Poor quality of sleep and its consequences on mental health during COVID-19 lockdown in Italy

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42 **Abstract**

43 Background

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45 Coronavirus disease 2019 (COVID-19) seriously affected all Italy. The extreme virulence, the
46 speed of propagation resulted in restrictions and home confinement. This change was immediately
47 perceived by people who found themselves exposed to feelings of uncertainty, fear, anger, stress
48 and a drastic change in the diurnal but above all nocturnal lifestyle. For these reasons, we aimed to
49 study the quality of sleep and its connection to distress levels and evaluate how lifestyle changed in
50 the Italian population during the lockdown.

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52 Methods

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54 Through an internet survey we recruited 6,519 adults during the whole COVID-19 lockdown (from
55 10th March – 1st phase - to 4th May – 2nd phase). We investigated the socio-demographic and
56 COVID-19 related information and assessed sleep quality using the Medical Outcomes Study -
57 sleep scale (MOS-SS) and mental health with the short form of Depression, Anxiety, and Stress
58 Scales – 21 Items (DASS-21). Multiple logistic regression model was used to evaluate the
59 multivariate association between the dependent variable (good sleeper vs. poor sleeper) and all the
60 variables that were significant in the univariate analysis.

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62 Results

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64 3,562 (55.32%) participants reported poor sleep quality according to the MOS-Sleep Index II score.
65 The multiple binary logistic regression results of poor sleepers reveal several risk factors during the
66 outbreak restrictions: female gender, living in Central Italy, having someone close who died due to
67 COVID-19, markedly changed sleep-wake rhythm characterized by earlier or postponed habitual
68 bedtime, earlier habitual awakening time and reduced number of afternoon naps, extremely severe
69 levels of stress, of anxiety, and of depression.

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72 Conclusions

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74 This is the first study designed to understand sleep quality and sleep habits during the whole lockdown
75 in the Italian population that provides more than 6,000 participants in a survey developed specifically
76 for the health emergency related to COVID-19. Our study found that more than half of the Italian
77 population have had impaired sleep quality and sleep habits elevated psychological distress during
78 the COVID-19 lockdown containment measures. A multidisciplinary action should be taken in order
79 to plan appropriate responses to the current crisis caused by the COVID-19 health emergency.

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1 Introduction

Coronavirus disease 2019 (COVID-19) was firstly identified as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in December 2019 by healthcare professionals in Wuhan City (China). Since then, it has rapidly spread throughout Hubei Province and other areas in China soon becoming a worldwide health problem affecting more than 100 nations. Italy was the most impacted European country. During the same period, the World Health Organization indicated “COVID-19” as the official name to refer to the severe acute respiratory syndrome caused by SARS-CoV-2 (World Health Organization, 2020). Italy was the most importantly impacted country in Europe.

As for Italy, the prime minister introduced the “I stay home” government decree (Gazzetta Ufficiale della Repubblica Italiana, 2020) which interested the entire country and formerly invited people to stay at their homes. Travel restrictions, lockdown of schools and workplaces were the most relevant measures of “I stay home” decree together with the use of protective devices.

It is certainly unquestionable that this decision helped to prevent the further spread of the virus and was a necessary arrangement to limit the number of patients in hospitals. Nevertheless, from a psychological point of view, people undergoing this first form of intervention have been exposed to feelings of uncertainty, fear, anger and frustration that may easily lead to anxiety, boredom and/or uneasiness (Brooks et al, 2020; Rubin and Wessely, 2020; Wang et al, 2020; Holmes et al, 2020)

This new situation where people were forced to manage work or study at home, with all the burden of worries derived from almost inevitable health risks and social distancing, is having a strong impact on daily functioning and night-time sleep (Altena et al, 2020).

Sleep and stress have been described in a bidirectional relationship across the life span (Lo Martire et al, 2019) with stressors impacting on sleep quality and vice versa. In particular, high levels of cognitive and physiological arousal in response to stressors have been hypothesized to interfere with sleep according to the hyperarousal model of insomnia within the framework of a self-reinforcing loop (Harvey, 2002; Morin et al, 2002; Morin and Espie, 2003; Harvey et al, 2005; Bonnet and Arand, 2010; Riemann et al, 2010, Harvey et al, 2014; Riemann et al, 2015). In this difficult period, vigilance was constantly high: feelings of loss, excessive use of internet to seek information or to maintain social relationships, worries about being infected, impulsive decisions and rigid expectations were just some of the factors that could have interfered with a good sleep quality in the Italia population. Moreover, quarantine could have reduced the daylight exposure, which is essential for synchronizing the circadian body clock, consequently affecting many processes including sleep and mood (Mc Clunck, 2013; Vadnie and Mc Clunck, 2017). Hence in this study we aimed to study the quality of sleep in the Italian population during the lockdown imposed by the “I stay home” decree issued by the Italian government (10th March) to its end (4th May – the so-called 2nd phase) expecting to find a disturbed sleep.

In addition, since sleep quality is well known as being a crucial element of psychological health and a disturbed sleep has been related to psychopathology (Herstein et al, 2019), we wanted to study levels of anxiety, depression and stress in the Italian population in relation to the quality of sleep experienced during the look down.

2 Material and Methods

2.1 Study design

We conducted a cross-sectional study using a short socio-demographic and COVID-19 related information chart and self-administered questionnaire delivered through internet survey. Data were collected from the issue of the “I stay home” Italian government decree (“1st phase” – total lockdown) on 10th March to 4th May 2020 (“2nd phase” – end of lockdown).

2.2 Ethical statement

This study was conducted in accordance with the Declaration of Helsinki and the study protocol was approved by the Ethics Committee of the Center for Research and Psychological Intervention (CERIP) of the University of Messina. Electronic informed consent was obtained from each participant prior to starting the investigation. Participants could withdraw from the survey at any moment without providing any justification.

2.3 Procedure and participants

The data were collected through an online survey (conducted with Microsoft Azure). In the Microsoft Azure platform, information and consent to the processing of personal data have been prepared and, furthermore, consent has been requested to provide an email contact; the subject was asked to create an identification code in order to anonymize it. Only after expressed consent the URL of the Google Form (Google Form) was available and the subject needed to affix the identification code previously created to secure anonymity for all the Partners and collaborators involved in this multicenter project. Questionnaires were created on the Google Cloud platform which was anonymous. The survey study was advertised via university communication systems as well as online forums (e.g., through virtual learning environments and Facebook accounts) or WeChat groups. Our questionnaire was set to proceed only when each option was completed before the final submission.

The study surveyed a convenience sample of 6,519 adults from 18 years old or above who lived in Italy and were recruited via advertisements in several Italian universities (University of Parma; University of Messina; Catholic University of Milan; University of Milan, La Statale; University of Napoli, Federico II). The exclusion criteria included different nationalities aside from the Italian one and incomplete questionnaires. Thirty-seven respondents were excluded for incomplete data and 43 participants were excluded because they have other nationality.

2.4 Measures

2.4.1 Demographic information

The variables examined in the socio-demographic section included: gender, age, marital status (single or not), education level (secondary education or higher), occupation (employed or unemployed), nationality and region of origin, general information about family and home (children, number of people living in the house, size of the house, presence of garden), type of occupations, information about work changes (modalities, number of hours), issues related to COVID-19 (positive relatives or friends), social relationships changes (face to face contacts, online).

According to the Italian Institute of Statistics (ISTAT), the Italian territory can be subdivided into three macro-areas defined as follows: North (1): Valle D'Aosta, Piedmont, Lombardy, Liguria, Emilia Romagna, Friuli-Venezia Giulia, Trentino-Alto Adige, Veneto; Center (2): Lazio, Marche, Tuscany and Umbria; South (3) Abruzzo, Molise, Campania, Apulia, Basilicata, Calabria, Sardinia and Sicily.

The classification of occupations is based on an official list ("Nomenclatura e classificazione delle unità professionali – CP2011, ISTAT). Additionally, we added the following categories: unemployed or looking for work; pensioners; working students or not, and we extrapolated the health professions from the ISTAT categories.

2.4.2 The Medical Outcomes Study – Sleep Scale (MOS-SS)

The sleep quality of the Italian population during the lockdown period was assessed using the Medical Outcomes Study- sleep scale (MOS-SS) (Hays and Stewart, 1992). The MOS-SS is a self-administered validated instrument with 12 self-reported questions to determine sleep quality and quantity within a 4-week period. Ten of the 12 MOS-SS items are scored on a six-point categorical scale ranging from “all of the time” to “none of the time”. The question about the time required to fall asleep uses a five-point categorical response scale ranging from “0 to 15 minutes,” to “more than 60 minutes”. “Sleep duration” is reported by subjects as the average number of hours they sleep each night. All domains except sleep duration are converted from 0 to 100, and item 2 is recorded as the average number of hours slept per night (0-24 hours).

The questionnaire provides six measures for sleep quality: sleep disturbance, snoring, awakening short of breath or with headache, sleep adequacy, somnolence and sleep duration/optimal sleep. Finally, MOS-SS has a global index to assess quality of sleep defined Sleep Index II, an aggregate measure of responses to nine of the questions pertaining to four sleep domains (sleep disturbance, awakening short of breath or with headache, sleep adequacy and somnolence). Scores for the MOS-Sleep Index II range from 0 to 100, with higher scores indicating greater sleep problems. A cut-off scoring of 25.8 (Hays et al, 2005; Rejas et al, 2007) is considered as having poor sleep. The Italian version is available (Palagini and Manni, 2016).

In this study, the degree of reliability of Sleep Problem II index scales was good, with a Cronbach’s α of 0.85.

2.4.3 The Depression Anxiety Stress Scale – 21 (DASS-21)

Symptoms of common mental health status were assessed using the short form of Depression, Anxiety, and Stress Scales – 21 Items (DASS-21) (Lovibond & Lovibond, 1996). The DASS-21 is a self-report measure in which participants rate the frequency and severity of depression, anxiety, and stress (emotional reactions). Items consist of statements referring to the previous week and each item is scored on a 4-point scale (0= “Did not apply to me at all”, to 3= “Applied to me very much, or most of the time”).

As measured by the DASS-21, depression assesses dysphoria, anhedonia, lack of incentive, and low self-esteem; anxiety refers to somatic and subjective symptoms of anxiety and an acute response of fear; stress evaluates irritability, impatience, tension, and persistent arousal.

Subscale scores are calculated as the sum of the responses to the seven items from each subscale multiplied by 2 to suit the original 42 items (REF). The cut-offs for severe rating of depression, anxiety and stress are ≥ 21 , ≥ 15 and ≥ 26 , respectively Lovibond & Lovibond, 1996).

In the current study, the Italian version of DASS-21 showing excellent psychometric properties was adopted (Bottesi et al, 2015).

Excellent levels of reliability were detected in this sample (Depression, $\alpha = 0.89$; Anxiety, $\alpha = 0.83$; Stress, $\alpha = 0.90$).

2.5 Statistical analysis

Continuous variables were presented as mean and standard deviation (SD), while categorical variables as absolute (n) and relative frequency (%). Chi-square test was used to evaluate the univariate association between MOS-Sleep Index II (sleep disturbance vs. no sleep disturbance) and all the variables described in the method section. Multiple logistic regression model was used to evaluate the multivariate association between the dependent variable (good sleeper vs. poor sleeper) and all the variables that were significant in the univariate analysis. The results were presented as odds ratio (OR) with respective 95% confidence interval (95% CI). A p-value of < 0.05 was considered statistically significant.

Cronbach's Alpha was used to evaluate the reliability of the questionnaires used in the survey. Statistical analysis was performed using statistical package Stata SE, 14.2.

3 Results

Our study sample consisted of 6,439 participants: 4,707 (73.1%) females and 1,732 (26.9%) males. The mean age of the sample was 33.9 (SD= 27.6; range 18–82 years) and most of the participants were living in Northern Italy (67.4%). Less than half of the sample had a high school diploma (46.9%) and 28.7% were students. With regard to marital status, 34.9% were unmarried and 28.6% had children.

In Tables 1A, B we show all characteristics and differences of the good sleeper and poor sleeper groups in terms of demographic data, living situation during the COVID-19 outbreak, COVID-19 outbreak-related questions, sleep-related data and mental health in terms of stress, anxiety and depression. There were 6,439 participants in our study. A total of 3,562 (55.32%) participants reported poor sleep quality according to the MOS-Sleep Index II score. All participants were divided into two groups, poor sleeper (MOS-Sleep Index II total score $\geq$ 25.8) and good sleeper (MOS-Sleep Index II total score <25.8). In Figure 1A, B we show the graphical representation of percentages of poor sleeper stratified for the variables.

Table 2 shows the multiple binary logistic regression results of poor sleepers. Significant factors were found in female gender (OR:1.650; 95% CI:1.443-1.889), living in Central Italy (OR:1.377; 95% CI:1.089-1.740), having someone close who died due to COVID-19 (OR:1.394; 95% CI:1.085-1.794), earlier (OR:1.591; 95% CI:1.220-2.076) or postponed (OR:2.100; 95% CI:1.813-2.418) habitual bedtime, earlier habitual awakening time (OR:1.47; 95% CI:1.142-1.909), reduced number of afternoon naps (OR:1.323; 95% CI:1.126-1.553), experiencing a mild (OR:2.091; 95% CI:1.746-2.505), moderate (OR:2.561; 95% CI:2.121-3.093), severe (OR:3.271; 95% CI:2.519-4.248), or extremely severe (OR:4.824; 95% CI:2.948-7.996) level of stress, having mild (OR:1.624; 95% CI:1.299-2.030), moderate (OR:2.378; 95% CI:1.969-2.872), severe (OR:3.249; 95% CI:2.327-4.537), or extremely severe (OR:3.841; 95% CI:2.609-5.654) level of anxiety, and having mild (OR:1.540; 95% CI:1.306-1.816), moderate (OR:1.667; 95% CI:1.306-1.995), severe (OR:1.775; 95% CI:1.348-2.337), or extremely severe (OR:2.394; 95% CI:1.663-3.446) level of depression. Furthermore, being positive to COVID-19 was almost significant (OR:1.973; $p=0.066$). In Figure 2A, B we show the graphical representation of Odds Ratio and relative 95%.

4 Discussion

As far as we know, this is the first study to assess sleep quality and its negative consequences on mental health in the Italian population during the whole COVID-19 lockdown (from 10th March – 1st phase - to 4th May – 2nd phase). This survey interestingly highlights how quarantine and restriction measures worsened sleep habits, leading to a whole series of consequences on people's health. In particular, our study found that 55.32% of the sample of 6,439 Italian participants experienced disturbed sleep during the outbreak restrictions.

In our study, the poor sleeper group presented with more negative effects on psychological well-being related to the COVID-19 lockdown. We outlined some risk factors for the development of sleep disturbance: female gender (60.5%), living in Central Italy, having children, losing a loved one due to COVID-19, having markedly changed sleep-wake rhythms specifically going to bed earlier or later than the usual time, getting up earlier than usual and having increased the habitual napping time, having highly severe stress (93.6%), anxiety (92.1%) and depression (90%).

286 The prevalence rate of poor sleepers in our population is consistent with 52.4% and 57.1% of two
287 Italian residents surveys [lockdown period: from 17th to 23rd March (Cellini et al, 2020) and from 18th
288 March to 2nd April (Casagrande et al., 2020)] and higher than in China's general population (36.38%)
289 (online survey from 18th to 25th February) (Zhao et al, 2020) during the outbreak. In addition, our
290 sample with sleep problems reported a remarkable alteration in their sleep habits: 64.8% reported
291 postponing or strongly anticipating (63.7%) bed time; 69.7% reported the need for delayed awakening
292 and an increased napping time in 60.8% during the daytime. All these lifestyle changes seem to be
293 followed by concerning symptoms, such as altered sleep-wake rhythms, which can be interpreted by
294 the negative psychosocial changes observed by Brooks et al. (2020), especially in sleep habits during
295 the COVID-19 outbreak. Evidence (Lo Martire et al, 2019) shows that temporally close excessive
296 and unpredictable stress can impact on the defense system and the central nervous system: stress is
297 modulated by the individual's psychological responses, which include neuro-endocrine and
298 behavioral components, such as changes in the activity and immune function of the hypothalamic-
299 pituitary-adrenal (HPA) axis. Consequently, the activation of the HPA system by stress is
300 incompatible with physiological sleep leading lower sleep quality, longer sleep latency, increased
301 awareness during the night, and more sleep complaints (Tempesta et al, 2013). On the other hand,
302 impairment of sleep quality is a common behavioral consequence of the acute and chronic response
303 to sleep, stress and trauma (Lo Martire et al, 2019) and determines further increases in the HPA
304 system, thereby promoting a vicious cycle of stress and worse sleep quality (Lo Martire et al, 2019)

305 In addition, our results showed that sleep habits affected by quarantine had a strong impact on sleep
306 quality: individuals who go to bed earlier (OR:1.591; 95%; IC: 1.220-2.076) or after the usual time
307 (OR:2.100; 95%; IC: 1.813-2.418) and wake up earlier (OR:1.477; 95%; IC: 1.142-1.909) than usual
308 or have increased habitual napping time (OR:1.117; 95%; IC: 0.974-1.280) have poor sleep quality.
309 Regular schedules also played a role: there is an association between irregular schedules and the
310 complaint of poor sleep (Pilz et al, 2018). Quality sleep requires regular schedules: numerous studies
311 on the deleterious effects of shift work and social jet-lag prove the negative effects of these disturbed
312 rhythms, both metabolically and psychiatrically (Sudi et al, 2019; Rutters et al, 2014; Levandovski et
313 al, 2011). The biological clock depends on a strong light signal in the morning to update the central
314 clock (Roenneberg et al, 2013). Exposure to intense light in the evening directly stimulates the arousal
315 systems, thus the individual remains more vigilant and goes to bed later (Phipps-Nelson et al, 2003).
316 In addition, exposure to light in the evening shifts the biological clock by blocking the secretion of
317 melatonin, causing early morning awakening. This lag may become confusing for the subject once
318 the confinement measures are over: resetting the clock can be difficult, with severe drowsiness and
319 sleeplessness in the evening.

320 The present study also found a strong association, also recently documented in the Italian population
321 (Cellini et al, 2020; Casagrande et al, 2020), between those who have poor sleep quality and
322 psychological distress. In particular, our study reveals that those who have low sleep quality had a
323 4.824 times higher probability of experiencing stress (95%; CI: 2.948-7.996), a 3.841 times higher
324 probability of experiencing anxiety (95%; CI: 2.609-5.654) and a 2.394 times higher probability of
325 experiencing depression (95%; CI: 1.663-3.446) versus those who do not have sleep problems.

326 Since quarantine is characterized by self-isolation, social estrangement, separation, loss of freedom
327 and uncertainty, negative emotions such as fear, anger and frustration are common and may lead to
328 anxiety, boredom and / or a feeling of uneasiness (Brooks et al, 2020; Qiu et al., 2020; Holmes et al,
329 2020). Such feelings endorse negative beliefs about the individual ability to cope. In this context,
330 Brooks et al (2020) present the main factors that seem to negatively influence our system during the
331 quarantine period: 1) duration of the quarantine; 2) fear of getting infected / spreading the infection;
332 3) feelings of frustration and boredom; 4) inadequate supply capacity; and 5) lack of sufficient /
333 salient information (Brooks et al, 2020). Moreover, the impossibility to take part in usual day-to-day

activities, like outdoor physical activity or physical contact with others, together with dramatic changes in working modalities might encourage a dysregulation of the wake/sleep cycle (Panahi and Tremblay, 2018)

According to the cognitive-behavioral model of insomnia, the 3P model, stress is the most common precipitating factor (Spielman et al, 1987). Therefore, all the highlighted COVID stressors seem to trigger elevated cognitive and physiological hyperarousal in a vicious circle that feeds itself. And could have impaired sleep quality. Furthermore, when the perceived stress exceeds an individual's resources, the consequent change in the emotional state (e.g., anxiety) affects wellbeing (Lazarus and Folkman, 1984; Lazarus et al, 1985). Moreover, recent studies underlined how sleep deprivation (Spiegelhalder et al, 2013) significantly reduces the functional connectivity in frontal brain regions, including the ventromedial regions involved in strategies of decision making based on reward and punishment. These alterations have been related with a loss in emotional control and a general tendency to take impulsive and risky decisions that may contribute to maintaining the mood disorder (Kalmbach et al, 2018).

Furthermore, in line with scientific evidence on sleep disturbances (Leger et al, 2008; Terzano et al, 2004; Ohayon and Smirne, 2002) the female gender is more exposed than the male to have a problem with sleep (OR = 1.60; 95%; CI: 1.443-1.889). According to other studies on epidemic and quarantine conditions, in nation-wide pandemic catastrophes, sleep disorders are more present in women than men (Kendler et al, 2001; McLean & Anderson, 2009). Some evidence (Davidson, 2008; Zhang and Wing, 2006; Driver et al, 1996; Baker and Drivers, 2004; Dzaja et al, 2005) shows that the changing hormone profile across the reproductive life of a woman, from puberty through the reproductive period to the postmenopausal years, may have a significant influence on sleep leading to sleep alteration or disruption and other vulnerabilities specific to psychological disorders in women (Soni et al, 2013).

Moreover, in our study, the death of someone close due to COVID-19 seems to be a risk factor (OR:1.394; 95%; IC:1.085-1.794) in the onset of a sleep disorder, as described in the literature (Morin et al, 2003; Healy et al, 1981; Monk et al, 2008). The death of family members or close friends can be very traumatic, especially when the circumstances are unexpected as in this period. Surely, in this dramatic period, not being able to bid farewell and give loved ones a worthy burial have certainly worsened the grief over the loss, with consequences on sleep.

Paradoxically, in our sample, neither age nor the type of occupation seemed to represent a risk factor in developing sleep disorders, as it has been instead described in the Chinese healthcare staff and attributed to the grueling work shifts and the constant witnessing of death and suffering. Most likely, our sample of healthcare professionals was too small (5.7%) compared not only to the other professions but also to the Chinese sample, since our survey was voluntary and did not involve a direct administration (Xue et al, 2020; Zhang et al, 2020; Xiao et al, 2020; Pappa et al, 2020) in the front line (hospitals), where these workers were active. In addition, with age, nighttime sleep becomes more fragmented and total sleep time is reduced (Ohayon et al, 2017). In this stressful condition where COVID induced profound changes in sleep habits, we may all find ourselves, regardless of age differences, experiencing sleep in a problematic way.

Additionally, in our study we saw that also not having children is associated with sleep problems (OR:1.292; 95%; IC: 1.004-1.663). School and work help parents to ease the construction of optimal sleep duration and quality in their children: by respecting time rules they develop a rhythm that is functional to the best sleep hygiene (Caldwell et al, 2020; Buxton et al, 2015). It follows that people who have kids, often burdened by the family load, pursue more regular sleep times than those who do not have children, who therefore can lack of fixed times and be prone to sleep deficiency. This is

more likely to be present when single adults do not adhere to sleep hygiene standards especially in this period of forced confinement at home.

Another interesting result that we reported is a risk of sleep problems (OR:1.377; 95%; IC: 1.089-1.740) in Central Italy, although those who live in Northern Italy have been considered the main Italian core of the emergency, due to the greater number of infections and deaths (Istituto Superiore di Sanità, 2020). Maybe, the worries about personal safety, transmitting the disease to family members, stigmatization from being infected, shift work, and interpersonal isolation can manifest by hyper-arousal states, as well as problems with anxiety and stimulus control. Stigma can lead to continued fear as people with a disease anticipate discrimination (Audet et al, 2013) and we know at the same time that stigma can be one of the most powerful barriers to delivering prevention, treatment, and care to the most vulnerable, who are at the same time the most in need. Moreover, it is possible to hypothesize that another explanation of this result is due to the fact that residents of this area, following the violent Aquila earthquake, have developed greater psychological consequences and are more prone to develop post-traumatic stress disorder symptomatology affecting sleep (Ferrara et al, 2016; Tempesta, 2013). Finally, the people living in this location perceive themselves to be at higher risk of infections. In fact, some studies (Cacciaglia et al, 2017; Alexander and Klein, 2001) suggested that people who were repeatedly exposed to traumatic events were prone to suffering from many psychological problems and consequently have sleep disturbances.

We believe that multidisciplinary action should be taken in order to plan appropriate responses to the current crisis caused by the COVID-19 health emergency. In particular, as our results highlight, the poor quality of sleep, especially in predisposed subjects, might represent a risk factor for the development of chronic insomnia or other sleep disorders. Moreover, we confirm the negative psychosocial changes observed by Brooks et al (2020), especially in sleep habits. These are probably caused not only by factors such as poor exposure to sunlight, reduced physical activity and psychological distress (Altena et al, 2020) but also to the lack of regular and scheduled activities.

In Italy, in fact, the Italian Associations of Sleep Medicine have started an intensive awareness campaign about sleep problems during the lockdown and developed an online help desk (<http://www.sonnomed.it/>) where the best sleep medicine experts (neurologists, pulmonologists, psychiatrists and psychologists) respond online to requests of whoever feels the need to improve sleep in this time.

Altogether, the results of our study seem to be relevant to outline risk factors for sleep quality in the Italian population during the COVID-19 emergency, but some limitations need to be considered. First, our study is not representative of the sample compared to the Italian population: it was a sample of convenience. In addition, the data and results derived from a cross-sectional design: it was difficult to make cause-and-effect hypotheses. Second, having adopted an online survey limits the generalizability of the results, although it currently represents the only solution for data collection in time of outbreak. Subsequently, recruitment bias emerged in our sample, which is characterized by a high number of students and women. This aspect should be considered in the interpretation of the results. Third, in this survey we adopted only a self-report questionnaire. Despite the importance of measuring the subjective perception of sleep and distress, semi-objective or objective measures of sleep (like sleep diary or actigraphy) and distress would be useful to support our findings.

5 Conclusion

This is the first study designed to understand sleep quality in the Italian population that provides more than 6,000 participants in a survey developed specifically for the health emergency related to COVID-

19. Our study found that more than half of the Italian population have had impaired sleep quality and sleep habits during the COVID-19 lockdown containment measures. The related factors included female gender, Italian territory, having children, loss of a loved one due to COVID-19, changes in sleep habits and elevated psychological distress. A multidisciplinary intervention for sleep disorders and related psychological discomfort is fundamental to take actions to deal with the current crisis caused by the COVID-19 health emergency.

Ethical statement

This study was conducted in accordance with the Declaration of Helsinki and the study protocol was approved by the Ethics Committee of the Center for Research and Psychological Intervention (CERIP) of the University of Messina. Electronic informed consent was obtained from each participant prior to starting the investigation. Participants could withdraw from the survey at any moment without providing any justification.

Author Contributions

CF provided substantial contributions to the conception of the work, deep analysis of the literature, study design, development, and final approval of the manuscript. AM contributed in the design of the study and participated in the development and revision of the work and agreement for final approval of the manuscript. CZ and AP contributed to data analysis and agreement for final approval of the manuscript. MCQ, VL, MFF, DL, EV, LB, ES, RC contributed to the revision of the work and agreement for final approval of the manuscript. LP, LGD, DR, GP and GC contributed to deep revision of the work, with literature analysis and agreement for final approval of the manuscript.

Conflict of Interest Statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. Giuseppe Plazzi is consultant and participated in advisory board for UCB Pharma, Jazz pharmaceuticals, Bioprojet, Takeda, and Idorsia outside the submitted work.

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Table 1 - A

Comparisons between the Good Sleeper vs. Poor Sleeper sample with chi-square tests on demographic data and living situations.

	Good Sleeper (n=2,877)	Poor Sleeper (n=3,562)	<i>p</i>
Demographic data			
<i>Gender, n (%)</i>			< 0.001
Males	1,017 (58.7)	715 (41.3)	
Females	1,860 (39.5)	2,847 (60.5)	
<i>Age (years old), n (%)</i>			
18-25	1,026 (39.4)	1,579 (60.6)	< 0.001
26-30	427 (40.7)	622 (59.3)	
31-40	406 (44.3)	511 (55.7)	
41-50	413 (52.1)	380 (47.9)	
51-60	455 (54.9)	374 (45.1)	
>60	150 (61.0)	96 (39.0)	
<i>Italian territory, n (%)</i>			
North	2,022 (46.6)	2,321 (53.4)	< 0.001
Center	175 (37.5)	292 (62.5)	
South	680 (41.7)	949 (58.3)	
<i>Education, n (%)</i>			
Elementary/Middle school	99 (45.0)	121 (55.0)	< 0.001
High school	1,358 (44.9)	1,663 (55.1)	
Bachelor's degree	480 (39.3)	741 (60.7)	
Master's degree	685 (46.9)	775 (53.1)	
Doctoral degree	255 (49.3)	262 (50.7)	
<i>Marital status n (%)</i>			
Single	946 (42.1)	1,303 (57.9)	< 0.001
Married or re-married	845 (52.3)	771 (47.7)	
Cohabitant	285 (48.1)	305 (51.9)	
In a relationship	657 (38.8)	1,035 (61.2)	
Divorced/separated/widowed	144 (49.3)	148 (50.7)	
<i>Children (yes), n (%)</i>			< 0.001
Yes	925 (50.2)	919 (49.8)	
No	1,952 (42.5)	2,643 (57.5)	

People living with you, n (%)

0	213 (45.0)	260 (55.0)	< 0.001
1	694 (49.9)	695 (50.1)	
2	687 (43.6)	887 (56.4)	
3	848 (44.0)	1,079 (56.0)	
4	318 (39.0)	496 (61.1)	
5+	117 (44.7)	145 (55.3)	

Home size (sq. m.), n (%)

≤ 80	693 (42.1)	954 (57.9)	< 0.001
81-100	703 (43.8)	902 (56.2)	
101-150	800 (46.5)	922 (53.5)	
> 150	681 (46.5)	784 (53.5)	

Having a Garden or Balcony, n (%)

Yes	2,624 (45.1)	3,198 (54.9)	< 0.001
No	253 (41.0)	364 (59.0)	

Work-related data*Working with the public, n (%)*

Yes	1,749 (42.7)	2,347 (57.3)	< 0.001
No	1,128 (48.1)	1,215 (51.9)	

Still working (yes), n (%)

Yes	1,622 (47.8)	1,772 (52.2)	< 0.001
No	1,255 (41.2)	1,790 (58.8)	

Work modality, n (%)

Only in office	343 (47.6)	378 (52.4)	0.033
Only through smart working	991 (45.5)	1,187 (54.5)	
In office and through smart working	138 (54.8)	114 (45.2)	
Mostly in office	58 (50.4)	57 (49.6)	
Mostly through smart working	142 (51.1)	136 (48.9)	

Consequences on work, n (%)

Increased working hours	340 (45.8)	403 (54.2)	0.582
Work interruption	687 (44.8)	846 (55.2)	
Stable, with same starting time	60 (45.5)	72 (54.5)	
Stable, with earlier starting time	532 (45.7)	633 (54.3)	
Stable, with postponed starting time	189 (48.6)	200 (51.4)	

Reduced working hours	577 (43.5)	751 (56.5)	
Unemployed	502 (42.9)	669 (57.1)	
Other	1 (50.0)	1 (50.0)	
<i>Occupation, n (%)</i>			
Retired	69 (59.9)	48 (41.0)	< 0.001
Student	717 (38.8)	1,133 (61.2)	
Working student	317 (37.2)	534 (62.8)	
Healthcare employee (public/private)	150 (40.4)	221 (59.6)	
Police/military	33 (62.3)	20 (37.7)	
Artisan, laborer, farmer	59 (58.4)	42 (41.6)	
Employee/manager/owner of business activity	298 (49.3)	306 (50.7)	
Employee/manager/owner of industrial activity	241 (59.2)	166 (40.8)	
Intellectual profession	255 (47.7)	280 (52.3)	
Unemployed/searching	108 (36.2)	190 (63.8)	
Office executive job	21 (60.0)	14 (40.0)	
Technical profession	175 (54.0)	149 (46.0)	
Non-qualified profession	381 (48.3)	408 (51.7)	
Other	53 (51.0)	51 (49.0)	

Table 1 - B

	Good Sleeper	Poor Sleeper	<i>p</i>
	(n=2,877)	(n=3,562)	
COVID-19 related data			
<i>COVID-19 positive, n (%)</i>			
No	2,803 (44.9)	3,431 (55.1)	0.303
Yes	18 (34.6)	33 (65.4)	
Had symptoms but no swab test	42 (38.9)	66 (61.1)	
No answer/other	8 (30.4)	10 (69.6)	
<i>Forced quarantine , n (%)</i>			
No	2,649 (45.1)	3,219 (54.9)	0.037
Yes	221 (40.2)	329 (59.8)	
No answer	7 (33.3)	14 (66.7)	
<i>Someone close positive, n (%)</i>			0.002

Yes	377 (40.0)	566 (60.0)	
No	2,500 (45.5)	2,996 (54.5)	
<i>Someone close died, n (%)</i>			0.004
Yes	160 (38.3)	258 (61.7)	
No	2,717 (45.1)	3,304 (54.9)	
<i>Changes in physical relationships, n (%)</i>			
Decreased	2,554 (45.1)	3,108 (54.9)	< 0.001
Stable	171 (47.8)	187 (52.2)	
Improved	152 (36.3)	267 (63.7)	
<i>Changes in online relationships, n (%)</i>			
Decreased	147 (42.7)	197 (52.3)	0.020
Stable	958 (47.3)	1,068 (52.7)	
Improved	1,772 (43.5)	2,297 (56.5)	
Sleep-related data			
<i>Changes in the habitual bedtime, n (%)</i>			
Earlier	151 (36.3)	265 (63.7)	< 0.001
Stable	1,494 (59.3)	1,025 (40.7)	
Postponed	1,232 (35.2)	2,272 (64.8)	
<i>Changes in the habitual awakening time, n (%)</i>			
Earlier	154 (30.3)	354 (69.7)	< 0.001
Stable	1,284 (54.3)	1,079 (45.7)	
Postponed	1,439 (40.3)	2,129 (59.7)	
<i>Changes in the habitual napping, n (%)</i>			
Reduced	1,085 (43.9)	1,387 (56.1)	< 0.001
Stable	1,249 (48.3)	1,336 (51.7)	
Increased	542 (39.2)	839 (60.8)	
Mental Health			
<i>Stress, n (%)</i>			
Extremely severe	25 (6.4)	362 (93.6)	< 0.001
Severe	121 (14.9)	694 (85.1)	
Moderate	274 (25.2)	811 (74.8)	
Mild	291 (36.9)	498 (63.1)	

Normal	2,166 (64.4)	1,197 (35.6)	
<i>Anxiety, n (%)</i>			
Extremely severe	38 (7.9)	504 (92.1)	< 0.001
Severe	49 (12.1)	355 (87.9)	
Moderate	203 (22.7)	693 (77.3)	
Mild	159 (33.2)	320 (66.8)	
Normal	2,428 (59.0)	1,690 (41.0)	
<i>Depression, n (%)</i>			
Extremely severe	55 (10.0)	497 (90.0)	< 0.001
Severe	107 (19.4)	444 (80.6)	
Moderate	338 (27.6)	888 (72.4)	
Mild	411 (41.1)	590 (58.9)	
Normal	1,966 (63.2)	1,143 (36.8)	

Table 2. Multivariable logistic regression analysis of the Poor sleeper sample.

Variable	OR	<i>p</i>	95% CI
Demographic data			
Gender (female)	1.650	< 0.001	1.443-1.889
Age			
18-25	1.075	0.759	0.678-1.703
26-30	1.231	0.355	0.793-1.910
31-40	1.192	0.397	0.794-1.789
41-50	1.002	0.993	0.676-1.484
51-60	1.070	0.727	0.731-1.567
>60	reference		
Italian territory			
North	reference		
Center	1.377	0.007	1.089-1.740
South	1.129	0.102	0.976-1.306
Education level			
Elementary/middle school	reference		
High school	0.843	0.328	0.599-1.186
Bachelor's degree	0.951	0.789	0.660-1.371
Master's degree	0.931	0.703	0.648-1.340
Doctoral degree	0.880	0.540	0.585-1.323
Marital status			
Single	reference		
Married or re-married	0.948	0.691	0.731-1.231
Cohabit	0.839	0.177	0.650-1.083
In a relationship	0.891	0.144	0.764-1.040
Divorced/separated/widowed	1.022	0.905	0.715-1.460
Children (no)	1.292	0.046	1.004-1.663
People living with you			
0	reference		
1	0.809	0.129	0.616-1.063

2	0.933	0.627	0.705-1.235
3	0.893	0.437	0.672-1.186
4	1.113	0.506	0.812-1.526
5+	0.806	0.288	0.542-1.199
Home size (sq. m.)			
≤ 80	reference		
81-100	1.002	0.978	0.842-1.193
101-150	0.862	0.098	0.724-1.027
> 150	0.881	0.190	0.730-1.064
Having a Garden or Balcony(yes)	0.899	0.311	0.732-1.104
Working with the public (yes)	1.114	0.110	0.976-1.272
Still working (yes)	0.978	0.744	0.856-1.118
Occupation			
Retired	reference		
Student	1.027	0.926	0.589-1.788
Working student	0.992	0.977	0.564-1.744
Healthcare employee (public/private)	1.360	0.294	0.766-2.415
Police/military	0.924	0.851	0.404-2.114
Artisan, laborer, farmer	0.676	0.270	0.337-1.356
Employee/manager/owner of business activity	0.882	0.657	0.508-1.532
Employee/manager/owner of industrial activity	0.810	0.464	0.460-1.425
Intellectual profession	0.826	0.500	0.473-1.440
Unemployed/searching	1.249	0.458	0.694-2.247
Office executive job	0.828	0.693	0.325-2.110
Technical profession	0.755	0.341	0.424-1.346
Non-qualified profession	0.897	0.695	0.521-1.545
Other	0.718	0.338	0.365-1.414
COVID-19 positive			
No	reference		
Yes	1.973	0.066	0.957-4.070

No answer	2.036	0.204	0.679-6.100
Had symptoms but no swab test	1.341	0.221	0.839-2.145
Other	1.183	0.775	0.375-3.731
Forced quarantine			
No	reference		
Yes	0.873	0.239	0.698-1.094
No answer	1.385	0.578	0.440-4.360
Someone close positive (yes)	0.982	0.839	0.822-1.172
Someone close died (yes)	1.394	0.010	1.085-1.794
Changes in physical relationships			
Decreased	reference		
Stable	1.096	0.486	0.848-1.414
Improved	1.171	0.206	0.917-1.496
Changes in online relationships			
Decreased	reference		
Stable	0.988	0.930	0.748-1.304
Improved	1.038	0.786	0.793-1.359
Changes in the habitual bedtime			
Earlier	1.591	0.001	1.220-2.076
Stable	reference		
Postponed	2.100	< 0.001	1.813-2.418
Changes in the habitual awakening time			
Earlier	1.477	0.003	1.142-1.909
Stable	reference		
Postponed	1.019	0.791	0.884-1.175
Changes in the habitual napping			
Reduced	1.323	0.001	1.126-1.553
Stable	reference		
Increased	1.117	0.114	0.974-1.280
Stress			
Extremely severe	4.824	< 0.001	2.948-7.996

Severe	3.271	< 0.001	2.519-4.248
Moderate	2.561	< 0.001	2.121-3.093
Normal	reference		
Mild	2.091	< 0.001	1.746-2.505
Anxiety			
Extremely severe	3.841	< 0.001	2.609-5.654
Severe	3.249	< 0.001	2.327-4.537
Moderate	2.378	< 0.001	1.969-2.872
Normal	reference		
Mild	1.624	< 0.001	1.299-2.030
Depression			
Extremely severe	2.394	< 0.001	1.663-3.446
Severe	1.775	< 0.001	1.348-2.337
Moderate	1.667	< 0.001	1.306-1.995
Normal	reference		
Mild	1.540	< 0.001	1.306-1.816

Figure 1A. Percentages of poor sleeper stratified for the variables. In bold the significant associations in the multivariable logistic regression mode.
The icons are selected from <https://icons8.it/>

Figure 1B. Percentages of poor sleeper stratified for the variables. In bold the significant associations in the multivariable logistic regression mode.

The icons are selected from <https://icons8.it/>

A. DEMOGRAPHIC DATA, HOUSING AND PROFESSIONAL CONDITIONS

Figure 2a: Multivariable logistic regression model with MOS-Sleep Index II (good sleeper vs. poor sleeper) as dependent variable and the others factors as independent variables: graphical representation of Odds Ratio and relative 95% Confidence Intervals)

B. COVID-19 AND SLEEP RELATED DATA, MENTAL HEALTH

Figure 2b: Multivariable logistic regression model with MOS-Sleep Index II (good sleeper vs. poor sleeper) as dependent variable and the others factors as independent variables: graphical representation of Odds Ratio and relative 95% Confidence Intervals)