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Sleep duration and fatigue in construction workers: A preliminary study

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Abstract: The construction industry is known for its high rate of accidents. Among the different possible causes of this situation, we could find lack of sleep and fatigue. Chronic sleep deprivation is a determining factor in the deterioration of vigilance and alert, and consequently a risk factor for occupational accidents. Fatigue is the answer of our organism to sustained physical and mental stress. Regretfully, those topics have been ovelooked in the construction industry. The objective of this study is to understand better these phenomena, such as sleep duration and fatigue, and whether they are interrelated, and to propose strategies to mitigate them and contribute to the reduction of accidents in construction projects. We worked with 154 male construction workers from one Chilean construction company. To assess sleep quality, we used the Pittsburgh Sleep Quality Index (PSQI). To evaluate fatigue, we used a personal computer version of the Psychomotor Vigilance Test (PC-PVT) that measures alertness and vigilance. This 5-minute test was performed on construction workers on-site in the morning. Those people who took part in the test were classified into various groups according to self-reported sleep hours, namely: 7–9 h (26%), 5–7 h (61.7%), and <5 h (12.3%). These results were compared for three variables (Mean Reaction Time (RT), 10% faster, and 10% slower) using an Analysis of Variance (ANOVA) test. Differences were found for Mean RT and Slowest 10%, the difference being greater in the group that reported sleeping <5 h, but without statistical significance. Studies with a greater number of subjects and measurements are required throughout the working day.

Keywords: construction workers, fatigue, sleep duration, vigilance.

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1 Introduction

The construction industry has one of the greatest accident rates worldwide (Escamilla et al. 2016), and an elevated probability of injuries and occupational illnesses (Yuan et al. 2018). In Chile, the construction industry has an accident rate of 3.9%, much higher than the national average of 3.1%, considering 38 casualties due to work-related accidents in 2018 (Superintendencia de Seguridad Social 2018).

Fatigue is recognized as accident causation, being a trigger to human error (Techera et al. 2019). In the construction industry, the impact of fatigue is likely to be more serious, as the construction environment is dynamic and risky (Fang et al. 2015). In fact, risks on construction sites may be heightened due to inclement weather and mobile equipment, as well as changing and demanding schedules requiring additional work hours (Powell and Copping 2010). According to Techera et al. (2019), the most relevant drivers of fatigue are sleep deprivation and work environment factors, such as noise, vibration, and temperature. Sleep deprivation contributes to fatigue, affecting an individual's well-being, work performance, and safety (Powell and Copping 2010). Also, the quality and quantity of a person's sleep have major implications for cognitive performance, motor functioning, mental health, and long-term physical health (Litwiller et al. 2017).

Construction workers are prone to fatigue, since their work is characterized by heavy lifting and awkward work postures, so it is relevant to study it more thoroughly, especially regarding its association with sleep efficiency and quality. Regretfully, those topics have been very poorly studied in the construction industry. To understand better these phenomena and to propose strategies to mitigate them and contribute to the reduction of accidents in construction projects, the objective of this study is to understand if there is a relation between sleep duration and fatigue.

The sections in this article will introduce the work methodology carried out in this project, as well as the theoretical framework supporting the main topics studied. Later, the main results of this study, as well as a discussion and conclusion section, will be presented.

2 Fatigue and psychomotor vigilance test (PVT)

There are various definitions of fatigue in the literature. For example, fatigue can be described as a reduced ability to perform activities at the desired level due to lassitude or exhaustion of mental and/or physical strength (Techera et al. 2019). Also, it can be described as a process where the quality of the daily tasks performed deteriorates, causing loss of precision and efficiency, and where a series of physiological and psychological reactions appear, causing that the person cannot pay attention to the required action (Cajamarca et al. 2018).

Fatigue can have different causes such as sleeping a reduced number of hours and poor quality sleep, and consequences such as difficulties in concentrating or thinking clearly, and risking by falling asleep easily, jeopardizing personal safety or that of others (Cajamarca et al. 2018). In fact, because of physiological degradation, the ability of an individual to work safely and efficiently can be severely compromised by fatigue (Techera et al. 2019). Related to fatigue are two key physiological factors, loss of sleep and disruption of the circadian cycle. In both cases, adequate sleep is the only naturally occurring cure (Powell and Copping 2010). Then, people who suffer from fatigue acquire a sleep deficit that is probably not noticeable in the early stages, attributing this condition to other variables (Cajamarca et al. 2018). The relation among these two factors can be seen in a study that was carried out in people with Chronic Fatigue Syndrome, where the efficiency of sleep, perceived quality of sleep and daily sleep disorders were evaluated, according to the Pittsburgh index, showing as results that 86% presented poor sleep quality (Mariman et al. 2012).

Fatigue can be evaluated using the PVT that measure alertness and vigilance. The reaction time (RT) is measure as an indirect assessment of fatigue (Techera et al. 2018). PVT is considered the only technology with strong evidence of validation by independent researchers, laboratory studies, and field studies, and being considered by most researchers as the eminent method to objectively measure fatigue (Techera et al. 2018).

3 Sleep quality

Currently, the role of sleep has been relegated and the time spent sleeping has been decreasing over the years, as for many the sleep period is seen as a waste of time, even though we know that the consequences of poor sleep quality go beyond simple discomfort, affecting health conditions and life quality (Lira and Custodio 2018). Sleep quality and disorders (e.g, insomnia and sleep apnea) are associated with an increased risk of all-cause mortality, mental health problems, obesity, learning and memory problems, and chronic diseases. Sleep disturbances are also associated with increased risks of workplace accidents and car accidents due to daytime sleepiness as a result of a bad night's sleep (Wendt et al. 2019).

Sleep quality refers not only to the fact of sleeping well at night but also to have an adequate performance the following day. This is important as a determining factor in health and is also a precursor to a good quality of life (Borquez 2011). The literature reports that against stress caused by sleep restriction, an immunological reaction occurs, characterized by an increase in the count of leukocytes, neutrophils, and levels of C-reactive protein in the blood. Some authors argue that a single night of sleep restriction is required to cause this reaction and that 8–10 h of sleep are required to return to normal values (Vilasco et al. 2011). Also, drowsiness is a frequent problem whose prevalence is between 0.3% and 25% of the population (Mayor et al. 2010). The decrease in the number of hours of sleep, the alteration of the circadian rhythm, the use of some medicines, and the poor quality of sleep are some of the causes of drowsiness, and this is related to poor daily functioning, poor quality of life, increased accident rate and low academic performance (Borquez 2011).

To maintain performance and healthy neurobehavioral functioning, the average adult needs at least 7 h of sleep per night, as recommended by different sleep organizations (Goel 2017). The problem is that many people do not sleep so many hours. In fact, 30% of Americans get <6 h of sleep each night and most adults sleep substantially less on work nights than on nonwork nights (Litwiller et al. 2017). Then, chronic sleep loss is a significant public health issue (Goel 2017). Sleep deprivation can result from factors such as lifestyle, stress, poor sleep habits, and sleep disorders such as sleep apnea and restless legs' syndrome, putting both people at higher risk of accidents (Powell and Copping 2010).

To understand better the situation of people regarding sleep quality we can apply different psychometric instruments, such as the Pittsburgh Sleep Quality Index (PSQI). The PSQI is an instrument that measures the quality of sleep and its alterations based on references from the last 30 days. It is a standardized instrument used in the detection and evaluation of sleep problems developed by Buysse, Reynolds, Monk, Berman, and Kupfer in 1989 in the United States, with the objective of evaluating the quality of sleep and its clinical alterations. It has questions that are organized into seven aspects such as subjective sleep quality, latency, duration, efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction (Luna et al. 2015).

4 Research methodology

An observational, cross-sectional relational study was carried out in May 2019 whose population corresponded to workers in five construction sites of a company in Santiago, Chile (*N* = 1,700). A random sampling was performed, reaching a sample size of 154 subjects. To be included in the study the workers must have been in the company for >1 month and have at least 1 year of work experience in the field. The exclusion criteria include the following: a) have had a surgical intervention that required general anesthesia in the last 3 months b) have a life expectancy of <3 months, c) have an addiction to illegal drugs and/or alcohol; d) people who work shift systems (since it alters wakeful sleep cycles), e) people with living conditions that prevent them from sleeping through the night (for example, having dependent people in their care) and f) people with psychiatric disorders (except depression).

The research team visited each one of the construction projects to interview the workers. In each visit the following information was gathered:

- Sociodemographic information such as sex, occupation, schooling, and marital status, that were asked through a questionnaire designed for the study.
- Quality and quantity of sleep. This was evaluated through the application of the PSQI through an interview. Here, the score ranges from 0 to 21. A score >5 is rated as a poor sleeper.
- Fatigue level. To measure this variable, we used a personal computer version of the psychomotor vigilance test (PC-PVT) that indicates the reaction levels that are homologated to the fatigue level.
- Daytime sleepiness. To analyze this variable, the Epworth Sleepiness Scale was applied. The range of the score is from 0 to 24. Less than 6 points is considered normal, from 7 to 8 points it is considered moderate sleepiness, and >9 points it indicates excessive sleepiness. It was evaluated through an interview.

5 Results

The sample included 154 male construction workers. The age of the participants fluctuated between 20 years and 72 years with an average of 44.17 years. 37% declared unmarried, while 53.2% were married or living together, and most of the participants have children (78.6%). Regarding the years of study, the average number of years was 10.47. Concerning nationality, 82.5% declare themselves Chilean, followed by 8.4% of Peruvian workers, 3.9% of Haitians, and 3.2% of Colombians. The rest is divided between Argentines, Ecuadorians, and Venezuelans (Table 1).

Most construction workers declare that their perception of health is good (51.9%), 22.7% say they have very good or excellent health, while 25.4% consider that their health is fair or poor. 80.5% declare themselves satisfied or very satisfied with their life, while 18.8% declare that they are not very satisfied or dissatisfied. 50.6% do little or no physical activity, while only 18.2% do not declare themselves sedentary (Table 1). In relation to comorbidity, the declared condition more prevalent in the sample is hypertension (13.0%) followed by diabetes (5.8%) and diseases of the musculoskeletal system (3.2%). There were no cases of stroke, arrhythmia, or heart failure. It is highlighted that 60.2% of the sample is overweight or obese and 36.4% have a high cardiovascular risk (CVR) (Table 1).

Regarding sleep-related events, 24.7% of the interviewed construction workers sleep the average hours, that is, between 7 h and 8 h, while 74% sleep <7 h. The most prevalent condition is the presence of snoring (56.5%), followed by fatigue (44.8%), excessive sleepiness (42.9%), and drowning (40.3%), as shown in Table 2. In addition, 42.9% of the sample reported excessive sleepiness according to the Epworth scale (Table 2), which is consistent with the direct self-report of sleepiness (43.5%), while 39.6% did not present sleepiness. Also, there is a significant correlation between Epworth and Pittsburgh, of a direct type, since the higher the score in Epworth, the higher the score in Pittsburgh. This means that the lower the quality of sleep, the more daytime sleepiness (Table 3).

Tab. 1: Sociodemographic and health characteristics of the sample

N	154
Men	**100%**
Age	
Average	44.17 (SD: 12.72)
<35	45 (29.2%)
35–45	29 (18.8%)
>45	80 (51.9%)
Schooling	
Average years	10.47 (SD: 3.31)
Nationality	
Chilean	82.50%
Peruvian	8.4%
Haitian	3.90%
Colombian	3.2%
Other	2.0%
Marital status	
Married	35.7%
Single	37.0%
Cohabiting	17.5%
Other	9.6%
Perception of health	
Excellent – very good	22.7%
Good	51.9%
Regular – bad	25.4%
Satisfaction with life	
Very satisfied-satisfied	80.5%
Little satisfied	14.9%
Dissatisfied	4.6%
Exercise	
Not done	50.6%
≥3 times a week	18.2%
Comorbidity	
Arterial hypertension	13.0%
Diabetes	5.8%
Acute myocardial infarction	1.3%
Locomotor system	3.2%
Respiratory	0.6%
Neurological	0.6%
Mental health	0.6%
Obesity (BMI > 30)	32.7% (range 30.05–40.82)
Overweight (BMI 25–29.9)	27.5% (range 25.12–29.83)
Moderate CVR (waist circumference >94)	28.6% (range 95–101.5)
High CVR (waist circumference >102)	36.4% (range 102–126)

BMI, body mass index; CVR, cardiovascular risk; SD, standard deviation.

Tab. 2: Features related to sleep events

N	154
Sleep hours	
<7 h	74.0%
7–8 h	24.7%
>8 h	1.3%
Events during sleep	
Snore	56.5%
Drown	40.3%
Daytime conditions	
Fatigue	44.8%
Sleepiness Epworth Scale	
Lower or null (1–6 points)	39.6%
Moderate sleepiness (7–8 points)	14.9%
Excessive sleepiness (9–24 points)	42.9%

Tab. 3: Results of drowsiness, sleep quality and reaction (fatigue) according to type of instrument

Test	*N*	Minimum	Maximum	Average	SD
PITTSBURGH	154	1.00	19.00	7.01	3.19
EPWORTH	154	1.00	21.00	8.20	4.54
PVTMEAN	154	218.94	921.23	304.97	72.74
PVTMEDIAN	154	205.00	640.00	279.91	48.67

PVT, psychomotor vigilance test; SD, standard deviation.

Regarding 44.8% of the workers who declared fatigue, there is no evidence of a relationship between hours of sleep with fatigue (t = 1.618; P = 0.108), this means that the presence of fatigue is distributed equally among those people who sleep <7 h, between 7 h and 8 h and >8 h, that is, the hours asleep versus the presence or not of fatigue are independent (Table 4).

When analyzing the quality of sleep according to Pittsburgh, only 23.4% of the sample presented a good sleep (<5 Pittsburgh) (Table 5). 76.6% report some degree of difficulty sleeping. Of these, 37.7% (5–7 Pittsburgh) could present more than some unsuitable conditions for quality sleep, that is, snoring, getting up to the bathroom at night, nightmares, pain, among other conditions that occur less than once a week for the last month. Similarly, another 37.7% could present these conditions one or more times a week.

When analyzing the performance parameters in the psychomotor surveillance test (PC-PVT), a significant association between the age group of 20–29 years was observed with a better performance in the PC-PVT in all the compared parameters (Mean RT, Fastest10%, and Slowest10%) (see Table 6). Likewise, it is observed that workers with higher educational levels have better performance of the PC-PVT in all the parameters, as shown in Table 7. When analyzing the relationship of this test with marital status, a statistically significant difference is evidenced, with a worse performance of the married versus the other marital status (see Table 8).

Regarding the number of hours of sleep, a better performance in the test was observed in the group that reported sleeping between 5 h and 7 h per day on average, although it reached statistical significance only in the Fastest10% (results of the 90th fastest percentile) (see Table 9).

6 Discussion

About the characteristics of the sample, regarding age, the average was like a study carried out on Chilean workers (Salinas et al. 2014). The similarity between the average ages for this study and by Salinas et al. (2014) may be because both types of research are from the same country, so they may have similar compositions of their workforce. Regarding the age configuration of the sample, differences are found with other studies. For example, in a Spanish study carried out in 177 construction workers, 35% were between 35 years and 45 years old, 40% were under 35 years old and the remaining 25% were over 45 years old (Garzón et al. 2013), a situation that differs from this study. This difference may be because in the Spanish research it was controlled that the sample was made up of workers with different degrees of experience, which may have affected its natural configuration.

Tab. 4: Relationship between hours of sleep and declared fatigue

	Fatigue	*N*	Mean	SD	
Hours of sleep	Yes	69	5.72	1.24	$t = 1.618$
	No	85	6.04	1.19	$P = 0.108$

SD, standard deviation.

Tab. 5: Sleep quality according to Pittsburgh

Pittsburgh		Frequency	Percentage	Valid percentage	Accumulated percentage
Valid	<5	36	23.4	23.4	23.4
	5–7	58	37.7	37.7	61.0
	8–14	58	37.7	37.7	98.7
	>15	2	1.3	1.3	100.0
	Total	154	100.0	100.0	

Tab. 6: Comparative results of performance parameters in PC-PVT according to Age Group (ANOVA)

Parameters	20–29 years *N* = 29	30–39 years *N* = 24	40–49 years *N* = 41	50–59 years *N* = 40	60–75 years *N* = 18	*P*-value
	Average (±SD)	Average (±SD)	Average (±SD)	Average (±SD)	Average (±SD)	
Mean RT	274.54 (26.21)	290.32 (35.32)	320.72 (119.01)	305.41 (37.76)	341.88 (63.24)	0.010
Fastest10%	208.86 (16.73)	212.27 (17.09)	226.93 (38.56)	223.04 (22.60)	241.94 (27.03)	0.000
Slowest10%	402.70 (52.26)	488.44 (171.65)	554.51 (328.58)	529.89 (178.05)	669.57 (290.51)	0.000

PC-PVT, personal computer version of the Psychomotor Vigilance Test; RT, reaction time; SD, standard deviation.

Tab. 7: Performance results in the parameters of the PC-PVT according to Educational Level

Parameters	Low (<8 years) *N* = 44	Medium (8–12 years) *N* = 85	High (>12 years) *N* = 25	*P*-value
	Average (±SD)	Average (±SD)	Average (±SD)	
Mean RT	327.99 (74.67)	301.14 (77.92)	277.50 (26.01)	0.020
Fastest10%	236.44 (37.73)	217.98 (21.24)	208.93 (18.67)	0.000
Slowest10%	599.10 (284.63)	505.42 (229.81)	431.83 (104.96)	0.010

PC-PVT, personal computer version of the Psychomotor Vigilance Test; RT, reaction time; SD, standard deviation.

Tab. 8: Performance results in the parameters of the PC-PVT according to Civil Status

Parameters	Single *N* = 57	Cohabiting *N* = 27	Married *N* = 55	Separated *N* = 13	
	Average (±SD)	Average (±SD)	Average (±SD)	Average (±SD)	*P*-value
Mean RT	299.23 (56.86)	284.09 (38.04)	326.01 (99.86)	283.72 (23.28)	0.040
Fastest10%	218.46 (29.04)	215.34 (22.70)	230.03 (31.21)	213.87 (13.78)	0.050
Slowest10%	491.06 (200.88)	449.30 (131.03)	604.33 (310.17)	443.38 (89.12)	0.010

PC-PVT, personal computer version of the Psychomotor Vigilance Test; RT, reaction time; SD, standard deviation.

Tab. 9: PC-PVT performance results according to self-reported sleep hours

Parameters	<5 h *N* = 52	5–7 h *N* = 84	7–9 h *N* = 18	*P*-value
	Average (±SD)	Average (±SD)	Average (±SD)	
Mean RT	314.63 (103.57)	294.23 (35.42)	327.19 (89.03)	0.110
Fastest10%	222.32 (29.31)	217.44 (19.71)	240.56 (47.43)	0.010
Slowest10%	544.40 (305.96)	499.33 (164.38)	548.02 (304.27)	0.490

PC-PVT, personal computer version of the Psychomotor Vigilance Test; RT, reaction time; SD, standard deviation.

Regarding clinical parameters, the average body mass index (BMI) is similar, and the waist circumference is lower than the study of Chilean workers in Salinas et al. (2014). Compared to the general Chilean population, the proportion of overweight workers is lower and the proportion of obese is similar. Regarding physical activity, the people in the present research reported doing more physical activity than that reported by the workers in Salinas et al. (2014) and that the general Chilean population (Garzón et al. 2013; Departamento de Epidemiologia, Division de Planificación Sanitaria 2017). Regarding the proportion of workers with moderate and high CVR, this is higher than that presented by the Chilean general population (Departamento de Epidemiologia, Division de Planificación Sanitaria 2017). Regarding the suspicion of hypertension, risk of diabetes, and risk of myocardial infarction, the prevalence of workers are lower than the figures found in the Chilean population in the National Health Survey of 2017 (Departamento de Epidemiologia, Division de Planificación Sanitaria 2017). Probably these better figures are explained because the sample is made up of people who are working in a job and therefore in health conditions that allow them to do it.

Although workers present a lower proportion of chronic pathologies than the general population, they present a higher proportion of CVR, a situation that warns of the need to support them to prevent them from finally falling ill. This idea is reinforced with the findings of Yuan et al. (2018) showing that the most direct and relevant method to improve the efficiency and productivity of construction workers is through the promotion of physical and mental health, above others factors such as the social capital and social network of these people. These authors suggest that a frequent physical examination and a reasonable schedule and time of rest should be carried out to contribute to improving health and work efficiency and productivity.

Regarding sleep hours, 74% of workers sleep <7 h, similar to that reported by Meza (2019) where on average heavy machinery drivers sleep 6:41 h. However, these results differ from the study by Huauya (2019) carried out on construction workers in Peru, where 86% of the participants sleep between 7 h and 9 h. The situation of Chilean workers is worrying since Powell and Copping (2010) shows that those who sleep <8 h have an 8.9% increased risk of accidents, as well as daytime fatigue, psychomotor impairment, deterioration of physical and psychological health, and poor academic or work performance (Merino-Andréu et al. 2016). In relation to sleepiness measured with Epworth, the average scores achieved by the workers were slightly lower, that is, with less perception of sleepiness, than those reported by Pedrozo-Pupo and Córdoba (2020), who evaluated the general population in Colombia.

Regarding perceived sleepiness, in the study by Meza (2019), 59.28% of workers with a day shift during working hours similar to that of Chilean workers, indicate that at least once a week they present drowsy conditions while doing their jobs. For the present study, 14.9% indicated moderate sleepiness and 42.9% excessive, proportions similar to those found by Meza (2019). The high proportion of sleepiness that workers present evidence a greater probability of suffering some adverse event both in their work activities and in their daily life.

Regarding the quality of sleep evaluated by Pittsburgh, the study by Barón (2019) reports that 61% of workers in manufacturing companies present sleep problems with a score >5, a figure lower than the findings of this study where a 76.6% report some degree of sleep problems. Workers with Pittsburgh >5 have a 1.78 times more risk of occupational injuries compared to those with a rank <5 (Uehli et al. 2014).

Another important risk factor is fatigue since it is considered to have a negative effect on the performance of workers in relation to safety (Fang et al. 2015). In the present study, 44.8% of the workers felt fatigued when carrying out their daily activities and 42.9% declared excessive sleepiness. These results are superior to that of Huauya (2019) where only 22% report high levels of fatigue and to the study by Wendt et al. (2019) that showed that around 12% present daytime fatigue. However, this same study indicates that sleep disorders and fatigue during the day were greater among Brazilian adults with a lower educational level, which can be explained by the fact that more schooling is associated with higher income and greater awareness of the importance of sleep. Observing the results obtained in the psychomotor surveillance test (PC-PVT), it is observed that the higher the Educational Level, the better performance is achieved in all the parameters (Mean RT, Fastest10%, and Slowest10%), which coincides with that indicated by Wendt et al. (2019).

Putri et al. (2019) report that 82.7% of the workers in his study have mild fatigue and 14.6% moderate fatigue, higher values than those reported in the present study (44.8%). This could be explained by the poor quality of sleep presented by the sample (80%) (Putri et al. 2019). Also, a categorization of the perception of fatigue self-report was not performed in the present study.

Although it seems that there is a relationship between sleep duration and fatigue, this study is not conclusive to report this relationship, given that 44.8% of workers who declared fatigue did not have significant differences regarding the number of hours asleep when compared between groups sleeping <7 h, between 7 h and 8 h or >8 h. To conclude if there is a relationship, more studies are required to delve into fatigue, its forms of measurement, and the differentiation that must exist between the concepts of fatigue and sleepiness, an aspect that differs from each other, but for the general population it is usually the same, that is to say, they are confused. Thus, a sleepy person does not necessarily have fatigue, but a fatigued person may be sleepy. Sleepiness usually stems from poor sleep quality.

7 Conclusion

This study sought to describe sleep quality in construction workers, finding that less than a quarter of the sample (23.4%) presented good sleep quality (Pittsburgh <5) and two-thirds sleep <7 h. Regarding sleepiness, about half of the workers reported excessive sleepiness according to the Epworth scale, however, its relationship with hours of sleep was not evident. In this regard, studies are required that deepen the way of measuring sleepiness and the understanding of the difference between sleepiness and fatigue by the people evaluated. People between 20 years and 29 years of age, with a higher educational level and who slept between 5 h and 7 h, presented the best performance in psychomotor surveillance evaluated by the PC-PVT test, which is the objective means of evaluating fatigue.

The sample consisted of workers whose ages were like those of other construction workers in the same country. Even though most of them had a positive perception of their health, they presented different chronic health problems that affect their life quality and their performance at work, especially concerning overweight, obesity, and CVR. Although this is representative of what is happening in the country, given the great physical effort that working in construction means, these conditions must be faced in a structured way, ideally from the construction company itself, as a benefit for its workers. Any intervention and education that can be done regarding health issues will finally impact not only on the life quality of workers but also on their motivation and job performance. To better understand the situation experienced in construction projects, more in-depth studies are required to better assess the health status of workers.

Construction companies must be aware of the importance that sleep quality has in their workers, both personally and at work. In the latter case, the impact on safety and the accident rate has been widely demonstrated, making it relevant to carry out programs that educate workers on these issues to change their behavior. Given the above, in the next stages of this research, interventions will be carried out with workers to provide them with tools to improve their sleep quality, and then evaluate their impact on their fatigue levels.

It could be considered as a limitation of this study, that although the workers who participated worked in different construction projects, all were from the same company. Regarding the measurement of fatigue in the present study, it was always carried out first thing in the morning, which could have influenced performance. To have a better understanding of the phenomenon and have more information to compare the perception of fatigue and daytime sleepiness of workers, it is necessary to make more measurements with the PC-PVT at different times during the workday, to evaluate the performance of each individual throughout the day.

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