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Original article

Predictors of sleep quality in medical students during COVID-19 confinement

Indicateurs d'une qualité altérée du sommeil chez les étudiants en médecine au cours du confinement dû à la pandémie du COVID-19

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ABSTRACT

Objectives. – We aimed to assess sleep quality of Tunisian medical students during home confinement due to the COVID-19 pandemic, and to analyze the relationship between sleep quality and sociodemographic, clinical, confinement-related and psychological variables.

Methods. – A correlational cross-sectional study was conducted from April 11th to May 3rd 2020. Medical students who have been in home confinement and who accepted to participate in an online survey were targeted. Sociodemographic data, clinical variables, and data related to home confinement were collected. Participants also completed Pittsburgh Sleep Quality Index, Depression, Anxiety and Stress Scale and Beck Hopelessness Scale.

Results. – Results showed a high prevalence of poor sleepers among medical students (72.5%) with poor subjective sleep quality, increased sleep latency, sleep disturbances and daytime dysfunction. Multiple regression analysis revealed that family history of suicide attempts, tobacco use, perception of home confinement and reduced physical activity during home confinement significantly contributed to poor sleep quality. Among the psychological variables, anxiety and hopelessness significantly contributed to poor sleep quality in medical students during home confinement.

Conclusions. – Results revealed a high prevalence of poor sleep quality in medical students who have been in home confinement due to the COVID-19 pandemic. Except family history of suicide attempts, factors that significantly contributed to poor sleep quality were modifiable factors. Sleep quality and sleep parameters need to be assessed in this particular population and adequate measures aiming to promote quality of sleep need to be enhanced, given the crucial regenerative, homeostatic and psychological roles of sleep.

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R É S U M É

Objectifs. – Les objectifs de ce travail étaient d'évaluer la qualité du sommeil chez les étudiants en médecine au cours du confinement dû à la pandémie du COVID-19 et d'analyser la relation entre une qualité altérée du sommeil et les variables socio démographiques, cliniques et les variables liées au confinement.

Méthodes. – Une étude transversale a été menée du 11 avril au 3 mai 2020. La population cible était les étudiants en médecine qui ont été en confinement et qui ont accepté à participer à l'étude. Les données socio démographiques, cliniques et les données relatives au confinement ont été recueillies après le consentement éclairé des participants. Les participants ont également complété l'indice de qualité du sommeil de Pittsburgh, l'échelle de dépression, d'anxiété et de stress et l'échelle de désespoir de Beck.

Mots clés :

Qualité du sommeil
Étudiants en médecine
Confinement
Anxiété
Désespoir.

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Résultats. – Au total, 251 étudiants en médecine ont accepté de participer à l'étude, avec un taux de réponse de 18.83%. Les résultats ont montré une forte prévalence de mauvais dormeurs parmi les étudiants en médecine (72,5%) avec une mauvaise qualité subjective du sommeil, une latence accrue du sommeil, des troubles du sommeil et un dysfonctionnement diurne. Une analyse de régression multiple a révélé que les antécédents familiaux de tentatives de suicide, le tabagisme, la perception du confinement et la réduction de l'activité physique pendant le confinement contribuaient de manière significative à une mauvaise qualité du sommeil. Parmi les variables psychologiques, l'anxiété et le désespoir ont contribué de manière significative à la mauvaise qualité du sommeil chez les étudiants en médecine pendant le confinement.

Conclusions. – Les résultats ont révélé une prévalence élevée de mauvaise qualité du sommeil chez les étudiants en médecine qui ont été confinés à domicile en raison de la pandémie de COVID-19. À l'exception des antécédents familiaux de tentatives de suicide, les facteurs qui ont contribué de manière significative à une mauvaise qualité du sommeil étaient des facteurs modifiables. L'anxiété et le désespoir, une vulnérabilité cognitive au suicide, prédisaient une mauvaise qualité du sommeil après contrôle des autres variables de l'étude. Cela suggère que parmi les étudiants en médecine qui ont été confinés à domicile, ceux qui ont une mauvaise qualité de sommeil pourraient être les plus vulnérables psychologiquement avec un risque suicidaire plus élevé. Dans un contexte de confinement à domicile et d'éloignement social qui implique des difficultés d'accès aux soins médicaux ou psychologiques, le dépistage des troubles du sommeil et de la mauvaise qualité du sommeil chez les étudiants en médecine peut permettre d'identifier les plus vulnérables. La qualité du sommeil et les paramètres du sommeil doivent être évalués dans cette population et des mesures adéquates visant à promouvoir la qualité du sommeil doivent être instaurées, compte tenu des rôles cruciaux régénératif, homéostatique et psychologiques du sommeil.

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1. Introduction

Since its first identification in Wuhan in December 2019 [1], the coronavirus disease (COVID-19) has spread rapidly all over the world, with rising numbers of cases and deaths every day. World Health Organization characterized the outbreak as a Public Health Emergency of International Concern on 30 January, and a Pandemic on 11 March [2,3]. The Tunisian government confirmed its first case of COVID-19 on March 2nd, 2020. Since then, the number of cases started to escalate, spreading to all 24 regions of the country by April 18th. Alarmed by the scarceness of intensive care units in the country, authorities enhanced several measures in order to control the spread of the disease. Hospitals were struggling to provide more intensive care beds. Air traffic plummeted. Night curfews were declared. Large gatherings were cancelled, and by March 13th, home confinement was indicated for all fields, except vital sectors. This public health event inflicted psychological pressure on the Tunisian authorities, medical staff, health care providers and the general population.

Medical students were not spared from the psychological pressure, especially during home confinement. Delays in their already charged academic schedules, changes in their routines, obligation to stay at home for an unknown period of time with the impossibility to engage in social activities and living with uncertainty are likely to have negative effects on students' mental health. Their levels of depression, anxiety and stress may be increased [4,5] and their sleep quality may be adversely affected [6].

Sleep is a key indicator of physical and psychological health. It has crucial regenerative, homeostatic, cognitive and psychological roles and it directly impacts on next day functioning [7]. Sleep is highly influenced by environmental factors such as stress, day light exposure, noise levels and activity levels during the preceding day [6] and by socio-cultural factors such as social support [8].

Despite its necessity for controlling the spread of COVID-19, home confinement may increase stress levels because of social isolation and the impossibility to engage in socially rewarding activities [6]. It may also increase the risk of mental health difficulties [9]. In addition, home confinement lessens the level of daylight exposure as well as the level of physical activity during the day. Consequently, home confinement may adversely affect sleep

quality [6]. Cellini and colleagues recently assessed sleep quality of 1,310 Italian people including 809 university students. They found that during home confinement, people were spending more time in bed but, paradoxically, reporting a lower quality of sleep [10]. They also reported that the increase in sleep difficulties was stronger for participants who showed higher levels of depression, anxiety and stress [10].

Sleep quality of medical students during home confinement has not been addressed elsewhere. We aimed in this study to assess sleep quality of Tunisian medical students during home confinement, and to analyze the relationship between sleep quality and relevant sociodemographic, clinical, confinement-related and psychological variables. The study aimed to explore to what extent sleep quality is lessened in medical students during home confinement and to what extent clinical variables (personal history of medical and psychiatric conditions, substance use), confinement-related variables (duration of COVID-19 news tracking, Internet use, consumption of caloric food and physical activity) and psychological variables (depression, anxiety, stress levels and hopelessness) significantly contributed to poor sleep quality in medical students.

2. Methods

2.1. Study design and participants

We conducted a correlational cross-sectional study from April 11th, 2020 to May 3rd, 2020, using an anonymous online survey. The survey started exactly one month after the beginning of home confinement recommended by the Tunisian Government. Target population was undergraduate medical students registered in the four Faculties of Medicine of the Tunisian country. Source population was undergraduate medical students registered in the Faculty of Medicine of Sousse, Tunisia. A total of 1333 medical students were invited to fulfill an online questionnaire, using Short Message Service and announcement and information about the study were posted on the online platform of the Faculty of Medicine of Sousse. Respondents completed, after consent, the survey within approximately 30 minutes.

2.2. Measures

The online study survey started, after presentation of the study aims and after consent, with sociodemographic data (age; gender; marital status; year of medical course; leisure activities), clinical variables (family and personal history of medical conditions; family and personal history of psychiatric disorders; tobacco use and alcohol and other substances consumption), and data related to home confinement. These data included habitation during home confinement; duration of COVID-19 news tracking per day; perception and perceived advantages of home confinement; consumption of foods rich in calories, fat or sugar; Internet and Smartphone use during home confinement and physical activity during home confinement.

The following sections of the survey comprised three instruments.

Depression, Anxiety and Stress Scale (DASS-21) was used in its French version to measure the emotional states of depression, anxiety and stress of the study participants [11]. It consists in a set of three 7-item self-report subscales. Depression subscale comprised items 3, 5, 10, 13, 16, 17 and 21. Total depression score was distributed into normal (0–9), mild depression (10–13), moderate depression (14–20), severe depression (21–27) and extremely severe depression (28–42). Anxiety subscale included items 2, 4, 7, 9, 15, 19 and 20. Total anxiety score was divided into normal (0–7), mild anxiety (8–9), moderate anxiety (10–14), severe anxiety (15–19) and extremely severe anxiety (20–42). Stress subscale comprised items 1, 6, 8, 11, 12, 14 and 18. Total stress score was divided into normal (0–14), mild stress (15–18), moderate stress (19–25), severe stress (26–33) and extremely severe stress (34–42).

Beck Hopelessness Scale (BHS), a 20-item self-report measure, was used in its French version to assess cognitive dimensions of depression [12]. It may be used as an indicator of suicidal intents. All items are scored on a true-false rating scale. After recoding negatively worded items, the number of endorsed items is summated to an overall score that ranges from 0 to 20, with higher scores corresponding to a higher level of hopelessness. Beck et al. suggested the following classification of the overall score: 0–3, normal range; 4–8, mild hopelessness; 9–14, moderate hopelessness and 15–20, severe hopelessness [13]. In addition, a cut-off score of 9 was set up as an indicative and predictive value of suicidal intents [14].

Pittsburgh Sleep Quality Index (PSQI) was used in its French version to evaluate study participants' sleep quality during the month preceding the evaluation [15]. Subjects with PSQI overall score greater than five are considered as poor sleepers. PSQI also permits the calculation of the following seven sleep components, with a score of each of them ranging from 0 (no difficulty) to 3 (severe difficulty): subjective sleep quality, sleep latency, sleep duration, usual sleep efficiency, sleep disturbances, use of sleep medication and daytime dysfunction.

2.3. Statistical analysis

Data were analyzed using the Statistical Package for Social Science, version 23. Distribution of continuous variables was compared to normal distribution via Shapiro-Wilks test. Our study variables were non-normally distributed. We determined the extreme values and we calculated medians and inter-quartile intervals for quantitative variables. Differences between groups for a continuous variable were tested using Mann-Whitney test for the comparison of two groups or Kruskal-Wallis test for the comparison of several groups. Correlations between two quantitative variables were tested via Spearman's correlation test.

To determine the unique impact of psychological variables on the quality of sleep, three sets of predictors: clinical, confinement-related and psychological variables, were entered in steps into a hierarchical multiple regression model. These variables were

chosen based on their statistical significance in the analytic models adopted in this study. Clinical variables were included in the first step. Confinement related variables were entered as potential confound in the second step (perception of home confinement, consumption of caloric food, Internet and smartphone use and physical activity during home confinement). In the third step, depression, anxiety, stress and hopelessness scores were entered.

The significance level was set at 0.05 in all statistical tests.

2.4. Ethical considerations

The study protocol was approved by the Institutional Board of the Faculty of Medicine of Sousse. Participation was elective and anonymous. Aims of the study were clearly explained in an introduction and participants who agreed to fulfill the questionnaire should click on the start button.

3. Results

The response rate was 18.83%. Characteristics of medical students included in this study are illustrated in Table 1. Eighty-four students (33.5%) perceived home confinement as an unbearable situation. In addition, 67.7% ($n = 170$) were considered to suffer from depression, 55.8% ($n = 140$) were considered to suffer from anxiety and 44.6% ($n = 112$) were considered to suffer from stress. Based on the cut-off value of nine, 31.1% ($n = 78$) of the participants showed a high level of hopelessness.

Table 2 represents sleep characteristics of our study sample. During home confinement, 72.5% of medical students were considered as poor sleepers. Sleep duration was equal to or more than 7 hours in 84.5% ($n = 212$) and less than 7 hours in 15.5% ($n = 39$) of medical students. Sleep quality was perceived as « somewhat poor » in 32.7% ($n = 82$) and « very poor » in 11.2% ($n = 28$) of medical students. As for sleep latency, 20.3% of the students took 30 to 60 minutes to fall asleep and 17.9% took more than 60 minutes to fall asleep. Most prevalent situations explaining sleep disturbances in medical students during home confinement were: having bad dreams (73.3%), waking up in the middle of the night or early in the morning (66.9%), feeling too hot (61.8%) and getting up to use the bathroom (48.2%). The other situations were having pain (47.4%), the inability to breathe comfortably (36.3%), having too cold (34.3%) and coughing or snoring loudly (29.1%).

Use of sleep medication was reported by 37 students (14.7%). Daytime dysfunction was detected in 68 students (27.1%).

Associations between sleep quality and the different study variables are illustrated in Table 3. PSQI scores were significantly associated with family history of suicide attempts ($P = 0.019$), personal history of medical conditions ($P = 0.028$), tobacco use ($P < 0.0001$), perception of home confinement ($P < 0.0001$), duration of COVID-19 news tracking per day ($P = 0.044$) and perceived advantages of home confinement ($P < 0.0001$). Students who reported a considerable increase in consumption of foods rich in calories and those who reported considerable decrease in physical activity during home confinement showed significantly higher PSQI overall scores. Students who reported considerable increase in Internet and Smartphone use during home confinement also showed significantly higher PSQI overall scores.

The intercorrelations of our study variables are illustrated in supplemental materials. PSQI overall scores were strongly and positively correlated with depression scores ($P < 0.01$; $r = 0.572$), anxiety scores ($P < 0.01$; $r = 0.531$), stress scores ($P < 0.01$; $r = 0.507$) and hopelessness scores ($P < 0.01$; $r = 0.495$).

Results of hierarchical regression analysis with sleep quality as dependent variable are represented in Table 4. Family history of suicide attempts, tobacco use, perception of home

Table 1
Descriptive statistics of the study sample (N = 251).

Variables	Number (%)	Minimum	Maximum	Median (Q1–Q3)
Response rate	–18.83			
Age		18	31	21 (20–23)
Gender				
Female	207 (82.5)			
Male	44 (17.5)			
Marital status				
Single	195 (77.7)			
In a relationship	55 (21.9)			
Married	1 (0.4)			
Year of medical course				
First year	65 (25.9)			
Second year	44 (17.5)			
Third year	49 (19.5)			
Fourth year	47 (18.7)			
Fifth year	46 (18.3)			
Family history of medical condition(s)	172 (68.5)			
Family history of psychiatric disorder(s)	89 (35.5)			
Depression	52 (20.7)			
Bipolar disorder	16 (6.4)			
Anxiety disorders	36 (14.3)			
Substance use disorders	9 (3.6)			
Suicide attempts	15 (6.0)			
Suicide	6 (2.4)			
Personal history of medical condition(s)	49 (19.5)			
Obesity	17 (6.8)			
Diabetes	3 (1.2)			
Thyroid dysfunction	7 (2.8)			
Cardiovascular disorders	4 (1.6)			
Cancer	1 (0.4)			
Other disorders	18 (7.2)			
Personal history of psychiatric disorder(s)	77 (30.7)			
Depression	35 (13.9)			
Bipolar disorder	2 (0.8)			
Anxiety disorders	41 (16.3)			
Substance use disorders	1 (0.4)			
Suicide attempts	7 (2.8)			
Tobacco use	21 (8.4)			
Alcohol consumption	10 (4.0)			
Cannabis use	2 (0.8)			
Having one or more leisure activities	184 (73.3)			
Habitation during home confinement				
Alone	7 (2.8)			
With a flatmate	3 (1.2)			
With parents and/or family member	241 (96.0)			
Perception of home confinement				
Stressful yet manageable situation	167 (66.5)			
Unbearable situation	84 (33.5)			
Duration of COVID-19 news tracking per day				
No news tracking at all	18 (7.2)			
<2 hours	157 (62.5)			
2–4 hours	52 (20.7)			
4–6 hours	14 (5.0)			
>6 hours	10 (4.0)			
Perceived advantages of home confinement				
Yes	239 (95.2)			
No	12 (4.8)			
Consumption of foods rich in calories, fat or sugar during home confinement				
No change in consumption	85 (33.9)			
Decrease in consumption	36 (14.3)			
Moderate increase in consumption	101 (40.2)			
Considerable increase in consumption	29 (11.6)			
Physical activity during home confinement				
Practicing sport during home confinement	48 (19.1)			
Considerable decrease in physical activity	97 (38.6)			
No physical activity	106 (42.2)			
Internet and Smartphone use during home confinement				
No change in use	38 (15.1)			
Moderate increase in use	71 (28.3)			
Considerable increase in use	142 (56.6)			
DASS-21 Depression score		0	42	14 (8–24)

Table 1 (Continued)

Variables	Number (%)	Minimum	Maximum	Median (Q1–Q3)
Depression: severity distribution of scores				
Normal	81 (32.3)			
Mild	26 (10.4)			
Moderate	65 (25.9)			
Severe	27 (10.8)			
Extremely severe	52 (20.7)			
DASS-21 Anxiety score		0	42	10 (4–16)
Anxiety: severity distribution of scores				
Normal	111 (44.2)			
Mild	12 (4.8)			
Moderate	53 (21.1)			
Severe	24 (9.6)			
Extremely severe	51 (20.3)			
DASS-21 Stress score		0	40	14 (6–22)
Stress: severity distribution of scores				
Normal	139 (55.4)			
Mild	33 (13.1)			
Moderate	35 (13.9)			
Severe	35 (13.9)			
Extremely severe	9 (3.6)			
Hopelessness score (BHS)		0	20	5 (3–10)
Hopelessness: severity distribution of scores				
Normal range	83 (33.1)			
Mild hopelessness	90 (35.9)			
Moderate hopelessness	60 (23.9)			
Severe hopelessness	18 (7.2)			

DASS-21, Depression, Anxiety and Stress Scale - 21 items; BHS, Beck Hopelessness Scale; Q1-Q3, Interquartile interval.

Table 2

Sleep characteristics of the study sample (N = 251).

Characteristics	Number (%)	Minimum	Maximum	Median (Q1–Q3)
Bedtime		21:00	11:00	2:00 (00:00–3:30)
Time to get up		5:00	22:00	11:00 (9:00–13:00)
Sleep latency (minutes)				
≤ 15 minutes	77 (30.7)			
16 to 30 minutes	78 (31.1)			
31 to 60 minutes	51 (20.3)			
> 60 minutes	45 (17.9)			
Hours of sleep per night		2	12	8 (7–9)
Sleep efficiency				
> 85%	182 (72.5)			
From 75 to 84%	39 (15.5)			
From 65 to 74%	18 (7.2)			
< 65%	12 (4.8)			
PSQI components scores				
Subjective sleep quality		0	3	1 (1–2)
Sleep latency		0	3	2 (1–3)
Sleep duration		0	3	0 (0–1)
Usual sleep efficiency		0	3	0 (0–1)
Sleep disturbances		0	3	1 (0–1)
Use of sleep medication		0	3	0 (0–0)
Daytime dysfunction		0	3	1 (1–2)
PSQI overall score		0	19	6 (4–9)
PSQI cut off				
Good sleepers	69 (27.5)			
Poor sleepers	182 (72.5)			

PSQI: Pittsburgh Sleep Quality Index; Q1–Q3: interquartile interval.

confinement and physical activity during home confinement significantly contributed to sleep quality in medical students during home confinement. After controlling for clinical variables and confinement-related variables, anxiety and hopelessness were significant contributors of sleep quality.

4. Discussion

Sleep quality constitute a significant indicator of students' physical and/or psychological wellbeing as well as their abilities to cope with stressful situations and multiple required tasks [16–18]. After COVID-19 outbreak in Tunisia, medical students became

confronted with an unpredicted stressful situation, rather than the habitual academic pressure, which is home confinement for several weeks.

This is, to the best of our knowledge, the first study investigating sleep quality in medical students who have been in home confinement for at least one month, and characterizing factors which would significantly contribute to poor sleep quality in this study population.

In total, 251 medical students responded to the study survey with a response rate of 18.83%. A recent study assessed sleep parameters of Italian population during home confinement included 1,310 young adult participants [10]. This higher number

Table 3
Association between sleep quality and the different study variables in 251 medical students.

Variables	PSQI overall score	
	Median (Q1–Q3)	P-value
Gender		0.719
Female	7 (4–9)	
Male	6 (3.25–9)	
Marital status		0.78
Single	7 (4–9)	
In a relationship	6 (5–9)	
Married	8 (8–8)	
Year of medical course		0.555
First year	6 (4–8)	
Second year	6 (5–9)	
Third year	7 (5–9)	
Fourth year	7 (4–9)	
Fifth year	6 (4–9)	
Family history of medical condition(s)		0.073
Yes	7 (4.25–9)	
No	6 (4–8)	
Family history of psychiatric disorder(s)		0.053
Yes	7 (4.5–10)	
No	6 (4–8.25)	
Family history of suicide attempts		0.019
Yes	8 (7–11)	
No	6 (4–9)	
Personal history of medical condition(s)		0.028
Yes	8 (5–9)	
No	6 (4–9)	
Personal history of psychiatric disorder(s)		0.011
Yes	7 (5–10)	
No	6 (4–8)	
Personal history of suicide attempts		0.2
Yes	6 (2–7)	
No	6.5 (4–9)	
Tobacco use		<0.0001
Yes	9 (7–13)	
No	6 (4–8.25)	
Alcohol use		0.1
Yes	8.5 (5.75–11)	
No	6 (4–9)	
Having one or more leisure activities		0.432
Yes	6 (4–8)	
No	7 (4–9)	
Habitation during home confinement		0.511
Alone	7 (6–9)	
With a flatmate	8 (5–8)	
With parents and/or family member	6 (4–9)	
Perception of home confinement		<0.0001
Stressful yet manageable situation	5 (3–8)	
Unbearable situation	9 (6.25–11)	
Duration of COVID-19 news tracking per day		0.044
No news tracking at all	6 (3.75–8)	
< 2 hours	6 (4–9)	
2 - 4 hours	7 (5–9)	
4 - 6 hours	8 (6–11.5)	
> 6 hours	8 (4.75–14)	
Perceived advantages of home confinement		0.006
Yes	6 (4–9)	
No	10 (7–12.5)	
Consumption of foods rich in calories, fat or sugar during home confinement		0.01
No change in consumption	6 (4–8)	
Decrease in consumption	7 (4.25–8)	
Moderate increase in consumption	7 (4–9)	
Considerable increase in consumption	8 (6–12.5)	
Physical activity during home confinement		0.032
Practicing sport during home confinement	5.5 (4–8)	
Considerable decrease in physical activity	7 (5–10)	
No physical activity	6 (4–9)	
Internet and Smartphone use during home confinement		<0.0001
No change in use	6 (4–7.25)	
Moderate increase in use	5 (4–8)	
Considerable increase in use	7 (5–9.25)	

Table 3 (Continued)

Variables	PSQI overall score	
	Median (Q1–Q3)	P-value
Depression: severity distribution of DASS-21 scores		< 0.0001
Normal	4 (3–6)	
Mild	5 (2.75–8)	
Moderate	7 (5–8)	
Severe	8 (6–10)	
Extremely severe	9 (8–12.75)	
Anxiety: severity distribution of DASS-21 scores		< 0.0001
Normal	5 (3–7)	
Mild	5.5 (4–7.75)	
Moderate	7 (5–9)	
Severe	8 (8–10)	
Extremely severe	9 (7–12)	
Stress: severity distribution of DASS-21 scores		< 0.0001
Normal	5 (3–7)	
Mild	7 (5.5–8.5)	
Moderate	8 (6–10)	
Severe	9 (8–11)	
Extremely severe	7 (6–12)	
Hopelessness: severity distribution of scores		< 0.0001
Normal range	5 (3–7)	
Mild hopelessness	6 (4–9)	
Moderate hopelessness	8 (6–10)	
Severe hopelessness	10 (9–13.25)	

SASS-21: Depression, Anxiety and Stress Scale–21 items; PSQI: Pittsburgh Sleep Quality Index; Q1–Q3: interquartile interval. P-value obtained with Mann–Whitney U-test or Kruskal–Wallis test.

of participants, compared to the respondents in this study, might be explained by the snowball sampling strategy utilized. Previous studies investigating sleep quality in medical students, but not during home confinement, showed higher response rates, ranging from 22.78% to 100% [19]. During home confinement, all medical students' lessons were posted online in a short period of time. They had a lot to assimilate with much less guidance from their seniors and without clinical training which is an important learning opportunity to them and this may explain the low response rate in this study.

Results showed a high prevalence of poor sleepers among medical students with poor subjective sleep quality, increased sleep latency, sleep disturbances and daytime dysfunction. Among the predictors of poor sleep quality, family history of suicide attempts, tobacco use, perception of home confinement and physical activity during home confinement were significantly associated with sleep quality. Among the psychological variables, anxiety and hopelessness significantly contributed to sleep quality in Tunisian medical students during home confinement.

4.1. Quality of sleep in our study sample

During home confinement, 72.5% of medical students showed a poor quality of sleep. An other Tunisian study evaluated sleep quality in medical students during exam periods, using the same instrument, found a prevalence of poor sleep quality of 53.3% [20]. If we examine the literature data, the prevalence of poor sleep in medical students is variable across studies mainly due to the use of different measurement tools and to the differences of students' sociodemographic characteristics across the countries [21]. Nevertheless, there is consistent evidence that poor sleep quality and sleep disturbances are common among medical students around the world [21]. The prevalence of poor sleep found in this study surpasses the reported pooled prevalence of a recent meta-analysis with 25,735 included medical students [19]. Using PSQI, the meta-analysis found a prevalence of 52.7% (95%CI: 45.3% to 60.1%) [19]. Poor sleep quality is prevalent among medical students and it is significantly more prevalent in medical students than

other university students or the general population [21,22]. Results suggest that medical students showed, after at least one month of home confinement, greater poor sleep quality. The regularity and the good quality of sleep-wake cycles are influenced by numerous environmental factors including daylight exposure, physical activity and social interactions [23]. These crucial determinants of a good quality of sleep might be affected during home confinement and might explain our results [6,23]. Low levels of activity during the day affect sleep negatively [6]. Moreover, daylight exposure during the day plays a crucial role in inducing sleepiness, as it promotes melatonin release during the night [6]. Daylight exposure is quite reduced during home confinement. This might also explain the fact that 50% of the participants in this study went to bed between 00:00 am and 3:30 am. In addition to the environmental changes induced by home confinement, heightened stress levels during COVID-19 pandemic may negatively impact on sleep quality and sleep quantity [23]. Reduction in sleep quantity and/or poor sleep quality, whether related to changes in environmental factors due to home confinement and/or to heightened stress levels due to the pandemic, would make people more vulnerable to viral infections, increase the risk of psychiatric and addictive disorders and negatively impact on cognitive performances and decision-making, with consequent increased risk-taking and impulsivity [23].

The proportion of medical students who slept less than 7 hours per day during confinement was 15.5%, a proportion much lower than the reported 58.7% (95%CI: 45.3% to 72.0%) in a meta-analysis [19]. Daytime dysfunction at least once a week was reported by 27.1% of medical students, a proportion that is lower than others reported in the literature. Daytime sleepiness was reported in 36.9% [24] and 63% [25] of medical students. This might be explained by the fact that during home confinement, medical students lost their daily routines and they had much less academic responsibilities with no more clinical trainings and face-to-face courses, thus much less stress and work overload. Similarly to our findings, Cellini and colleagues found that, during home confinement, Italian people aged between 18 and 35 years went to bed and woke up later than their usual and showed an increase in poor sleep quality despite the fact that they were spending more time in bed [10].

Table 4
Hierarchical regression analysis with sleep quality as dependent variable.

Variable	PSQI overall score											
	Step 1				Step 2				Step 3			
	B	CI 95%	r	P-value	B	CI 95%	r	P-value	B	CI 95%	r	P-value
Family history of suicide attemps	-0.145	(-3.795; -0.304)	-0.151	0.022	-0.163	(-3.895; -0.725)	-0.189	0.004	-0.110	(-3.038; -0.057)	-0.137	0.042
Personal history of medical condition(s)	-0.112	(-2.021; 0.102)	-0.117	0.076	-0.087	(-1.703; 0.209)	-0.103	0.125	-0.072	(-1.514; 0.275)	-0.092	0.174
Personal history of psychiatric disorder(s)	-0.123	(-1.875; 0.023)	-0.126	0.056	-0.036	(-1.138; 0.594)	-0.042	0.536	0.064	(-0.360; 1.318)	0.076	0.262
Tobacco use	-0.237	(-4.393; -1.356)	-0.240	<0.0001	-0.151	(-3.228; -0.434)	-0.171	0.010	-0.109	(-2.645; -0.006)	-0.133	0.049
Duration of COVID-19 news tracking per day	-	-	-	-	0.100	(-0.050; 0.925)	0.118	0.078	0.049	(-0.244; 0.677)	0.063	0.356
Perception of home confinement	-	-	-	-	0.355	(1.681; 3.506)	0.352	<0.0001	0.158	(0.198; 2.111)	0.159	0.018
Perceived advantages of home confinement	-	-	-	-	0.070	(-0.713; 2.992)	0.081	0.227	-0.012	(-1.961; 1.579)	-0.014	0.832
Consumption of foods rich in calories, fat or sugar during home confinement	-	-	-	-	0.013	(-0.375; 0.462)	0.014	0.838	0.012	(-0.347; 0.423)	0.013	0.846
Internet and smartphone use during home confinement	-	-	-	-	0.101	(-0.079; 0.769)	0.107	0.110	0.098	(-0.059; 0.726)	0.113	0.095
Physical activity during home confinement	-	-	-	-	0.080	(-0.125; 0.736)	0.093	0.163	0.108	(0.010; 0.814)	0.136	0.045
DASS-21 Depression score	-	-	-	-	-	-	-	-	0.148	(-0.016; 0.107)	0.098	0.146
DASS-21 Anxiety score	-	-	-	-	-	-	-	-	0.273	(0.040; 0.165)	0.214	0.001
DASS-21 Stress score	-	-	-	-	-	-	-	-	-0.112	(-0.113; 0.032)	-0.074	0.272
Hopelessness score (BHS)	-	-	-	-	-	-	-	-	0.211	(0.058; 0.255)	0.208	0.002

B: standardized beta coefficient; CI, confidence interval; r: Spearman's rank correlation coefficient; p: statistical significance; PSQI: Pittsburgh Sleep Quality Index; DASS-21, Depression, Anxiety and Stress score - 21 items; BHS: Beck Hopelessness Scale.

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4.2. Relationships between sleep quality and the study variables

We didn't find a significant association between poor sleep quality and gender in our study. This corroborates with the findings of Azad and colleagues who concluded in their review that the effect of gender on medical students' sleep quality is inconsistent [21]. Results revealed that tobacco use and reduced physical activity during home confinement significantly contributed to poor sleep quality in medical students. They are in line with previous findings addressing the association between these lifestyle factors and sleep quality [26,27]. Results also revealed that medical students who perceived home confinement as an unbearable situation showed significantly greater PSQJ scores and students' perceptions of home confinement significantly contributed to poor sleep quality. After controlling for clinical variables, and confinement-related variables, anxiety remained a significant predictor of poor sleep quality. These results are in line with other Tunisian and Egyptian studies reporting a significant association between anxiety and poor sleep quality [20,28]. Another study found that medical students with anxiety were about four times more prone to poor sleep quality compared to others [29]. Sleep quality is closely related to environmental factors, and stressful situations can be precipitating factors of sleep disturbances [18]. In addition, pre-sleep cognitions including worrying, analyzing and active thinking at bedtime are significantly correlated with insomnia [30,31]. Worrying, cognitive hyperarousal and hypervigilance were also significant predictors of sleep disturbances in medical students [32]. These data may explain the relation found between anxiety and sleep quality in a context of home confinement, a situation associated with fear, uncertainty and anxiety [4,5,33].

A unique feature of this study is the finding that hopelessness remained significantly associated with poor quality of sleep above and beyond depression and stress in medical students during home confinement. Family history of suicide attempts, a major suicidal risk factor, also significantly contributed to poor sleep quality. Hopelessness represents unfavorable attributional styles about anticipations of the future. It is considered by Beck as a sensitive indicator of immediate and long-term suicide potential [34]. Consistent with Beck's observation, several studies confirmed that greater levels of hopelessness predicted suicidal ideations, suicide attempts and death by suicide [35]. The relationship between sleep quality and hopelessness in medical students has not been addressed elsewhere. However, numerous studies reported that sleep disturbances and poor sleep quality were significantly associated with suicidal ideations in college and medical students [36,37]. Poor sleep quality remained associated with suicidal ideations above and beyond depressive symptoms [38]. In their large nationally representative sample of adults, Geoffroy and colleagues found in their 3-year prospective study that participants who attempted suicide reported significantly more frequent trouble falling asleep, more early morning awakening and more hypersomnia [39]. In addition, the shared effect of all these sleep complaints was associated with an increased risk of suicide attempts, independently of psychopathology [39]. Authors suggested that sleep disturbances should be considered as a biomarker of suicidal risk [39]. Beck and colleagues demonstrated that hopelessness is more strongly related to suicidality than to depression [13]. Hopelessness is also considered as a major suicide risk factor by the World Health Organization which recommends its assessment in suicidal individuals [40]. Hence, hopelessness should be alarming, especially in the context of home confinement due to the COVID-19 pandemic. During this difficult period, medical students who have been confronted to stressful news and increasing death rates worldwide, are facing uncertainty. In addition, 33.5% of this study sample perceived confinement as unbearable. Under such circumstances, taking into consideration the cognitive model

of suicidal behavior, suicide might be considered as a viable solution that permits regaining appeasement in hopeless medical students [41]. Hopelessness, unlike family history of suicide attempts, is a modifiable factor [40]. Once it is identified, appropriate measures for its management should be initiated. For instance, a clinical trial conducted in Kenya Medical Training College confirmed the effectiveness of four psychoeducation sessions in the reduction of hopelessness, suicidal ideations, suicide attempts, anxiety and depression at 6 months follow-up [42].

This study's findings revealed a high prevalence of poor sleep quality in medical students who have been in home confinement due to the COVID-19 pandemic. Except family history of suicide attempts, factors that significantly contributed to poor sleep quality in medical students were modifiable factors: physical activity, tobacco use, perception of home confinement and psychological factors. Sleep quality need to be assessed in this particular population and adequate measures aiming to promote quality of sleep need to be enhanced, given the crucial regenerative, homeostatic, cognitive and psychological roles of sleep.

Family history of suicide attempts significantly contributed to poor sleep quality in medical students during home confinement. Anxiety and hopelessness, a cognitive vulnerability for suicide, predicted poor sleep quality after control for the other study variables. This suggests that among medical students who have been in home confinement, those showing poor quality of sleep might be the most psychologically vulnerable with a higher suicidal risk. In a context of home confinement and social distancing which implies difficulties to access medical or psychological care, screening for sleep disturbances and poor sleep quality in medical students might help to identify the most vulnerable ones to psychological support and/or psychiatric care. As suggested by Geoffroy and colleagues, sleep disturbances may constitute a potential therapeutic target to suicide prevention beyond psychiatric disorders [39]. Further studies need to be conducted in order to address the effect of the management measures of sleep problems on anxiety, hopelessness and suicidality of medical students.

This study's findings should be considered in the context of several limitations. The low response rate and the small sample size impede the representativeness of the study results. The cross-sectional design made the assessment of sleep quality over a period of time and of the longitudinal impact of confinement on sleep impossible. A subjective measure was used to evaluate sleep quality in this study.

Disclosure of interest

The authors declare that they have no competing interest.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.encep.2021.03.001>.

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