

CrossRef DOI of original article:

1 The Influence of Sleep Quality on Chronic Pain

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3 *Received: 1 January 1970 Accepted: 1 January 1970 Published: 1 January 1970*

4

5 **Abstract**

6

7 **Index terms—**

8 **1 INTRODUCTION**

9 Sleep is an essential physiological process that performs the maintenance of several mechanisms inherent to human
10 homeostasis, playing an active role in both cognition and health 1,2 .

11 Sleep is typified in humans by 5 stages that are differentiated by the presence or absence of rapid eye movements
12 (rapid eye movement: REM; no rapid eye movement: N-REM), in addition to various physiological variables,
13 such as the cardiorespiratory pattern and muscle tone.

14 Reactivity to auditory, visual, tactile and painful stimuli is reduced or abolished in relation to vigil, particularly
15 in deep sleep phases. A predictable sleep cycle is about 90 minutes, which traces the variation between the 4
16 stages from N-REM sleep to REM sleep 3 .

17 The ideal average sleep time is 7 to 8 hours per night, however, the structure of sleep varies between individuals
18 and their age therefore, a healthy sleep is one that has quality and quantity determined to maintain a state of
19 wakefulness during the day 4 .

20 The capability of the individual to adjust his/her sleep and wakefulness cycle is oriented by several external
21 elements such as luminosity, temperature, sounds, as well as by the neurochemical bio-rhythm that comes with
22 the circadian variations, with specific changes in body temperature and in the secretion of several hormones and
23 neurotransmitters, related to different stages of sleep and wakefulness 3 .

24 The supraoptic nucleus receives light impulses from the optic nerve stimulating the pineal gland to secrete
25 melatonin, an essential neuro-hormone in the chronobiology of the sleep-wake cycle, having its peak in the first
26 hours of the night and hence considered as one of the "gates" for entering sleep, thus, if the individual forces
27 the London Journal of Medical and Health Research state of wakefulness fighting against sleep he/she loses the
28 propitious moment to enter the state of sleep 3 .

29 A range of evidences suggests that sleep, or the lack of it, may interfere with certain brain functions such
30 as learning, memory and the regulation of endocrine and autonomic secretion According to the World Health
31 Organisation (WHO), four out of ten people do not get good quality sleep, and sensitivity to pain can be
32 modulated by the quality and quantity of sleeping hours 5,6 .

33 According to IASP 7 (International Association for the Study of Pain) pain is defined as: "an unpleasant
34 sensory and emotional experience associated, or similar to that associated, with a real or potential tissue injury",
35 being also considered a subjective experience, influenced in various degrees by biological, psychological and social
36 factors. The IASP recommends chronic pain as that one lasting more than six months, of continuous or recurrent
37 condition (three episodes in three months).

38 Due to its long duration, chronic pain becomes no longer a warning sign, losing the ability to maintain
39 homeostasis, leading to suffering and functional impairment, which progressively incapacitates the individual
40 generating socioeconomic costs. More than one third of the Brazilian population deems that chronic pain
41 compromises the usual activities and more than three quarters consider that chronic pain is limiting for
42 recreational activities, social and family relationships 8 .

43 The WHO estimates that an average of 30% of the global population suffers with chronic pain. In Brazil, this
44 is equivalent to 60 million Brazilians.

45 Around 50% of those affected by the problem face routine impairment, such as absence and inability to
46 work or even to perform the simplest tasks, estimates the Brazilian Society for the Study of Pain (SBED). Not
47 surprisingly, 75% to 80% of medical attention in public services are motivated by complaints of pain, according

7 SLEEPING DATA

48 to international epidemiological data, informs the Ministry of Health. 9 The biopsychosocial approach claims
49 that the experience of pain is determined by the interaction between biological factors including nerve pathways
50 as well as biochemical processes, psychological factors covering emotions, thoughts, beliefs, expectations and
51 attributions, and finally, social factors ranging from interpersonal interactions and sociocultural expectations 10
52 .

53 Therefore, the aims of this study were to investigate whether there is a relationship between the quality of
54 sleep and chronic pain, specifically to identify factors that may commonly impair sleep and pain concomitantly.

55 2 II. METHODS

56 3 III. RESULTS

57 4 General data

58 The research resulted in 101 responses given to the form, however, 59 participants were excluded, 07 of these
59 did not present pain, 34 did not London Journal of Medical and Health Research answer any question related to
60 sleep and 18 in which the pain does not fit chronic pain, which would compromise the objectives of this study.
61 Thus, 42 participants composed the present results, being 27 women (64.29%) and 15 men (35.71%).

62 The mean age of the participants was 34.25 years (± 11.30). The high standard deviation is explained by the
63 great discrepancy of age, in which the study counted on volunteers from 19 to 68 years old.

64 The mean age of women was 34.25 years (± 11.30) and men 34.77 years (± 11.30).

65 Physical activity was practiced by 57.14% of the volunteers (n=24), 41.66% of whom were female (n=10) and
66 58.33% male (n=14), and 42.86% (n=18) did not practice any type of physical activity, of whom 94.44% (n=17)
67 were female and 5.55% (n=1) male.

68 Among the volunteers who practiced physical activity, three groups were defined, where group "A" defined
69 muscle strengthening, representing 37.5% of participants (n=9), group "B" for those who practiced only aerobic
70 activity, represented by 16.66% (n=4) of volunteers and group "C" for individuals who practiced both modalities
71 of group A and B, consisting in this group 45.83% (n=11).

72 In terms of frequency of physical activity, it was diverse, from 2 to 6 times a week, with the following results:
73 2x=12.5% (n=3), 3x=29.16% (n=7), 4x =12.5% (n=3), 5x= 33.33% (n=8) and 6x = 12.5% (n=3).

74 The preferred times for training were divided into morning with 29.16% (n = 7), afternoon with 16.66% (n =
75 4), night with 45.83% (n = 11), and 8.33% (n = 2) of the volunteers trains at various times according to their
76 availability.

77 It is noteworthy that none of the volunteers worked at night and slept during the day.

78 5 Pain Data

79 Regarding the characteristics of pain, the classification from 0 to 10 was adopted as a method to assess the
80 intensity, and it was found that the mean pain level of the participants was 4.70 (± 2.09). The distribution in
81 the respective levels of pain can be observed in table 1 below. Caption: Left column represents the number
82 of pain reference according to the numeric pain scale (0 to 10), the middle column represents the number of
83 participants corresponding to the intensity of pain classification, and the right column represents the percentage
84 of participants in each level of pain intensity. Source: The author herself.

85 By using the classification of pain as weak (levels 1 to 3), moderate (levels 4 to 6), strong (levels 7 to 9) and
86 unbearable (level 10), the following results in the level of pain of the volunteers were obtained: weak 33 Regarding
87 the use of these substances, 52.38% (n = 22) make use of some type, such as chocolate, tea, ginseng, cinnamon,
88 energy drink and coffee, the latter being used by 90.90% (n=20) of those who use stimulants, and 47.61% (n=20)
89 do not use this class of substances.

90 Further analysis was carried out on the perception of the volunteer on the quality of sleep and the worsening
91 of pain, in which 64.29% (n=27) stated that whenever they slept badly the next day they reported worsening of
92 the pain, or still, that when the intensity of pain was greater during the day, the quality of sleep was worse, and
93 35.71% (n=15) of the participants could not make this correlation.

94 6 IV. RELATION BETWEEN DATA

95 In the analysis of the pain of the individuals associated with the quality of sleep, it can be observed in table
96 3 below, that most of the volunteers refer to good quality sleep, and these fall within the intensity of weak to
97 moderate pain, and as the intensity of pain increases to strong, most refer to poor quality sleep.

98 In the statistical analysis of these data, it was found that the worse the quality of sleep of the individual, the
99 greater the intensity of pain, with a high degree of significance where $p=0$.

100 7 Sleeping Data

101 A survey of the amount of hours of sleep was carried out by the volunteers, the results are presented in table 2
102 below: Very strong 1 (2,38%) ————— 1 (2,38%) —————-Caption: Column on the left refers to the intensity
103 of pain classified as weak, moderate, strong and very strong, followed by the number of volunteers who referred

104 pain in these intensities and subsequently the amount of participants who fit each type of sleep, on a scale from
105 very good to very bad. Source: the author herself.

106 Table 4 below shows the relationship between sleep quality and the of not having rested after the rest period,
107 and the presence of sleepiness during the day and as a result, it can be seen that the worse the quality of sleep,
108 the greater the feeling of not having rested, where $p= 0.03$ and the worse the quality of sleep, the greater
109 sleepiness during the day with $p= 0.007$. Caption: The left column shows the reference of the volunteer regarding
110 his/her quality of sleep, in the middle column the number of volunteers who had the sensation of not having
111 rested during the night and its relation with the level of pain; the right column shows the number of individuals
112 who reported sleepiness during the day. Source: author herself.

113 Another relation analysed was the practice of physical activity, the schedule of practice and pain intensity.
114 Table 5 below shows that the majority of individuals with intense pain do not practice physical activity.

115 The relationship between physical activity and pain presents a statistical analysis with $p<0.001$, proving that
116 sedentary individuals present greater intensities of pain. Caption: Left column shows the level of pain (weak,
117 moderate or strong), middle column shows the number of individuals who do or do not practice physical activity,
118 and in the right column the time of day that these individuals practice physical activity. Source: The author
119 herself

120 8 V. DISCUSSION

121 It is recommended a total sleep time greater than 7 hours for the population in general, since sleep is responsible
122 for regulating the body's homeostasis, being essential for the cognitive and physiological recovery of individuals
123 11,12 . In this study, it was observed that 59.52% (n = 25) of the volunteers slept less than 7 hours per night,
124 not following the recommended amount of hours.

125 Researchers suggest that some lymphokines do promote NREM sleep, such as the tumour necrosis factor alpha
126 (TNF-?) and interleukin-1 (IL-1), which means that these substances can regulate physiological sleep, as well as
127 other molecules from the immune system. The main symptom in individuals with sleeping disorders is excessive
128 daytime sleepiness, and these normally present with elevated interleukin-6 (IL-6) in the blood [13][14][15] . In
129 this scenario, it was found that 76.19% (n=32) of the volunteers in this study reported feeling sleepy during the
130 day. It is worth mentioning that no blood analysis was performed on the volunteers.

131 While healthy sleep facilitates immune functions, impaired quality or quantity of sleep can result in a low-grade
132 inflammatory response, the response as a consequence of sleep deprivation includes increased levels of nitric oxide
133 (NO), prostaglandin E2(PGE2) and IL-6, and possibly mediated by glia cells 16 .

134 Sleep deprivation imparts a low-grade inflammatory response, leading to increased pain sensitivity, as observed
135 in individuals with chronic pain 16 , in which the subjects of this study fit.

136 Nowadays, it is known that the treatment of chronic pain is complex and, in order to be effective, a
137 multidisciplinary approach is required, with physical exercises being a key part of the treatment, since physical
138 activity, besides being indicated as a non-pharmacological intervention with positive results for the treatment of
139 chronic pain, is an accessible therapy from the economic point of view [17][18][19] .

140 It is observed in this study that 51.4% (n=24) of the volunteers practices some type of physical activity, and
141 even so, they are affected by chronic pain. Although the clinical benefits of exercise in reducing the intensity of
142 chronic pain are highlighted, the physiological effects involved are still unclear; sometimes the analgesic effect is
143 contradictory 20 . One of the most described hypotheses to explain this increase in pain threshold -comparing
144 athletes or active and sedentary people -is the influence of the practice of activity and/or physical exercise on
145 endogenous mechanisms, which leads to the opioids release 21,22 .

146 Although the majority of volunteers in this research practiced physical activity, pain was present in all
147 volunteers, it was also observed that 33.33% (n=14) of the volunteers had pain of low intensity, in which 78.57%
148 (n=11) did some activity, 38.09% (n=16) presented pain of moderate intensity, of these, 62.50% (n=10) practiced
149 exercises, and 27.19% (n=11) reported pain of strong intensity, where only 27.27% (n=3) had physical activity
150 in their routine of life.

151 Researches elucidate the findings of this study, since they concluded in their studies that physical exercises can
152 be beneficial in reducing the intensity of chronic pain and in general aspects of quality and physical and mental
153 health [23][24][25] .

154 Souza 26 adds to the authors above that exercise does not need to be of high intensity to have an effect on
155 pain, concluding his research by affirming that moderate intensity aerobic exercise for more than 10 minutes is
156 able to activate endogenous mechanisms of pain control in healthy individuals.

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158 In a study conducted among elite athletes describes that behavioural factors related to the athlete's routine seem
159 to be more important for injury and pain, singling out sleep, which includes the amount of hours slept and the
160 quality of sleep 27 . Other studies 28,29 reported that sleep deprivation leads to a reduction in the production of
161 growth hormones (GH) and testosterone, as well as an increase in cortisol, thus directly affecting the organism's
162 homeostasis as defined by Hirshkowitz 12, a factor to be considered in the volunteers of this study.

10 VI. CONCLUSION

163 The time of doing physical activity in this study, according to the participants, was predominantly during the
164 evening, with 45.83% (n=11) training at this time of day. Stutz and collaborators 30 stated in their study that
165 the exercises practiced at evening do not interfere negatively in sleep, as long as the time of exercise is up to one
166 hour before bedtime and high intensity. Wendt et al 31 showed divergent results, in which the practice of evening
167 physical activity resulted in a negative effect on sleep, not depending on the intensity, but in relation to daytime
168 physical activity, which showed positive results on sleep . ??raemer 32 reports in a study that although the
169 neuroendocrine adaptations seem minimal, the hormonal response depends on the intensity, volume, involvement
170 of muscle mass, rest intervals and frequency, where high volume and moderate to high intensity exercises tend
171 to produce higher elevations of anabolic hormones such as GH and testosterone, but also of cortisol, which is
172 a catabolic hormone involved in the sleep process. Other researchers [33][34][35][36] corroborate with Kraemer
173 32 , that the relation of physical activity and its duration/intensity with the level of cortisol, in which, when
174 it is performed with a high level of effort and/or stress, either by intensity or duration, there is an increase
175 in the level of cortisol. Upon physical exercise there is secretion by the hypothalamus of the hormone that
176 releases corticotrophin, activating the pituitary gland, where it stimulates the release of adrenocorticotropin,
177 which stimulates the release of cortisol by the adrenal cortex. In the present study, the volume/intensity of
178 the physical activity performed by the volunteers was not evaluated, but its close relationship with the results
179 presented here is assumed.

180 The NREM sleep is regarded as the restorative sleep phase; authors have reported that the increase in cortisol
181 at night reduces the REM sleep phase and increases the NREM phase, which is explained by a biphasic effect of
182 cortisol, in which up to a certain level, it favours the REM phase, but when it is too high, it inhibits it 37 . In the
183 present study, it was verified that 76.19% (n=32) of the volunteers reported waking up feeling tired, even though
184 the majority, 52.38% (n=22) reported a good quality of sleep, which makes us wonder about the connection of
185 cortisol levels among these volunteers.

186 Another factor to be considered is that 52.38% (n=22) of the participants in this study use some kind of
187 stimulant substance during the day, especially coffee, used by 90.90% (n=20 of the 22 who take stimulants).
188 Caffeine activates the stress axis, raising glucocorticoids and catecholamines ??8 .

189 The effect of caffeine on glucocorticoid regulation has, therefore, the potential to alter circadian rhythms and
190 interact with stress 39 , which can be a factor related to changes in the quality of sleep, as well as associated with
191 chronic pain in the participants of this study, since 64.29% (n=27) of them described that after a bad night's
192 sleep, their pain worsened.

193 Hence, the relationship between sleep disturbance and chronic pain would probably be best characterised as
194 a reciprocal vicious circle, with pain contributing to sleep disturbance and also contributing to increased pain
195 sensitivity ?? .

196 Araújo and collaborators 6 corroborate with Smith ??0 stating that reduced sleep time increases the response
197 to pain and chronic pain conditions are capable of altering the sleep pattern.

198 10 VI. CONCLUSION



Figure 1:

199 1 2 3

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1

Level of Pain 0-10	Number of participants	% Representation
02	06	14,29%
03	08	19,05%
04	05	11,90%
05	08	19,05%
06	03	7,14%
07	06	14,29%
08	04	9,52%
09	01	2,38%
10	01	2,38%

Figure 3: Table 1 :

2

Sleeping hours	Quantity of Rep- an- re- swersen- ta- tion	%
4h	1	2,38%
4h30	1	2,38%
5h	2	4,76%
5h30	5	11,90%
6h	12	28,57%
6h30	3	7,14%
7h	9	21,43%
7h30	2	4,76%
8h	4	9,52%
+ de 8h	2	4,76%
Not specified (insomnia)	1	2,38%

It is highlighted that 59.52% (n=25) of the participants slept less than 7h per night, 26.19% (n=11) slept between 7 and 7h30 and only 14.28% (n=6) slept 8h or more as recommended by the WHO.

When analysing the quality of sleep from the point of view of the volunteers, the following results were obtained: very good sleep 7.14% (n=3), good 52.38% (n=22), bad 33.33% (n=14) and very bad 7.14% (n=3). However, despite the positive rate in reporting sleep quality as good, the feeling of NOT having rested during sleep was expressed by 76.19% (n=32) of the participants with only 23.80% (n=10) of those with the perception of sleep having been restorative.

Another evaluated element was sleepiness on the part of the participants during their daily activities, in which 76.19% (n = 32) reported feeling sleepy during their daily activities, while only 23.80% (n = 10) reported not feeling sleepy during the day. Only one of the volunteers (2.38%) did not feel sleepy during the day and did not use stimulants for the Central Nervous System.

Caption: Left column indicates the amount of hours of sleep per night; middle column the amount of volunteers who fit into a certain sleep time and in the right column the percentage of participants for each sleep period. Source: The author herself.

Figure 4: Table 2 :

10 VI. CONCLUSION

3

Level of pain	Quantity of individuals	Very good sleep	Good Sleep	Bad sleep	Very bad sleep
Weak	14 (33,33%)	3 (21,43%)	9 (64,29%)	2 (14,29%)	—
Moderate	16 (38,09%)	—	9 (56,25%)	5 (31,25%)	2 (12,5%)
Strong	11 (27,19%)	—	3 (27,27%)	7 (63,64%)	1 (9,09%)

Figure 5: Table 3 :

4

Sleep Quality	Feeling not rested Yes = 66,67% (n=1)	Sleepiness during the day Yes = 66,67% (n=1)
Very good (n=3)	No = 33,33% (n=2) Yes = 63,64% (n=14)	No = 33,33% (n=2) Yes = 72,72% (n=16)
Good (n=22)	No = 36,36% (n=8) Yes = 100% (n=14)	No = 63,64% (n=6) Yes = 85,71% (n=12)
Bad (n=14)	No = 0% (n=0) Yes 100% = (n=3)	No = 14,29% (n=2) Yes = 100% (n=3)
Very bad (n=3)	No = 0% (n=0)	No= 0% (n=3)

Figure 6: Table 4 :

5

Pain level	Practice of Physical Activities	London Journal of Medical and Health Research Schedule of physical activity
Weak (n=14)	Yes = 78,57% (n=11) No = 21,43% (n=3)	Morning = 36,36% (n=4) Afternoon = 18,18% (n=2) Evening = 45,45% (n=5) Morning = 20% (n=2) Afternoon = 30% (n=3)
Moderate (n=16)	Yes = 62,5% (n=10) No = 37,5% (n=6)	The Influence of Sleep Quality on Chronic Pain

Figure 7: Table 5 :

Figure 8:

200 The Influence of Sleep Quality on Chronic Pain volunteers classified their sleep as of good quality, it was
201 found that 76.19% of the individuals in this study reported waking up with the sensation of not having rested.
202 Tiredness upon waking up, as well as sleepiness during the day, was more frequent in the volunteers with greater
203 intensity of pain, being an inconsistency when they report having good quality sleep.

204 On the other hand, the practice of physical activity is being shown as one of the main and most important
205 forms of treatment in the control of chronic pain, since it can trigger the release of endogenous opioids that act
206 in the pain sensitivity control. Most participants practiced physical activity and reported weaker pains when
207 compared to sedentary individuals, whose pain had a greater intensity, indicating that exercise is a beneficial
208 factor, however, the intensity of physical activity may be related to the inflammatory index of the body and the
209 release of substances such as cortisol and IL-6 in the organism. Added to other factors such as coffee, which is
210 frequent in the routine of the volunteers of this study, the quantity of circulating inflammatory hormones and
211 cytokines in the organism may be directly linked to cases of chronic pain, as well as, associated to poor quality of
212 sleep, with the conclusion being that the greater the intensity of pain, the worse the quality of sleep. Nevertheless,
213 new studies are necessary, in which it is possible to measure the intensity of exercises, the quantity of circulating
214 hormones and cytokines for more complete results in the population that suffers with chronic pain.

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