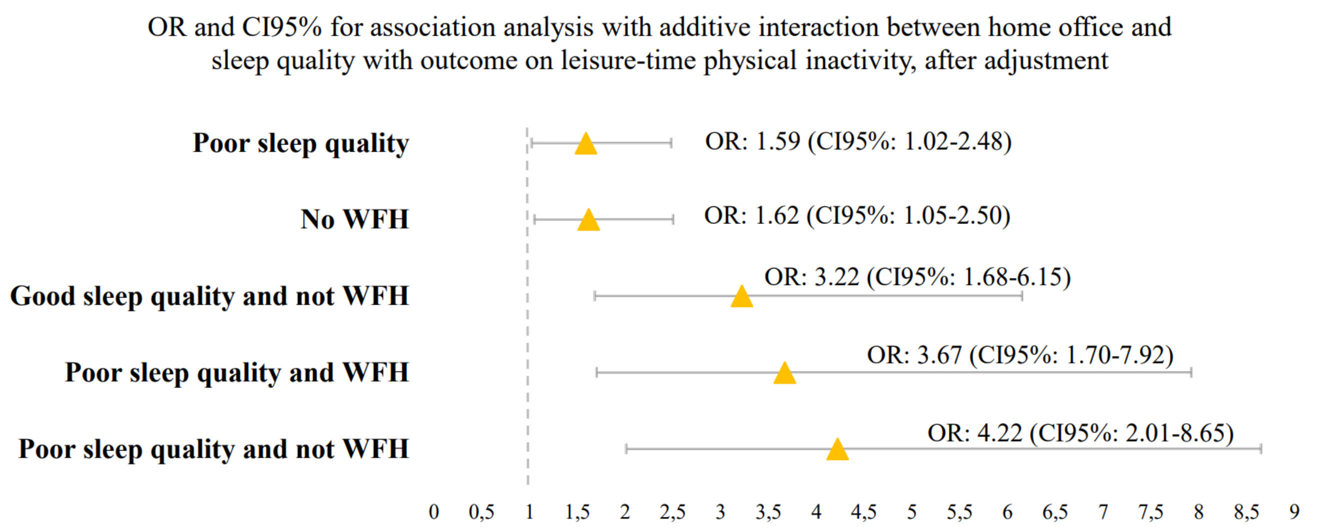
When we evaluated the association between sleep quality and PI at leisure, it was found that participants who exhibited poor sleep quality had an increased chance of PI at leisure (OR:1.59:95%CI:1.02-2.48). Furthermore, individuals who did not report WFH reported increased PI at leisure (OR:1.62,95%CI:1.05-2.50). A joint analysis was performed between the two factors (sleep quality and WFH). Individuals with poor sleep quality who did not WFH were 4.22 times more likely to have PI at leisure (OR=4.22;95%CI:2.05-8.65) (Figure 3).

Figure 3: Multivariate logistic regression between sleep, work from home, and leisure-time physical inactivity during the Covid-19 pandemic. Collected in two Brazilian municipalities during the period October-December 2020. COVID-Inconfidentes, 2020.



Legend: Directed acyclic graph (DAG) was used to support the theoretical model for the multivariate analysis. Multivariate regression adjusted according to a directed acyclic graph, according to a minimum and sufficient set of variables: sex, age, income, body mass index (BMI), marital status, skin color, anxiety, and depression. Joint analysis between the occurrence of two factors (sleep and work routine during social) associated with physical inactivity during leisure time.

4. Discussion

To the best of our knowledge, this is the first study to investigate the joint association between sleep and WFH on PI during social restriction caused by the Covid-19 pandemic. The results showed a high prevalence of PI during the pandemic. Both factors (no WFH and poor sleep quality) were associated with PI and, when combined, further exacerbated the negative scenario for PI.

The high prevalence of PI points to a challenging outlook for policymakers, public officials, researchers, and health professionals, as it is one of the major health problems of the 21st century [3, 37, 38]. In 2019, the WHO documented a warning and encouragement to increase the practice of PA worldwide since the increasing prevalence of PI will impact health systems, generating high costs, in addition to

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reverberating to the environment, economic development, well-being, and quality of life of the community. This document proposes reducing PI by 10% by 2025 and 15% by 2030 (WHO, 2019). In 2016, approximately 68% of global mortality and 74% of deaths in Brazil were attributable to non-communicable diseases (NCDs) [39], with the incidence of most of these diseases sharing modifiable risk factors such as PI [40, 41].

Our results indicate that poor sleep quality is significantly associated with PI, and this finding is in agreement with the scientific literature [42, 43]. Recent studies have shown that lack of sleep promotes daytime sleepiness and increased muscle fatigue and is a negative mediator of PA since it increases perceived fatigue [42]. Sleep interacts with central processing and influences mood disturbances and poor physical function [43-46].

Consistent with the results presented for poor sleep quality and leisure-time PA, better sleep quality and duration are closely associated with a greater amount (minutes) of moderate and vigorous physical activity (MVPA) the next day [43, 44, 47, 48]. Cross-sectional [49, 50] and longitudinal studies [51] have shown that individuals who sleep poorly are less likely to meet PA guidelines [5].

In addition, better sleep quality at night predicts higher PA levels the next day [51]. Tang et al. (2014) observed that nights, when individuals had higher sleep quality, were followed by days of higher PA [43]. According to Baron et al. (2013), exercise during the day was not associated with sleep during the following night, but they showed that sleep influenced exercise the next day (for every 30-minute increase in sleep onset latency above the mean value, there was a one-minute decrease in exercise duration the next day [44]. Furthermore, Van Helder and Radomski (1989) found that sleep deprivation implies a decrease in exercise time to exhaustion since poor sleep promotes metabolic disturbance, with an increase in insulin resistance and a decrease in glucose tolerance, altering the supply of energy substrates to skeletal muscle [52]. Sleep loss affects exercise tolerance, motivation, and mood, while a good night's sleep decreases fatigue and increases physical vigor [53].

During the Covid-19 pandemic, one of the pragmatic measures was to maintain physical distance in places where people congregated, such as workplaces; therefore, performing tasks at home has become an alternative for many companies and employees. An increased prevalence of WFH has been observed in recent studies published during the pandemic period. In a longitudinal study conducted in the US, it was observed that 72% of office workers switched to remote work during social activities [14]. Accordingly, a study conducted in Tokyo found that this same form of work doubled from 13.2% in March 2020 to 27.9% in April 2020 [54]. In a study by Mcdowell et al. (2020) in Iowa City (USA), the authors observed a 54% increase in WFH compared to before the Covid-19 pandemic. Finally, in Sweden, before the pandemic, only 12% of workers reported WFH to a high or very high degree, whereas this proportion increased to 76% during the period of SARS-CoV-2 circulation [55].

The results of the present article point out that not being in WFH increased the risk for PI, but findings like these are still inconclusive. The opposite was observed by Fukishima et al. (2021), in which individuals in the WFH group spent significantly less time in MVPA than those in the no WFH group [54]. Reinforcing such findings, Xiao et al. (2021) reported an overall reduction in PA and exercise, which may have occurred because of restrictions on staying at home [16].

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In the US, scholars have observed no significant changes in PA practices among the observed employment categories (WFH, employment remained unchanged, or lost employment) [56]. In another longitudinal study that sought to understand the impact of the pandemic on lifestyle and well-being among office workers, the authors observed no statistical differences in the PA of remote workers, which remained stable during the social restriction period [14]. Accordingly, Hallman et al. (2021) described no differences in PA practice between WFH and office workdays. We believe that social restriction, as a function of Covid-19, may have led to differentiated conduct among countries. In Brazil, there are no strict restrictions on exposure in open places (such as parks and open-air gyms); therefore, leisure activities can be performed. Therefore, the findings for WFH workers may vary.

We speculate that individuals who were not in the WFH group seemed to suffer restrictions in their work routine, especially the time spent commuting (traffic and/or public transportation), reducing the time available during the day to be physically active. WFH subjects can have greater flexibility in their schedules and time to dedicate to PA practice in their leisure time. Thus, differences in working hours may be decisive in the patterns of adherence to PA practice. Income and education are important social determinants in this triad (WFH, income, and education) since those who work at home have higher education and, consequently, higher income. Therefore, they have more knowledge about the importance of PA for health, and more money to pay for PA professionals and establishments (such as gyms).

The abrupt changes in WFH and other factors associated with the Covid-19 pandemic provide a unique moment to explore the combined relationship between WFH and sleep and how this affects PA practice. We hypothesized that poor sleep quality, in conjunction with no WFH, would exacerbate the negative scenario for PI. Our findings confirm this hypothesis. The non-WFH routine may be related to more time spent at work (either by commuting in public transport or traffic, or even longer on the workday) [57] at the cost of impacting other behaviors, such as reduced sleep time and leisure activities. In addition, traffic and the workplace can present themselves as stressors, negatively affecting sleep quality and time. Data published during the period of social restriction indicated longer sleep duration on work-at-home days than on work-in-office days (34 minutes increase) [55]. Conroy et al. (2021) pointed out that not having a morning commute and a more flexible work schedule allows individuals to sleep more consistently with their endogenous circadian sleep phase [57]. Thus, additional hours of sleep have been observed in WFH workers during the Covid-19 pandemic [58-61]. This transition from their previous behavior to WFH can have beneficial implications for the health and well-being of individuals [55, 58].

This research has several strengths: the robust sample methodology with probabilistic selection and sample weight, providing statistical power for the study. The interviews were face-to-face, which allowed for greater accuracy in the information obtained. As limitations, the measures were obtained through self-report and thus are subject to the common problems of recall bias, potentially underestimating risky behaviors or overestimating protective behaviors. Despite the incorporation of the counterfactual graphical approach that brings robustness to the study [62], the authors recognize the bi-directionality of the association, a consequence of the cross-sectional design, and, therefore, a limitation of the study. It is important to highlight that PA practice suffers from the complex action of individual, social, environmental, and political factors and has complex relationships [63]. However, it is important to note that the hypotheses have been carefully defined according to the current scientific literature and articulated in counterfactual terms to build theories that can underpin the driving assumptions of the analyses.

5. Conclusions

These findings make important contributions to the literature. From a public health perspective, incentives for a more physically active society are essential, and local, regional, national, and global public policies for health promotion are necessary. For changes in this behavior, efforts and foundations are relevant to raising awareness in society, providing knowledge and understanding about the benefits, influences, and impacts of PA on health, as well as its effect on the treatment and prevention of various diseases [64]. An active lifestyle is a basic human right and should be incorporated into public policy so that everyone has access, regardless of community, race, or purchasing power. Furthermore, the data provide the support that sleep, and not being in WFH, is significantly associated with PI during social restriction. A greater understanding of the daily relationships between WFH and sleep-impacting leisure-time PA may improve the effectiveness of future behavioral interventions.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets generated and/or analyzed as part of the current study are not publicly available due to confidentiality agreements with subjects. However, they can be made available solely for review and not for publication by the corresponding author upon reasonable request.

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