Quantifying subjective sleep quality: Does anxiety, mobile phone dependence and coping style predict sleep quality?

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Abstract

Sufficient and efficient sleep can be affected by an individual's behaviour such as mobile phone dependence and management of daily life stressors through the use of coping styles. The current study explored whether the components of Consensus Sleep Diary would predict the composite score of Pittsburgh Sleep Quality Index (PSQI). In total, 29 participants completed a seven-day Consensus Sleep Diary and a one-off questionnaire assessing mobile phone dependence, anxiety, coping styles and PSQI at the end of the survey. The regression findings revealed a significant model of the sleep diary components predicting composite score of PSQI, global PSQI, but none of the sleep components significantly contributed to the outcome. Relative to other diary components, effect sizes of Wake After Sleep Onset (WASO) and Number of Awakenings (NWAK) were greater. A model was hypothesized suggesting that level of anxiety, mobile phone dependence, rational coping, detached coping, emotional coping and avoidant coping would predict the global PSQI. Although the hypothesized model was significant, only detached coping and emotional coping significantly predicted the sleep quality and with large effect. Results suggested that overall sleep quality may have a greater association with sleep fragmentation components like WASO, NWAK as well as detached and emotional coping styles. Therefore, for better sleep, the general population should improve their sleep continuation and the way they manage stress. Implications involve promoting healthy coping styles in universities, the work-place, clinical settings and awareness campaigns.

Key words: sleep quality, anxiety, mobile phone dependence, coping styles, sleep fragmentation

Introduction

Good sleep quality is crucial to an individual's social, cognitive and personal capacities (Gildner, Liebert, Kowal, Chatterji & Snodgrass, 2014). The current technology-driven world has seen a reduction in sleep quality caused by disruption in sleep patterns and hampering of an individual's internal processes like managing anxiety and stress (Sano et al., 2015). Unhealthy sleep patterns, repetitive sleep disturbances and shorter sleep latencies affect the lifestyle, work- functioning (Kabrita, Hajjar-Muca & Duffy, 2014) and neurobehavioral functioning (Shekleton et al., 2014). In light of reduced sleep quality, there is a need to investigate growing dependence on the mobile phone, heightened levels of anxiety and maladaptive coping styles which have worsened the sleep quality. The present study used a retrospective design for examining subjective sleep quality and developed a model of anxiety, coping style and mobile phone dependence that predicts sleep quality. Additionally, the study examined whether a composite sleep quality score of the questionnaire (PSQI; Buysse, Reynolds, Monk, Berman & Kpufer, 1989) can be predicted by the seven-day sleep diary (CSD; Carney et al., 2012).

Sleep Quality

Sleep quality is an individual's measure of sleep experience, integrating constructs of sleep initiation, duration, maintenance, alertness, external stimuli disturbances awakenings and refreshment upon awakening. Categorisation of sleep as 'bad' or 'good' is subjected to the individual's experience of healthy functioning and satisfaction felt upon waking up.

Prevalence rates of poor sleep quality range from 10% to 48% of general population (Ohayon & Smirne, 2002; Wong & Fielding, 2011), specifically 11% to 47% adolescents face difficulty in initiating and maintaining sleep (Liu & Zhou, 2002; Russo, Bruni, Lucidi, Ferrri & Violani, 2007). These statistics show a wide population is suffering from sleep difficulties, which is associated with anxiety, quality of mental life and socioeconomic status of the individual (Hinz et al., 2017). Therefore, lifestyle and environmental stressors would have an influence on the levels of sleep satisfaction for an individual. Poor sleep quality has been consistently linked with poor cognitive performance (Paavoven et al., 2010) stress (Lemma, Gelaye, Berhane, Worku & Williams, 2012), negative mood states (Zawadzki, Graham & Gerin, 2013), excessive rumination (Querstret & Cropley, 2012) and daytime sleepiness (Fortier-Brochu, Beaulieu-Bonneau, Ivers & Morin, 2012). These evidences underline the importance of exploring sleep quality in general population.

Role of sleep quality components

Indicators used to investigate sleep quality include sleep efficiency (ratio of total sleep time to time in bed), sleep latency (time taken to transit from wake state to asleep state), wake after sleep onset (WASO i.e. number of episodes per night wherein an individual is awake for greater than 5 minutes) and number of awakenings (frequency of episodes per night). Maintenance of these indicators is associated with sleep hygiene patterns (Knufinke, Nieuwenhuys, Geurts, Coenen & Kompier, 2017).

Furthermore, a recent meta-analysis of 277 studies provides a detailed view of sleep quality addressing both objective and subjective sleep measures (Ohayon et al., 2017). The results indicated that good sleep quality is denoted by a sleep latency ranging from 16 to 30 minutes, 0 or 1 awakenings per night, up to 20 minutes of WASO and a sleep efficiency ratio of 85%. Any deviation from these trends is categorised as poor sleep, specifically greater than 45 minutes of sleep latency, more than 4 awakenings per night, WASO of 41 minutes or more and sleep efficiency lower than 64% (Ohayon et al., 2017). They demonstrated that shorter sleep latency (Augner, 2011), higher sleep efficiency, lowered WASO and fewer awakenings per night were linked to better sleep quality. Therefore, analysing specific sleep components and attempting to establish their relationships with sleep quality can broaden implications of research. For instance, Knufinke et al. (2017) assessed 97 elite athletes for sleep quantity, quality and sleep hygiene for seven consecutive days using clinical questionnaires. The results drew attention to sleep onset latency and WASO for optimising sleep quality instilling better sleep hygiene, sleep-wake patterns and reduction of psychological strain. Hence, studying sleep components can shed light on what specific constructs an individual should target to improve overall sleep.

The equation of sleep continuity comprises of lesser fragmentation of sleep as illustrated in Ohayon et al. (2017) meta-analysis. Disrupted sleep has been found to result in increased daytime sleepiness (Dahl, 1996; Jones & Harrison, 2001) with reduced vigilance, impairing capacities of neurocognitive structures such as the prefrontal cortex, consequently affecting the performance of the individual (Anderson, Storfer-Isser, Taylor, Rosen & Redline, 2009). A cross-sectional study investigating effect of gender on sleep quality of 1485 elderly Dutch sample (Middelkoop, Smilde-van den Doel, Neven, Kamphuisen & Springer, 1996) observed that both, males and females suffered from excessive daytime sleepiness and an increment in time spent in bed. This was, in turn, associated with poorer sleep quality. This maintains the importance of sleep fragmentation for daytime functioning of individuals. The duration of sleep is an important indicator of sleep quality. Shorter sleep durations in 8 to 12-year old students is associated with poor sleep efficiency and impaired performance on attention and memory tasks (Vriend, Davidson, Corkum, Rusak, McLaughlin & Chambers, 2012). Consistent with these findings, longitudinal research shows that 186 (17-19 years) Canadian university students had a greater amount of sleep disturbances, shorter sleeping hours, later bedtime and later rise times during stressful periods at university and when away from home (Galambos, Lascano, Howard & Maggs, 2013). This would result in lower academic performance and overall a lower global Pittsburgh Sleep Quality score, which suggests poorer sleep quality (Gilbert & Weaver, 2010).

Henceforth, sleep quality should be measured through both continuity and duration or quantity components. A general review by National Sleep Foundation highlighted the importance of a need for clarity on the construct of sleep quality due to escalated public awareness for health and wellbeing (Ohayon et al., 2017). It illustrates the need to emphasise on the sleep quality components and awareness for how sleep quality can affect various dimensions of life.

Quantifying sleep quality

Subjective sleep quality can be quantified through the use of either questionnaires or diaries. These encompass questionnaires like Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989) or daily sleep logs monitored through sleep diaries like Consensus Sleep Diary (CSD; Carney et al., 2012). Both measures have been found to have good reliability, validity across varied population samples differing in age, geographical location, ethnicity, gender, occupations, education, and socioeconomic level (Ohayon et al., 2017). CSD-core lacks important constructs like 'use of sleep medication' and 'daytime dysfunction' that the PSQI has accommodated.

Additionally, both measures differ in the duration of retrospection as PSQI is administered at a single point and CSD collects a sleep log for 7 consecutive days. These differences exist in the time duration and accuracy of the data collected from participants (Landry, Best & Liu-Ambrose, 2015). Grandner, Kripke, Yoon & Youngstedt (2006) correlated the subjective measures of a self-developed sleep diary and PSQI in a non-clinical sample with a mean age of 33 while controlling for sleep disturbances and depression. Correlational relationships between the PSQI components and sleep diary variables were observed more in younger adults (M_{age} = 23) than the older sample (M_{age} = 66). For the older sample, all PSQI components correlated significantly with the diary variables like sleep efficiency, sleep latency, total sleep time and WASO but only sleep latency was significant in the younger group (Grandner, et al., 2006). However, the study did not adopt a standardized sleep diary measure to explore the criterion validity and limited generalization due to the selective sampling of physically healthy people. Furthermore, a study comparing 7-day sleep diary and a sleep questionnaire (developed by the research team) for an older sample found that both tapped similar sleep domains, but it could not be determined which measure was more efficient (Libman, Fichten, Bailes & Amsel, 2000). The use of a validated questionnaire instead of a self-developed questionnaire would have provided better scope for treatment and rehabilitation for the general population. Therefore, research needs to test the congruence between the standardized measures to determine whether the sleep quality measures can offer similar results when administered general population.

A model to predict sleep quality

Research investigating sleep quality has identified various factors that predict and contribute towards the construct's complexity. This includes factors such as exercise, technology exposure, mood, stress, depression and pain-specific disorders (Motl, McAuley, Snook & Gilottoni, 2009). In response to this literature on sleep quality, the following factors of mobile phone dependence, anxiety and coping styles, were investigated.

Mobile Phone Dependence

Recent advancements in technology have increased an individual's reliance on devices for managing daily life, leisure activities, social networking and maintaining knowledge (Leung, 2008). People seek the comfort of mobile phones to gain satisfaction and overcome negative states such as anxiety and stress (Billieux, Maurage, Lopez-Fernandez, Kuss, & Griffiths, 2015). Due to their attractive features,

the repetitive use of mobile phones reinforces the dependence upon them which later transforms into problematic behaviour (Billieux et al., 2015). For instance, a one-year follow-up of 20-24-year-olds found that greater mobile phone use was associated with symptoms of depression in women, stress symptoms in men and higher frequency of sleep disturbances (Thomée, Härenstam & Hagberg, 2011). They further explored the mobile phone exposure variables which could act as sources of stress and affect sleep. The cross-sectional analyses revealed that demands of being available were significantly associated with negative health outcomes (Thomée et al., 2011). Therefore, there is a possibility that the stress to stay available for work, family or personal reasons keeps the mind vigilant and cognitively active.

In addition to these qualitative mobile exposures, night-time text-messaging, emailing, browsing social media and notifications from the device can interrupt the sleep. Xanidis & Brignell (2016) examined the relationship between social networking use, sleep quality and cognitive functions in 324 social media users. The higher dependence induces withdrawal and compulsion, decreasing the quality of sleep. Consistent with these behaviours, individuals report 'feeling drained', 'lack of energy' because of getting up at night to check updates (Bhatia, Sharma & Chhabra, 2008) and texting (Ferraro, Holfeld, Frankl, Frye & Halvorson, 2015). This is concurrent to reduced sleep duration, increased interruptions in sleep with fewer deep sleep stages (Bhatia et al., 2008) and the categorisation of such individuals as “poor sleepers” (Ferraro et al., 2015). Furthermore, features such as calling and text-messaging on mobile phones are increasingly accessed at night (Van den Bulck, 2007). These studies have emphasised existing links with sleep quality but not determined whether the dependence could be predictive of poor sleep quality. The current trends predict a 4.9% of rise in smartphone ownership amongst general population by 2019 with an average of 94% increase within the group of 18-34-year olds (Statista, 2017), suggesting increment in the population who would be using cell phones in near future. Due to the assumption of higher technological exposure in the younger population, research is mostly conducted with university population or school students. Hence, surveying a wider generalized population could benefit in implications.

Anxiety

Key determinants of high mobile phone use such as a need to reduce negative states and demands of being accessible have been found to be correlated with higher anxiety. Cheever, Rosen, Carrier and Chavez (2014) examined the anxiety in university students when separated from their wireless mobile devices. The participants reported a higher level of anxiety as the duration of separation increased. Specifically, profuse mobile phone users reported increased anxiety levels when mediated by their dependency on the mobile devices. Adams and Kisler (2013) found that anxiety acted as a mediator between mobile phone use and sleep quality in university students. Global PSQI scores of the university students were significantly correlated with the level of anxiety and time awake due to the mobile phone. However, they could not provide evidence on whether or not mobile phone dependence was predictive of higher anxiety levels and poorer sleep quality. They suggested that more quantitative methods are required and more focus on the sleep quality variables.

The heightened level of anxiety has been found to affect sleep continuity measures like sleep onset latency and wake after sleep onset, as a result worsening sleep quality (Åkerstedt, Kecklund & Axelsson, 2007). However, similar results were not obtained in older adults. Spira, Stone, Beaudreau, Ancoli-Israel and Yaffe, (2009) found independent associations of anxiety with objectively measured sleep quality. Elevated anxiety in the older adults was characterised by greater sleep fragmentation and lower sleep efficiency but not with total sleep time, WASO or napping. These conflicting results suggest a combination of sleep duration and continuity variables can provide a greater insight into the sleep quality. However, it can be still be suggested that anxiety is associated with poorer sleep quality. Individual's characteristics, however, like self-esteem (Kim & Davis, 2009; Hong, Chiu & Huang, 2012), impulsivity (Billieux, Van der Linden, d'Acremont, Ceschi & Zermatten, 2007), self-efficacy and social support (Chiu, 2014) can act as protective factors for mobile phone dependence and anxiety.

Coping Styles

Behavioural and psychological stressors, such as anxiety, can be mediated by managing stress effectively. The cognitive and behavioural strategies employed by an individual to manage these demands by evaluating the resources available to them is known as coping (Lazarus & Folkman, 1984). According to their perspective, the extent of control over the situation can influence the choice of coping behaviour which, therefore, modifies the manner of coping utilised (Lazarus & Folkman, 1984). Coping styles can either be adaptive, or maladaptive; a style that can possibly helpful for a temporary period but is harmful in the longer run (Lazarus & Folkman, 1984). Literature suggests that adaptive coping is classified into rational coping- initiating action to change things and detached coping, aims at cognitively distancing the self from the stressor (Elkit, 1996). Contradictory to adaptive styles, maladaptive styles increase stress levels and are classified as emotional style (i.e. manipulating the affect felt towards the situation) and avoidance coping style is characterized by attempts to escape, ignore or block a situation psychologically and behaviourally (Espie, 2017).

Minimal work has explored the independent role of coping styles in sleep quality, but research has identified links between certain coping strategies and sleep quality. Most research is centred around emotion-focused and problem-focused styles in non-clinical samples and for avoidance coping in clinical populations. Compared to good sleepers, individuals facing sleeping difficulties perceive life events as more stressful due to an external locus of control (Morin, Rodrigue & Ivers, 2003). This lack of control would result in avoiding of stressors, lower energy levels and greater time spent in bed. Morin et al. (2003) compared 40 insomnia patients and 27 good sleepers for stress, presleep arousal, anxiety, coping skills and sleep for 21 days. The findings suggest that the misappraisal of stressors increased the vulnerability to insomnia and was associated with heavy reliance on emotion-focused coping. Additionally, the emotion-focused coping skill had a mediating effect on the relationship between sleep and cognitive presleep arousal, suggesting that engagement in emotion-centred thoughts hampered sleep efficiency. Supporting their results, Sadeh, Keinan, and Daon, (2004) found the use of emotion-focused coping increased during high-stress periods and was associated with shorter sleep in university students. Furthermore, greater problem-focused coping during both high and low-stress periods was associated with greater sleep duration. Hoyt, Thomas, Epstein and Dirksen (2009)

also concluded that greater use of avoidance coping for cancer-related stressors compromised the sleep quality and daily functioning. Therefore, we can draw a conclusion that emotion-focused coping would predict poorer sleep quality and adaptive coping styles like problem-focused should predict better sleep quality.

Past research has successfully found associations between compromised sleep quality and maladaptive coping styles. There is, however a shortcoming in focusing on broad themes of coping styles like problem-focused or emotion-focused and not identifying the specific element of coping style that could influence coping style. In an attempt to overcome this limitation, Roger et al's. (1993) classification of coping styles- rational, detached, avoidant and emotional styles have been employed to explore whether each of these coping styles could predict the sleep quality.

The current study

Despite the fact that the present literature has provided sufficient evidence for the association between mobile phone use, anxiety and sleep quality, the present study attempts to test a regression model (Figure 1) that predicts sleep quality from the aforementioned variables and coping style. The primary hypothesis was to test this conceptualized regression model (Figure 1). The study attempts to explore the outcome variable from sleep quality measures like the questionnaire and diary logs to determine the sleep patterns in a population diverse in age and gender. The use of two sleep measures allows investigation into whether the findings are concurrent. Incongruences in these findings could promote future research into the components of sleep quality. To explore the sleep quality variable of the model, regression and correlational analyses were conducted for the components of Pittsburgh Sleep Quality Index and Consensus Sleep Diary.

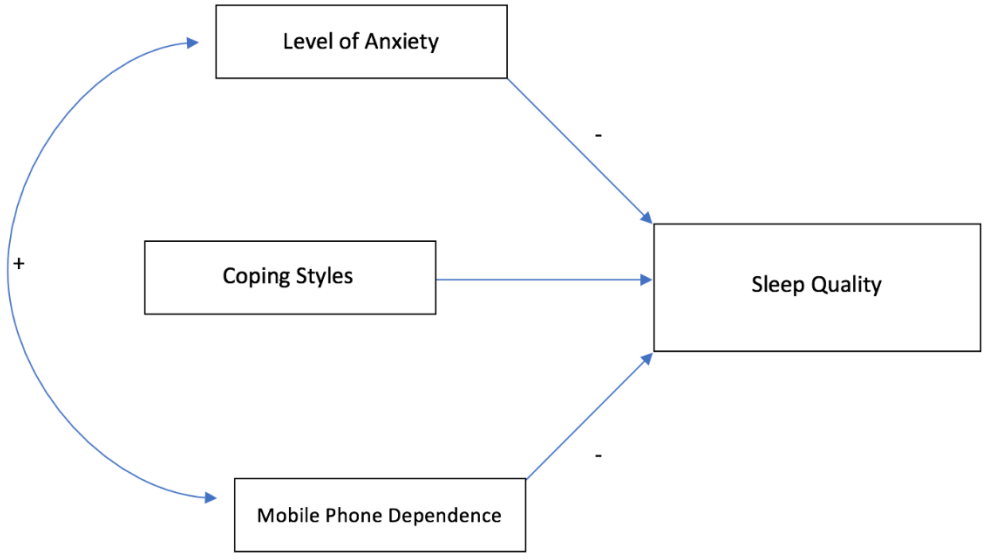

Figure 1: Hypothesised model to determine whether anxiety, mobile phone dependence and coping styles predicts sleep quality

Methods

Design

The study used a repeated-measures design. The predictors for the first model were Consensus Sleep Diary components and level of anxiety, level of mobile phone dependence, rational coping, detached coping, emotional coping, avoidant coping for the second model. The outcome variable for both the models was global PSQI score.

Participants

A total of 29 participants, 19-57 (*M* = 26.52, *S.D.* = 10.42) years old voluntarily participated in the 7-day study. Of the 29 participants, 22 were female (Age, *M* = 26.36, *S.D.* = 9.98) and 7 were male (Age, *M* = 27, *S.D.* = 12.56). A minimum of 26 participants were required for moderate effect size (partial r = - 0 .65, α = .05, d = 0.8; Landry et al., 2015). Participants under 18 years and those suffering from amnesia, sleep-related disorder and insomnia were not advised to not participate in the study. If participants met the exclusion criteria, they were guided to the end of the study directly. Additionally, data of 22 participants was excluded due to incompletion or drop-out during the study.

Measures

A consent form was embedded in the online recruitment survey. Participants provided demographic details and completed the following self-report measures:

Consensus sleep diary (Core-items only) (Carney et al., 2012)
CSD is a 9-item self-report diary collecting information regarding participants sleep over a duration. Participants provided information such as what time did they get to bed, how many awakenings they had before the final awakening and finally rate sleep quality on a 5-point Likert scale weighing from 'very poor' to 'very good'. The following sleep components: Total Sleep Time (TST), Sleep Onset Latency (SOL), Wake After Sleep Onset (WASO), total time spent in bed (TIB), sleep efficiency (SE) and sleep quality or satisfaction (SQ) were measured through the sleep diary. Sample items included in the measures

1. What time was your final awakening?
2. What time did you get out of bed for the day?
3. What time did you try to go to sleep?

Mobile Phone Dependence Questionnaire (Toda, Monden, Kubo & Morimoto, 2004)
MPDQ consists of 20 item that measures the extent of mobile phone dependence. The self-rated items were answered on a 4-point Likert scale ranging from *Always*(3) to *Hardly ever*(0). Higher score on MPDQ indicated higher mobile phone dependence of the participant. Previous studies have reported a high internal consistency of α = 0.94. Participants responded to items like following:

1. When I am riding on a train or in similar situations, I tend to handle my mobile phone.
2. Without thinking, I check my phone for email or voice mail even when it hasn't rung.
3. I express my true feelings better via email than by voice mail.

Beck Anxiety Inventory (Beck & Steer, 1987)
Beck Anxiety Inventory is a 21-item self-report measure where participants indicated experiencing anxiety symptoms during the past month. Participants indicated on a 4-point Likert scale (Not at All – 0, Mildly but it didn't bother me much – 1, Moderately – it wasn't pleasant at times – 2, Severely – it bothered me a lot -3) if they experienced anxiety symptoms like "numbness/tingling sensation", "scared", "face flushed". The total score of participants allowed grouping of participants into low anxiety (0-21), moderate anxiety (22-35) or severe anxiety (36 and above). The measure has an internal consistency of α=0.92 and test-retest reliability for a week score is 0.75 (Beck, Epstein, Brown, & Steer, 1988).

Coping Styles Questionnaire (Roger et al., 1993)
The Coping Styles Questionnaire measures the style employed by an individual to deal with stress. The 60-item questionnaire is grouped into adaptive coping styles-rational coping (task-focused), emotional coping; and maladaptive coping styles-detached coping and avoidance coping. Participants responded on a 4-point Likert scale ranging from Always (3) to Never(0) to items such as " I feel completely calm in the face of any adversity", "I look for sympathy and understanding from people", " Feel independent of the circumstances", "Eat more (or less) than usual" . Roger et al. (1993) provided internal consistencies and test-reliability values for scale and values of α = 0.79 and 0.75 respectively (Elklit, 1996).

Pittsburgh Sleep Quality Index (Buysse et al., 1989)
PSQI is a 19-item measure assessing the following sleep components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency; sleep disturbances, use of sleeping medication and daytime dysfunction. The questionnaire invited participant to provide data regarding their sleeping time, difficulty staying awake during routinely activities, use of sleep medication and other sleep-related items over the past month. Each of the 7 components were rated on a 4-pont Likert scale no difficulty (0) to severe difficulty (3) and a total of the seven components score yielded the global Pittsburgh Sleep Quality Index (global PSQI) score. The global PSQI score ranges from 0 to 21, allowing categorisation of participants into 'good' and 'poor' sleepers. The measure has an internal consistency with a Cronbach's α ranging from 0.77-0.80 and test-retest reliability of 0.87 (Backhaus et al., 2002).

Procedure

An online recruitment survey was set-up to recruit interested participants for the study. It provided regarding the purpose of the study, the procedure and their rights as a participant. On approval for participation, details such as email address, gender and age were garnered. Participants were informed that the study would start on the next day and anonymity throughout the consecutive 7-day would be protected using a unique participant code.

A 2- minute sleep diary was administered for 7 consecutive days through SurveyMonkey to provided email address. Upon providing consent, participant generated a unique participant code using the following guideline:

First and Second Letters: First two letters of Mother's name
Third and Fourth Letters: Last two digits of their contact number
Fifth and Sixth Letters: Two digits representing the month of your birthday
Seventh and Eight letters: Last two letters of place of birth

For the 7 days, sleep diaries were completed. On the 7th day, participants completed the final survey followed by the other set of questionnaires. They were informed that the last survey would take 30-40 minutes to complete. After providing consent and generating participant code, they responded to the Consensus Sleep diary, Coping Styles Questionnaire, Mobile Phone Dependence Scale, Beck Anxiety Inventory and Pittsburgh Sleep Quality Index. On completion, a detailed debrief was provided to the participant.

Ethics

Participant information sheet, consent form and debrief form were embedded in the survey to ensure participants had a comprehensive understanding of their participation. Participants were encouraged to voluntary take part in the study and ensured right to withdraw from the study at any point without stating any reason. Vulnerable groups such as individuals under age of 18 years and those suffering from sleep-related disorders or amnesiacs were advised not to take part as it might cause distress to them. No personal details except age, gender an email address were collected during the survey. Identification of the participant was secured using a unique participation code generated by the participants themselves. Email address used to contact the participants were deleted upon the completion of study. The debrief form reiterated the purpose of study and information regarding confidentiality and the right to withdrawal from the study. Participants were provided with contact details of counselling services like MIND, Samaritans and PlusGuidance. For any potential concerns in relation to research or for further information regarding the study, participants were encouraged to contact researcher using the supervisor email address. The data was stored and secured on a password-protected computer and H-drive. The study was approved by the School of Medicine and Science Ethics committee, University of Buckingham. It was conducted in adherence to the British Psychology Society ethical guidelines and code of human research ethics.

Results

Quantitative data was downloaded from SurveyMonkey in a SPSS format. First, the seven-day diary data was matched using each participant's code. An average of 7-day CSD components were calculated for each day following each day calculation. A scoring guide for CSD was developed based on previous research (Carney et al., 2012). The next step involved analysing the seventh day data for coping style, anxiety, level of mobile phone dependence and PSQI questionnaire components. These variables were scored using standard scoring guides (Roger et al., 1993; Beck et al., 1998; Toda et al., 2004; Buysee et al., 1989). A dataset was compiled for the average 7-day diary components for each participant consisting of scores of the coping styles (rational coping, emotional coping, detached coping, avoidant coping), the level of anxiety, the level of mobile phone dependence and the components of PSQI

questionnaire. Furthermore, regression analysis was conducted for testing hypothesis as no outliers were found during preliminary analyses.

Means, standard deviations and summary of other descriptives for each variable have been presented in Table 1.

Table 1*: Descriptives of population: Mean (95% Confidence Interval), Standard Deviation, Standard Mean Error, Skewness and Kurtosis for each variable: (a) Level of anxiety, level of mobile phone dependence, coping styles, (b) Consensus Sleep Diary components, (c) Pittsburgh Sleep Quality Index components*

(a) Level of anxiety, level of mobile phone dependence, coping styles

	M (95% CI)	*SD*	SE_{mean}	*Skewness*	*Kurtosis*
Level of Anxiety	11.90 (8.87, 14.93)	7.97	1.48	.87	1.38
Level of mobile phone dependence	19.97 (16.85, 23.08)	8.20	1.52	.40	-.53
Rational Coping	29.24 (26.43, 32.05)	7.40	1.37	-.33	.33
Detached Coping	19.52 (16.79, 22.25)	7.20	1.33	.28	.29
Emotional Coping	16.14 (13.18, 19.10)	7.78	1.44	.55	-.04
Avoidant Coping	17.90 (15.83, 19.96)	5.43	1.01	-.40	.43

Note. M = mean; SD = standard deviation, SE_{mean} *= standard error of the mean*

(b) CSD component

	M *(95% CI)*	*SD*	SE_{mean}	*Skewness*	*Kurtosis*
Sleep Onset Latency	15.57 (11.62, 19.53)	10.41	1.93	.65	-.81
Wake after sleep onset	6.74 (3.67, .80)	8.06	1.50	2.24	6.30
Number of Awakenings	1.07 (.75, 1.39)	.84	.16	.89	.57
Sleep Quality	3.74 (3.50, 3.98)	.63	.12	.49	-1.08
Time in bed (in minutes)	490.24 (467.63, 512.86)	59.45	11.04	-.68	.64
Total Sleep Time (in minutes)	467.93 (443.86, 492.00)	63.28	11.75	-.97	.83
Sleep efficiency (%)	95.07 (93.68, 96.47)	3.67	.68	-.96	-.08

Note. M = mean; SD = standard deviation, SE_{mean} *= standard error of the mean*

(c) PSQI components

	M (95% CI)	*SD*	SE_{mean}	*Skewness*	*Kurtosis*
Subjective Sleep Quality	.9310 (.68, 1.18)	.65	.12	.07	-.44
Sleep Latency	.79 (.48, 1.10)	.82	.15	.83	.30
Sleep Duration	.55 (.31, .79)	.63	.12	.71	-.38
Habitual Sleep Efficiency (%)	.62 (.33, .92)	.78	.14	.80	-.82
Sleep disturbances	1.17 (.97, 1.38)	.54	.10	.16	.36
Use of sleep medication	.14 (-.03, .31)	.44	.08	3.43	12.01
Daytime Dysfunction	1.10 (.79, 1.41)	.82	.15	-.20	-1.47
Global PSQI score	5.31 (4.30, 6.32)	2.65	.49	.79	.42

Note. M = mean; SD = standard deviation, SE_{mean} *= standard error of the mean*

The sleep diary components showed a great amount of variance specifically for WASO, NWAK and SE. Therefore, it suggests that sleep could vary in different aspects while components like SOL and SQ could remain intact over the period. This highlights that it is useful to collect data across a short period.

Correlational analysis (Table 3) between the respective components of the sleep diary and the questionnaire components indicated that the composite score of questionnaire i.e. the global PSQI was significantly associated with all components except for the variables, Time in Bed and Daytime Dysfunction. Therefore, PSQI score was used as sleep quality indicator for all the further tests. For further analysis, a multiple regression was conducted to observe whether the sleep diary components could predict the global PSQI score.

Table 3: *Pearson product moment correlations amongst the diary and questionnaire components*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Consensus Sleep Diary															
1. Sleep Onset Latency	-														
2. Wake after sleep onset	0.39*	-													
3. Number of awakenings	0.18	0.57**	-												
4. Sleep Quality	- 0.47**	- 0.39*	- 0.58**	-											
5. Time in bed	- 0.12	- 0.08	0.16	0.03	-										
6. Total Sleep Time	- 0.33	- 0.27	0.05	0.15	0.97**	-									
7. Sleep Efficiency	0.87**	- 0.70**	- 0.33	0.48**	0.38*	0.58**	-								
PSQI questionnaire															
8. Subjective sleep quality	0.35	0.58**	0.47*	- 0.71**	- 0.22	- 0.34	- 0.52**	-							
9. Sleep latency	0.64**	0.26	0.10	- 0.18	- 0.06	- 0.19	- 0.56**	0.31	-						
10. Sleep duration	0.47**	0.32	0.01	- 0.24	- 0.45*	0.54**	- 0.58**	0.36	0.30	-					
11. Habitual sleep efficiency	0.09	0.27	0.17	- 0.11	0.12	0.06	- 0.14	0.30	0.04	0.08	-				
12. Sleep disturbances	0.11	0.54**	0.49**	- 0.36	0.13	- 0.21	- 0.33	- 0.54**	0.33	0.24	- 0.01	-			
13. Use of sleep medication	0.02	0.30	0.10	0.17	0.23	0.17	- 0.09	0.16	0.18	- 0.16	0.05	0.05	-		
14. Daytime dysfunction	0.27	0.22	0.40*	- 0.61**	- 0.16	- 0.23	- 0.35	- 0.48**	0.25	0.16	0.18	0.36	- 0.14	-	
15. Global PSQI	0.53**	0.61**	0.44*	- 0.55**	- 0.18	- 0.34*	- 0.67**	0.80**	0.64**	0.51**	0.44*	0.61*	0.18	0.65**	-

$^{**}p < 0.001$, $^{*}p < 0.05$

Regression analyses

Preliminary Analysis

The data was tested for regression assumptions. The analysis of standardised residuals did not indicate any outliers in the data (Std. Residual Min = -1.46, Std. Residual Max = 1.70). The assumption of multicollinearity was not met as VIF values for 2 components were above 10 (Sleep onset Latency, Tolerance = .06, VIF= 17.8; Wake after sleep onset, Tolerance = .13, VIF= 7.94; Number of awakenings, Tolerance = .44, VIF= 2.28; Sleep quality, Tolerance = .51, VIF= 1.95; Time in bed = .28, VIF= 1.24; Sleep Efficiency, Tolerance = .03, VIF= 35.75;). The data met the assumption of independent errors (W = 2.44). The histograms of standardised residuals indicated normally distributed errors and the normal P-P plot of standardised residuals showed points close to the line but not on them completely. The assumption of homogeneity of variance and linearity was also met. Although the model did not meet assumptions, statistical test was conducted to investigate whether all the components could be grouped to predict the outcome variable.

Regression analyses generated a significant model of diary components: SOL, WASO, SQ, NWAK, TIB and SE predicting the global PSQI score, $F(6, 22) = 4.44$, $p = .004$, adj. $R^2 = .42$. However, Total sleep time was excluded from the model. Though none of the variables significantly contributed in prediction of the global PSQI score, standardised scores revealed WASO and NWAK had relatively stronger effect than other variables. Regression coefficients, confidence intervals and standard errors can be found in Table 4 (below). The standardized coefficients suggest that changes in WASO and NWAK could generate greater change in the global PSQI score.

Table 4. *Summary of Multiple Regression Analysis with linear model of predictors of Sleep Quality, with 95% confidence intervals of standardised regression coefficients reported in parentheses.*

Variable	*B*	SE_B	*β*	*p*
Intercept	45.2 (-74.03,164.42)	47.49		.440
Sleep Onset Latency	-.03 (-.35, .29)	.15	-.12	.841
Wake after sleep onset	.05 (-.22, .33)	.13	.16	.688
Number of Awakenings	.10 (-1.32, 1.51)	.68	.03	.887
Sleep Quality	-1.17 (-2.92, .57)	.84	-.28	.178
Time in bed (in min)	.001 (-.02, .03)	.01	.01	.961
Sleep Efficiency (%)	-.38 (-1.66,.91)	.62	-.52	.550

Note. B = unstandardized regression coefficient; SE_B *= Standard error of the coefficient; β = standardised coefficient and p significant at .05.*

Main Analysis: Predicting global PSQI score from Anxiety, Coping styles and Level of mobile phone dependence

The assumptions for the standard regression analysis were met. The analysis of standardised residuals did not indicate any outliers in the data (Std. Residual Min = -2.80, Std. Residual Max = 2.83). The assumption of collinearity was also met as there was not any issue of multicollinearity (Anxiety, Tolerance = .67, VIF= 1.5; Rational Coping, Tolerance = .44, VIF= 2.28; Detached Coping, Tolerance = .36, VIF= 2.77; Emotional Coping, Tolerance = .56, VIF= 1.80; Avodiant Coping Tolerance = .81, VIF= 1.24; Level of mobile phone dependence, Tolerance = .81, VIF= 1.24). The data met the assumption of independent errors (W = 2.23). The histograms of standardised residuals indicated normally distributed errors and the normal P-P plot of standardised residuals showed points close to the line but not on them completely. The assumption of homogeneity of variance and linearity was also met.

The model for global PSQI score predicted from level of anxiety, rational coping, detached coping, avoidance coping, emotional coping and level of mobile phone dependence was statistically significant, $F(6, 22) = 3.63$, $p = .012$, adj. $R^2 = .36$. Of the six variables, only detached coping and emotional coping contributed statistically significant to the prediction, $p < .05$ and had highest values of standardised coefficients. Regression coefficients, confidence intervals and standard errors can be found in Table 5 (below).

Table 5. *Summary of Multiple Regression Analysis with linear model of predictors of Sleep Quality, with 95% confidence intervals of standardised regression coefficients reported in parentheses.*

Variable	*B*	SE_B	*β*	*p*
Intercept	-1.332 (-6.42, 3.76)	2.454		.593
Level of anxiety	.01 (-.12, .137)	.06	.03	.878
Rational Coping	-.076 (-.25, .09)	.08	-.21	.359
Detached Coping	.31 (.12, .50)	.09	.84	.003
Emotional Coping	.24 (.09, .38)	.07	.69	.002
Avoidance Coping	-.07 (-.24, .10)	.08	-.14	.412
Level of Mobile Phone Dependence	.01 (-.11,.12)	.05	.02	.897

Note. B = unstandardized regression coefficient; SE_B *= Standard error of the coefficient; β = standardised coefficient and p significant at .05.*

Table 6 summarises the correlational analyses conducted for better understanding of the relationship among the predictors and outcome. None of the predictor variables were significantly correlated with the global PSQI score. The correlations between the level of anxiety and level of mobile phone dependence reached significance. There was a significant positive correlation between detached and rational coping.

Table 6: *Correlations among global PSQI score and predictors*

Variable	1	2	3	4	5	6	7
1. Level of anxiety	-						
2. Rational Coping	0.13	-					
3. Detached Coping	- 0.14	0.73**	-				
4. Emotional Coping	0.44*	- 0.28	- 0.43*	-			
5. Avoidance Coping	0.09	- 0.02	0.09	0.31	-		
6. Level of mobile phone dependence	0.42*	0.01	- 0.07	0.15	0.02	-	
7. Global PSQI scores	0.24	0.21	0.36	0.36	0.16	.08	-

$^{**}p < 0.001$, $^{*}p < 0.05$

The hypothesised model was updated with the current results:

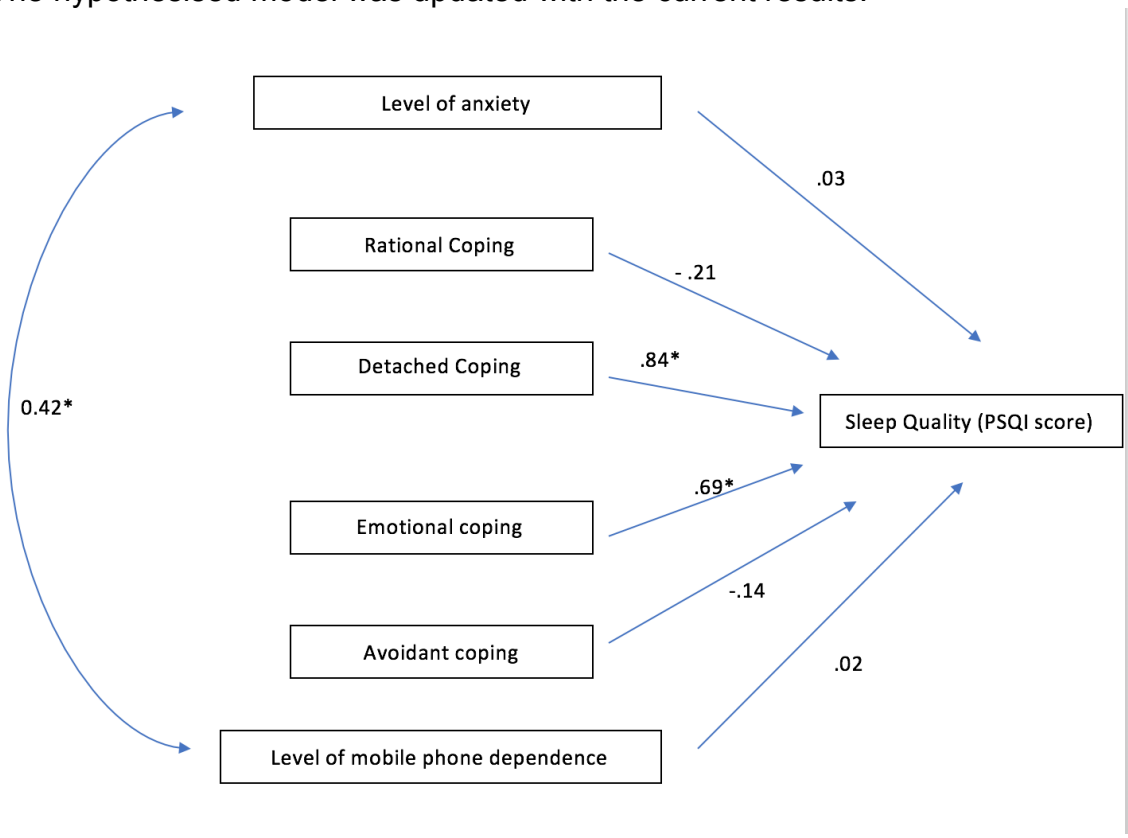

Figure 3: Updated results for the hypothesised model to determine whether anxiety, mobile phone dependence and coping styles predicts sleep quality

Discussion

The analyses partly supported the hypothesized model for predicting sleep quality. Detached coping and emotional coping were the only significant contributors to the overall significant model predicting the global PSQI score from the following predictor variables: the level of mobile phone dependence, level of anxiety, rational coping, detached coping, emotional coping and avoidant coping. The level of anxiety and mobile phone dependence did not predict the global PSQI score, unexpectedly suggesting that anxiety and mobile phone dependence are not associated with sleep quality. A significant positive correlation, however, was found between anxiety and mobile phone dependence. Furthermore, the significant regression model of the diary components: Sleep onset latency, wake after sleep onset, number of awakenings, sleep quality, time in bed and sleep efficiency accounted for an effect of *adj.* R^2 = .42 on the global PSQI score, but the diary variables were not significantly associated with the global PSQI score. This may suggest that although the Consensus Sleep Diary measures the sleep quality construct; results from the 7-day diary could also be obtained from the one-off composite PSQI score.

This current study aimed to explore whether global PSQI score could be predicted from the sleep diary components. The analyses showed that although the model was significant, the diary components were not associated with the composite questionnaire score. Wake after sleep onset and number of awakenings, however

were found to account for more variance in the global PSQI score than the sleep onset latency, sleep efficiency, time in bed, sleep quality components. These results have two major conclusions. First, WASO and NWAK are relatively more important components of sleep quality than the others. WASO is the length of night-time awakenings and NWAK is the frequency of such episodes, suggesting that these components are indicative of sleep fragmentation. The present study partially lends support to the suggestion made by Knufinke et al. (2017), that to optimise sleep quality the individual should focus on both the sleep onset latency and wake after sleep onset. These findings, however, were conducted on 97 athletes who may have been conscious of their sleeping patterns and had different lifestyle routines than the general population targeted in the presented study. Regardless of this and in concordance with Knufinke et al. (2017), WASO predicted sleep quality in the present analyses, suggesting that healthy maintenance of sleep hygiene patterns in general population is characterised by both WASO and NWAK and not sleep onset latency.

According to the previous findings, sleep fragmentation components have been found to be associated with daytime dysfunction. Fragmentation would mean that the individuals would have less restorative sleep, consequently leading to fatigue (Jones & Harrison, 2001) and cognitive impairment during the day (Anderson et al., 2009). In concurrence with this, while positive significant correlations were found between Daytime Dysfunction and NWAK, no correlations were found with WASO in the present study. These results resemble Keklund and ÅKerstedt's (1997) Karolinska Sleep Diary factor analysis findings. A high load of the awakening factor was found on sleep quality and attributed to the ease of awakening and feeling refreshed (Keklund & ÅKerstedt's, 1997). This suggests that number of awakenings played a dominant role in sleep fragmentation and would hamper the individual's activities during the day. Contradictory to the present results, sleep efficiency and total sleep time contributed towards the perception of a better sleep than in the study (Keklund & ÅKerstedt's, 1997). Sleep efficiency and total sleep time were associated with the duration of an individual's sleep, which was not reflected in the present analysis. Therefore, either sleep quantity components are not as relatively important in comparison to sleep continuity or that these components are more susceptible to memory distortion when recalling the next day. This attends to the recommendation of providing clarity on the specific sleep components can generate better sleep quality (Ohayon et al., 2017). It also suggests what future research should focus on when addressing what affects the WASO and NWAK during sleep.

Libman et al. (2000) could not establish the best measure of sleep quality amongst the modified Lacks' Sleep dairy and the self-developed sleep questionnaire. Contrary to the goal of establishing the best measure, this present study explored whether the sleep diary components could successfully predict the composite sleep questionnaire score. To overcome Libman et al's. (2000) limitation of using a self-developed questionnaire, standardised measures were used to test the hypotheses. A significant model was found with CSD components predicting the PSQI composite score with moderate effect size (adj. R^2 = .36). This suggests that the PSQI questionnaire can substantiate findings of past research that have been based on sleep diary measures. Furthermore, it is suggested that difference in components across two measures is important but is successful in predicting sleep quality in a general population. In agreement with Grandner et al. (2006), except Time in Bed, all sleep diary variables were significantly correlated with the Global PSQI score. A

majority of the PSQI component scores, however, were not significantly correlated with the sleep diary variables. Therefore, as expected, a congruency was found between the measures but not amongst the components.

It was hypothesized that mobile phone dependence, coping styles and anxiety would be associated with sleep quality. With respect to the high correlations observed between the global PSQI score and the components of the diary, as well as the questionnaire components, the composite PSQI score was used for further regression models. A significant model was found for level of mobile phone dependence, level of anxiety, rational coping, detached coping, emotional coping and avoidant coping predicting the global PSQI score with a moderate effect size (adj. R^2 = .42). The sleep quality variable was mostly accounted by changes in detached and emotional coping, followed by nonsignificant values of level of anxiety, level of mobile phone dependence, avoidant coping and rational coping. Although the model was significant, these results did not support the hypotheses.

The level of mobile phone dependence and level of anxiety accounted for less than 5% of the effect in the model and were not significantly associated with the sleep quality. These results suggest that these variables would not necessarily be independently associated with sleep quality. Contradictory to Adams and Kilser's (2013) findings, no significant correlations were found between PSQI scores and mobile phone dependence or anxiety levels. These findings refute Adam and Kisler's (2013) model of anxiety acting as a mediator between mobile phone use and sleep quality. Buffering constructs like self-esteem (Hong et al., 2012; Kim & Davis, 2009), social support (Chiu, 2014), social self-efficacy and self-efficacy (Billieux et al., 2007) might have confounded the results of the present study.

Complementary to Spira et al's. (2009) findings, it can be concluded that anxiety might have independent associations with both objectively and subjectively measured sleep quality. In general, this sample reported low levels of both mobile phone dependence and anxiety, limiting the generalisability of the model. It might be interesting to test the model in sample with wider spectrum of anxiety and dependence levels. On the contrary, consistent with Cheever et al's. (2014) findings, levels of anxiety were positively correlated with levels of mobile phone dependence. This sample accommodated a wide age range who had access to mobile phones, and who use mobile phone to gain satisfaction and overcome negative states like anxiety (Billieux et al., 2015). The correlation results stir the argument as to why sleep quality could not be predicted despite significant correlations between the level of anxiety and mobile phone dependence. The buffering constructs may also be responsible for these findings. A mediation analyses could be conducted for exploring how the self-esteem, self-efficacy or support available could mediate anxiety and sleep quality in future.

There was a significant positive and relatively large effect (β = .84) of detached coping on the sleep quality. Literature suggests that detached coping style would allow an individual to feel more control over their situation and categorise it in an adaptive manner (Lazarus & Folkman, 1984). Combining prior literature and present findings, it can be suggested that use of detached coping style would allow an individual to have better sleep. The detachment is an immediate unresponsiveness to the negative stimuli and would, therefore, allow them to relax. This can overcome factors such as rumination (Querstret & Cropley, 2012), anxiety (Åkerstedt et al., 2007) and

engagement in negative psychological states of stress (Lemma et al., 2012 or mood (Zawadzki et al, 2013), allowing for better sleep. Due to effective management of the stress and good sleep, performances during the day would not be impaired. The positive outcomes of the detached coping style can encourage individuals to rely on this coping style. This supports Sadeh et al's. (2004) findings wherein problem-focused coping strategies during both high and low-stress periods in university students was associated with greater sleep duration. The problem-focused coping strategy relates closely to detached coping as it encourages individual to either reduce or remove stressor. Removal of a stressor is a characteristic of a detached coping style, indicating that university students might have positively appraised their situations and attempted to disengage with the situation, allowing for greater sleep duration (Espie, 2017). Further analysis should explore possible associations between detached coping and sleep duration components of sleep quality.

The linear regression conducted for global PSQI score demonstrated an association with emotion coping style. The emotion coping style accounted for a significant amount of variance (β = .69) on the global PSQI, suggesting that it has a moderate effect on the sleep quality. This replicates Morin et al's. (2003) results of sleep quality and emotion-focused coping strategy. Supporting their conclusion, the misappraisal of stressors and ineffective management of stress using emotion-centred coping style could affect the sleep quality. It was further suggested that the overuse of this coping style increased vulnerability to insomnia. Therefore, emotion coping could have a negative influence on sleep quality components and might put an individual at risk for sleep-related disorders. This kind of maladaptive coping style could compromise sleep quality, make sleep-symptom severity worse and interfere with the daily functioning of the individual (Hoyt et al., 2009). Contrary to treating it as a maladaptive coping style, Theadom, Cropley and Humphrey (2007) defined emotion-focused coping strategy as the ability of an individual to focus on their emotions by communicating with social systems and positively reinterpreting the events. In accordance with their results, an increase in emotion-focused coping strategy was associated with positive affect, but the coping style did not correlate with sleep quality of the individual. Furthermore, they found that emotion-focused strategies did not improve life quality for fibromyalgia patients. The results of the present study also show a direct relationship between emotion coping and sleep quality, while the level of anxiety and emotion coping shared a significant correlational relationship. It can, therefore, be concluded that individuals might reflect that emotion coping style can provide temporary relief from the negative state, but the denial of emotions and not reacting to thoughts would consequently worsen the quality of their sleep and life.

The rational and avoidant coping style, however, did not have associations with sleep quality in the present study. No research has been conducted to support or reason how rational coping style would be associated with sleep quality. However, Roger et al. (1993) classified it as an adaptive coping style. Analysing the effect sizes in the regression model of sleep quality (Table 5), findings illustrated that the strength of detached coping is four times stronger than rational coping, yet correlational analyses between two variables were highly significant (Table 6). From the correlation results, it can be concluded that the coping styles are not distinct and might have an underlying latent variable. However, their difference of effect sizes in regression model highlights that they might have distinct qualities and have a different kind of

relationship with sleep quality. It would be interesting to investigate how different these coping styles are across the sleep quality components.

With regard to the avoidant coping style, prior research showed that avoidant-focused coping style was associated with sleep quality. Compared to approach-based coping, Hoyt et al., (2009) found that the use of avoidance-focused coping is associated with sleep-related symptoms and interference in the routine of cancer patients. It was explained that reduction in mood states would compromise sleep. The present findings do not appear to corroborate Hoyt et al's. (2009) findings. On the other hand, it does provide support to Hofsetter, Lyasker & Mayeda (2005) who did not find any association between escape-oriented avoidance and PSQI in a schizophrenia sample. Future studies, therefore, might need to focus on ignored or blocked avoidance and not escape-oriented avoidance. A major barrier in the existing body of literature and the present study is the difference in the measures. The studies using the COPE inventory classify the styles into avoidance-coping and approach-coping (Hoyt et al., 2009), whereas Hofsetter et al., (2005) conducted coping analyses through the Ways of Coping Questionnaire, which involves subscales of confrontation coping, self-controlling, social support seeking, acceptance of responsibility, escape-avoidance, planned problem-solving and positive appraisal. Due to inconsistency in the use of these self-report measures, the components measured might vary. This could explain the strength of specific coping styles in contrast to their relationship outside the regression model. The measure used in this study might have components that are significantly mapping on to each other and would require a factor analysis to allow greater evaluation from the perspective of sleep quality. Additionally, the past research has focused on clinical populations and not considered the role of these four coping styles in the general population. A clinical population might have greater use of specific coping style, and results from such studies would not be an accurate representation of the general population. Therefore, the present study has found novel results that can be generalized across the non-clinical sample.

This current study faced a high-dropout rate, as participants were expected to complete a diary across seven consecutive days. It was difficult to attract older participants due to use of an online platform. The results, however, attracted a small sample with a wide age (19-57 years) which strengthens support for the results. In future, in spite of this, data collection from older population could be conducted by contacting elderly care homes, retirement homes and senior citizen centres. The design of the study instructed participants to recollect sleep-related details which might be subjected to memory distortion. However, significant models of the diary and questionnaire suggest that the retrospection might have been accurate. Nevertheless, caution must be used when generalizing these results across a population that may have addictive behaviours or work in high-stress jobs as the variables might vary as a result of this. An important limitation of the present study is the Mobile Phone Dependence Questionnaire. The existing body of literature does not hold a questionnaire that measures dependence instead of use or addiction. MPDQ allowed for the measurement of the scale of dependence but lacked items that are frequently used by the current population such as social networking sites and applications. Therefore, an updated and valid version of MPDQ could give greater insight into the influence of mobile phone dependence on sleep quality.

This research has led us to conclude that sleep continuity, detached and emotional coping styles have an effect on the sleep quality of the general population. Sleep fragmentation components appeared to have a relatively greater effect on sleep quality than others. This suggests that sleep interventions conceived for general population should target fragmentation and aspects of continuity to boost sleep quality. The composite score of PSQI was found to have associations with the diary and questionnaire components. This allows wider applicability of the questionnaire measure in monitoring the progress of sleep in home-settings and strengthening its impact through wider research. The ease of accessibility, administering and its flexibility in capturing all the sleep components should encourage greater use of PSQI. These findings also substantially add to our understanding about the effect of coping style on sleep quality. It highlights the importance of detached and emotional coping in regulating sleep quality by detaching from stressors and healthy appraisal of the stimuli. Surprisingly, no evidence was found for the effect of mobile phone dependence and anxiety on sleep quality. This study, however, clearly has some limitations. Nevertheless, this could help in integration of coping styles in awareness programmes and health campaigns promoting healthy sleep patterns. As the literature in the field is not yet rich, exploring how detached and emotional coping are associated with specific sleep components is strongly recommended in future research.

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