

## **Sleeping with technology: The impact of bedtime smartphone usage on the sleep quality of undergraduate students**

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### **Abstract**

*The aim of this final year research project was to explore bedtime smartphone usage and the impact this had, if any, on the sleep quality of undergraduate students. Questionnaire data from a sample of 54 participants aged 18 and over was gathered between December 2022 and February 2023. The questionnaire itself included items from the Pittsburgh Sleep Quality Index (PSQI) and Smartphone Addiction Scale (SAS). In terms of findings, all participants used their smartphones late into the evening and at bedtime before going to sleep, with social media and messaging used most frequently. There was a significant relationship between participants who used their smartphones more before bed, going to bed later and feelings of tiredness in the morning. The study's findings suggest that students who use their smartphones more at bedtime also have a higher chance of developing problems associated with sleep which, in turn, is known to lead to other negative attributes including a decrease in academic performance. Overall, there should be more focus on the physical and mental health and wellbeing of students and the quality of their sleep which may be affected by growing smartphone use at university.*

Keywords: Smartphone use, sleep quality, undergraduate student, questionnaire survey

### **Introduction**

Since the first smartphone was invented in the 1970s, they have significantly increased in importance in our daily lives. Whether for work, calls, texts, social media use, and so on, we use them for almost everything. According to research conducted at Kings College London, one in four children and young adults now use their smartphones in ways that are similar to behavioural addictions (Sohn et al., 2021). Indications of smartphone addiction include excessive screen time, unnecessary phone checking, withdrawal symptoms due to lack of access, eye strain and sleep disturbances (Chen & Gau, 2016; Parasuraman et al., 2017). In certain instances, 'nomophobia', or no mobile phobia, can also result in a reduction in daily exercise

and academic decline (Lin & Zhou, 2022). With adequate sleep duration and sleep quality essential for physical and emotional well-being (White et al., 2011; Buboltz et al., 2009), university students are a group particularly at risk of poor sleep and sleep-related disorders. In one study involving the Pittsburgh Sleep Quality Index (PSQI), for example, about 60% of a sample of 1,125 university students were classified as poor-quality sleepers (Lund et al., 2010), the associated issues of which include trouble falling asleep, frequent night-time awakenings, nightmares and daytime fatigue (Schlarb et al., 2012, 2017). Poor sleep and sleep-related disorders can also be the result of other factors including adjusting to being away from home, having to work unusual hours and managing studies and a new social life while also trying to maintain a healthy lifestyle (Foulkes et al., 2019).

This study aims to explore the relationship between bedtime smartphone use and sleep quality. More specifically, the study will examine whether the intensity and duration of smartphone use before bedtime has an impact on sleep quality, thereby adding to our knowledge of the field.

## Literature Review

Recent research has established an association between smartphone use and poor sleep quality. Specific causes of this association include receiving phone calls, text messages, blue light exposure and listening to music (Orzech et al., 2016; Levenson et al., 2017). Students in higher education have particularly poor sleep quality and considered a high-risk group and should therefore be prioritised for research in this area (Sivertsen et al., 2019; Hale et al., 2020; Hershner, 2020). In a descriptive study by Luvira et al. (2020), results showed that 72.5% of the 240 university students involved experienced sleep problems, with 41.3% actually aware of the problem. These problems included difficulty staying asleep, night-time awakenings and daytime naps.

### *Smartphone use in young adults*

Young adults (e.g. 18-29 year olds) have been identified as one of the largest and most active users of smartphones, with usage growing exponentially over time (Al-Barashdi et al., 2015). University students may easily develop a dependence on their smartphones because they use them to unwind and escape the pressures of studying (Rabiu et al., 2016). According to a study of 89 adolescents in the US, the most popular features of smartphones are texting and calling (Tao et al., 2017). Within an hour of going to bed, 83% of these students still used their smartphone, and approximately 66% checked them before getting out of bed in the morning (Moulin & Chung, 2016). Boumosleh & Jaalouk (2017) investigated the prevalence of smartphone addiction symptoms in a survey that included the Smartphone Addiction Scale. 688 undergraduate students participated and the findings revealed that 38.1% reported having trouble sleeping, 35.8% slept for less than four hours a night, and 35.9% experienced daytime sleepiness as a result of using a smartphone before going to bed.

### *Defining sleep*

Sleep is defined as a sedentary mental and physical state, characterised by altered consciousness, inhibited sensory and motor activity, and diminished interactions with the environment. During sleep, to reorganise and store information, certain neurons related to memory and attentive learning must be dormant (Hale et al., 2020). Humans experience two different types of sleep: REM sleep, which has highly active brainstem neurons, and non-REM sleep, which is characterised by reduced activity in brainstem systems (Siegel, 1990; Siegel, 2005). Insufficient sleep has been classified as a “public health problem” by the Centres for Disease Control and Prevention (Hale et al., 2020). Sleep is increasingly being researched as it is a key component to living a healthy lifestyle, including good physical and mental health, all of which is essential with respect to academic performance (Lin & Zhou, 2022). However, a limitation of current research is the lack of clarity regarding the amount of sleep that students should get, with some studies indicating that 7 to 8 hours per night is sufficient (Watson et al., 2015). However, the National Sleep Foundation (NSF) has updated its recommendations that adults aged 18 to 64 should sleep 7 to 9 hours every night (Hirshkowitz et al., 2015). According to the Health-Related Quality of Life Report, young people who get less than seven hours of sleep per night are insufficiently rested, have lower physical and mental wellbeing and have worse general health, as well as poor academic outcomes (Sivertsen et al., 2015; Watson et al., 2015; Hayley et al., 2017). Additional research has shown associations between sleep quality and psychological health, with sleep having an influence on stress, depression and anxiety levels (Arora et al., 2014; Walsh et al., 2020; Joshi et al., 2021). The most significant psychosocial factors influencing sleep problems have been identified as educational demands, social commitments, and technology use, which many students experience when they first move to university (Carskadon, 1990; Van den Bulck, 2007). These sleep disturbances often occur when the sympathetic nervous system is thrown off causing hyperarousal (Espie, 2002; Harvey, 2002).

### *Bedtime smartphone use and sleep quality*

Research into the connection between bedtime smartphone use and sleep quality among students has increased over time (Al-Khlaiwi & Meo, 2004; Li et al., 2015; Cellini et al., 2020; Ragupathi et al., 2020; Duraccio et al., 2021; Yuen Fook et al., 2021). This relationship is worth investigating as university students have emerged as one of the most sleep-deprived groups who are more likely to use new technology (Thulin & Vilhelmsen, 2007; Forquer et al., 2008). While many studies have examined the relationship between smartphone use and sleep disturbances, they didn't always look at whether there was a connection to smartphone use immediately before and after going to bed. Given that smartphone use has dramatically increased, and that sleep is a fundamental human need, it is crucial that we understand the connections between sleep and smartphone use at this time. Among those studies available, use of smartphones at bedtime has been linked to shorter sleep duration, lower quality of sleep, more daytime sleepiness and insomnia

(Munezawa et al., 2011). Exelmans & Van den Bulck (2016) examined 844 participants from Belgium in a face-to-face interview with standardised questions, including the Pittsburgh Sleep Quality Index (PSQI), the Fatigue Assessment Scale (FAS), the Bergen Insomnia Scale (BIS), bedtime and rise time, and sleep duration. The study's results showed that individuals who used their smartphone more before bed had significantly worse sleep quality, insomnia symptoms and later rise times, especially among young respondents. This was supported by a large UK study by Sohn et al. (2021) that included 1,043 college students with an average age of 19 to 22 years. Of these, 38.9% also showed smartphone addiction symptoms which was linked to poorer sleep, the percentage consistent with other studies conducted in similar age groups around the world.

### *Mechanisms affecting sleep quality*

Smartphone-related sleep disturbances are frequently caused by mental and/or emotional arousal (Joshi et al., 2021) which occurs when the brain believes it is still functioning as a result of smartphone use (Cain & Gradisar, 2010; Exelmans & Van Den Bulck, 2016; Joshi, 2022). Thomée et al. (2011) conducted a study with 4,163 students who responded to a questionnaire to find out how using smartphones affected their ability to sleep. The findings revealed a relationship between excessive smartphone use, interrupted sleep and daytime fatigue. There are two mechanisms explaining how smartphones might impact the quality of sleep. The first is exposure to irradiation and blue light (Burkhart & Phelps, 2009; Lawrenson et al., 2017; Ishizawa et al., 2021). Blue light exposure has the ability to weaken and reduce the production of the hormone melatonin which helps to control the sleep cycle. A study by Jniene et al. (2019) aimed to assess the use of blue light emitting devices before bed, healthy routines and sleep quality amongst 294 Moroccan medical students. The findings revealed that 97.3% of participants used a blue-light emitting device just before bed with 35.3% reporting having trouble sleeping suggesting some relationship between the two. The second mechanism is called sleep displacement, whereby smartphone usage results in later bedtimes and less sleep (Van den Bulck, 2007; Cain & Gradisar, 2010). When you experience sleep displacement, you may also lose track of time without even realising it, and so your sleep time is displaced.

### *The present study*

Overall, the studies mentioned above suggest that there is a clear relationship between smartphone use and sleep quality. The aim of this study was, therefore, to determine whether there is a relationship between smartphone use particularly before bed and the quality of sleep. Studies in this area are essential because undergraduate students frequently use smartphones which can result in a variety of negative effects. In this study, the following research questions were raised:

- To what extent do undergraduate students use their smartphones after lights out?

- What is the relationship between bedtime smartphone use and quality of sleep?

## Methodology

### *Sampling*

Convenience sampling via email and social media gave rise to a total of 54 undergraduate student participants studying a variety of degrees mostly at the University of Lincoln but with a small number from elsewhere. This sampling technique is considered inexpensive and simple with target participants easily accessible (Wright, 2006; Etikan et al., 2016; Cohen et al., 2017).

### *Data collection and analysis*

Participants were each required to complete a 31-item, Jisc Online Survey including a request for essential demographic data, smartphone use and sleep characteristics via a small number of forced-choice, Likert-type and open questionnaire statements including some drawn from the Pittsburgh Sleep Quality Index (PSQI) and the Smartphone Addiction Scale (SAS) in order to draw comparison (Buysse et al., 1989; Kwon et al., 2013). Despite their disadvantages (Oppenheim, 2000; Redline et al., 2002; Bell, 2014), the questionnaires could be completed in a short amount of time, anywhere and at any time, as well as guarantee anonymity (Denscombe, 2010). The data for this study were imported directly into and analysed using SPSS (v.28). Indicative questionnaire items are presented as follows:

*Do you currently own a smartphone?*  
*How many hours a day do you spend on your phone?*  
*What time do you usually go to bed at night?*  
*How much time do you think you spend on your phone before you go to sleep?*  
*What is the main reason for your bedtime phone use?*  
*Do you switch your phone off before you go to sleep?*  
*Do you sleep with your phone next to your bed?*  
*How long do you think it takes you to fall asleep each night?*  
*How many hours of actual sleep do you think you get at night?*  
*Do you generally have trouble sleeping?*  
*What time do you usually get up in the morning?*  
*How do you feel when you get a poor night's sleep?*

### *Ethical considerations*

Ethical approval was obtained in advance following all University of Lincoln and external guidance and procedures (Roberts & Allen, 2015; University of Lincoln, 2018; BERA, 2018).

## Findings

### *Gender and age*

Characteristics of the sample of 54 students can be seen in Table 1. Participants were aged between 18 and 31 years, with most aged 18 to 20 (59.2%). The majority identified as women (77.8%). Almost all were studying for an undergraduate degree across a range of disciplines at the University of Lincoln with some attending other UK universities.

<b>Age (years)</b>	<b>n</b>	<b>%</b>
18-20	32	59.2
21-24	19	35.2
25-31	3	5.6
<b>Gender</b>	<b>n</b>	<b>%</b>
Woman	42	77.8
Man	10	18.5
In another way	1	1.9
Prefer not to say	1	1.9

*Table 1: Essential participant characteristics (n=54)*

### *Sleeping habits*

Participant sleep characteristics/habits can be seen in Table 2. Overall, most participants tended to go to bed between 11.00pm and 1.00am each night (53.7%), with the same number mostly rising between 9am and 11am (53.7%) the following day. On average, this equated to a perceived estimate of 7.4 hours of actual sleep every night, and at the lower end of the recommended 7 to 9 hours. However, 46.3% of participants fell below this interval completely. Interestingly, 53.7% also thought they fell asleep in under thirty minutes, 38.8% thought it took 30-60 minutes and 7.5% thought it took over an hour. Of the 54 participants, 38.9% felt they generally had trouble sleeping, often because they could not get to sleep within 30 minutes, or because they woke up in the middle of the night or early morning. Only one participant said that an illness and medication led to trouble sleeping. When experiencing a poor night's sleep, participants felt tired (94.4%), irritable (77.8%), frustrated (50.0%), upset (38.9%), anxious (37.0%) or even depressed (29.6%). A small percentage (9.3%) felt that they experienced poor sleep which usually involved difficulty falling and staying asleep, daytime fatigue or an urge to take naps.

### *Details of smartphone usage at bedtime*

As expected for this age group, all participants owned a smartphone, and indicated a common daily screen time use of 4 to 5 hours. This is consistent with the UK average

of a little over four hours per day. However, 1.5 of these hours was regularly spent on smartphones during the evening and at bedtime. During this time, only 46.3% of participants always used the night-time brightness setting on their smartphone. Figure 1 represents the most used applications at this time and Figure 2 represents the reasons for use. 66.7% of participants thought they often or always spent too much time on their phone and 70.3% felt that their phone often or always made their bedtime later. There was a significant association between spending too much time on a phone and having a later bedtime ( $p=.010$ ) as reflected in Table 3. When it came to cutting down on smartphone use, 38.9% of participants indicated that they had tried often or regularly but failed. Furthermore, 85.2% of participants indicated that they slept with their phones next to their bed and 35.2% admitted to sometimes checking their smartphone in the middle of the night.

<b>Sleep habit</b>	<b>n</b>	<b>%</b>
<b>Bed time</b>		
9-11pm	6	11.1
11pm-1am	29	53.7
After 1am	19	35.2
<b>Wake time</b>		
Before 7am	4	7.4
7-9am	16	29.6
9-11am	29	53.7
After 11am	5	9.3
<b>Time to fall asleep (minutes)</b>		
0-30	29	53.7
31-60	21	38.8
More than 60	4	7.5
<b>Time asleep (hours)</b>		
5 or less	2	3.8
6-7 hours	23	42.5
8-9 hours	28	51.8
10+ hours	1	1.9
<b>Daytime sleepiness (per week)</b>		
1-2 days	11	20.3
3-4 days	18	33.4
5-6 days	9	16.7
Everyday	16	29.6
<b>Urge to nap (per week)</b>		
Never	15	27.7
1-3 days	27	50.0
3-4 days	6	11.1
4-6 days	1	1.9
Everyday	5	9.3
<b>Sleep quality</b>		
Very good	1	1.9
Fairly good	37	68.5
Fairly bad	12	22.2
Very bad	4	7.4

Table 2: Participant sleep habits (n=54)

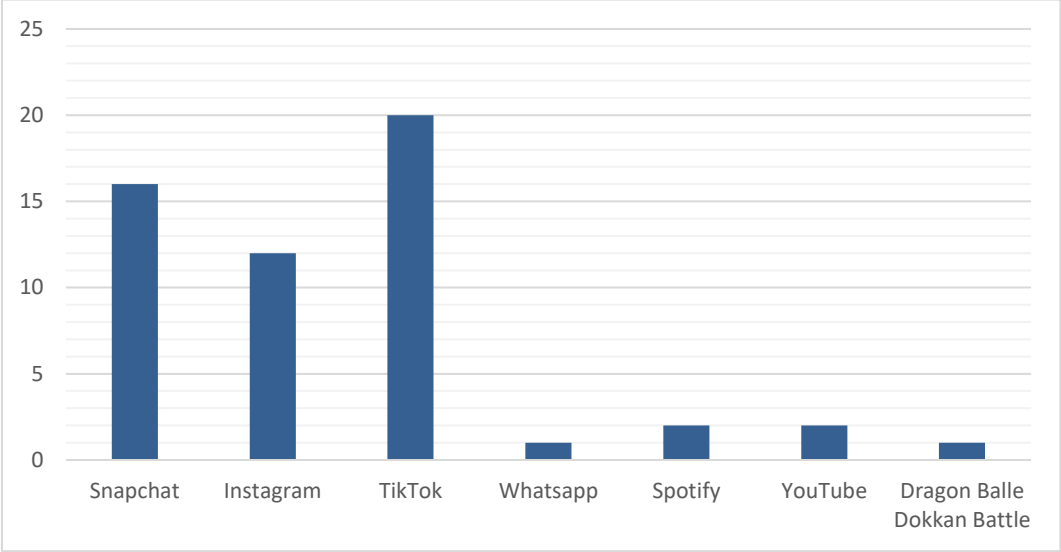


Figure 1: Most used evening and bedtime applications

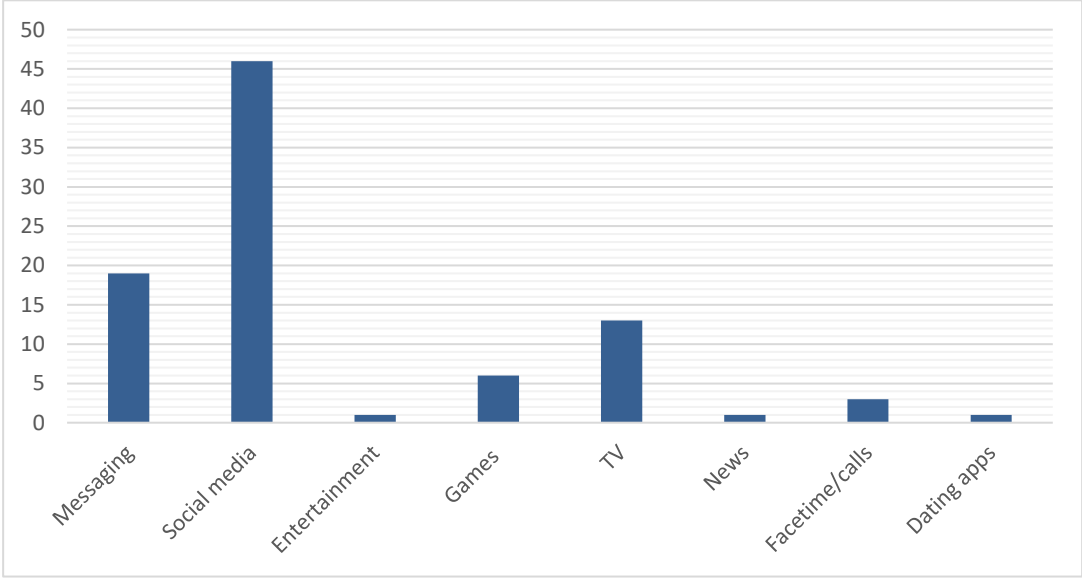


Figure 2: Reasons for bedtime smartphone use



		Do you think you spend too much time on your phone?				Total
		Rarely	Sometimes	Often	Always	
Do you find that using your phone before you sleep makes your bedtime later?	Never	1	0	0	0	1
	Rarely	0	4	0	0	4
	Sometimes	1	4	2	4	11
	Often	0	6	9	5	20
	Always	0	2	10	6	18
Total		2	16	21	15	54

*Table 3: Relationship between time on phone and bedtime (n=54)*

### *Bedtime smartphone usage and sleep quality*

When it came to sleep quality, 70.4% of the 54 participants rated this as fairly good or very good, in the case of one participant only. In comparison, 22.2% rated their sleep quality as fairly bad with 7.4% indicating very bad. Most participants woke up feeling tired between 3 and 4 days a week but with 29.2% feeling tired every day. A correlation between waking up feeling tired and hours spent on the phone at night before going to sleep was significant ( $r = .306, p = .024$ ). These results are consistent with other studies indicating that those students who used their smartphones more at night were more at risk of being poor sleepers (Munezawa et al., 2011; Exelmans & Van den Bulck, 2016). There was no significant correlation between bedtime smartphone use and wakeup time ( $r = -.007, p = .960$ ) or between the amount of time participants spent asleep and their bedtime smartphone use ( $r = -.140, p = .312$ ).

### *Distracting devices*

When it came to keeping up enough enthusiasm to get things done, 38.9% of participants said that smartphone use was somewhat of a problem and 20.4% felt it was a very big problem, while 59.3% of participants felt that they were easily distracted. 64.8% also found it hard to stay focused while studying in which 87.0% felt their phones were a distraction. Figure 3 shows what participants felt distracted them the most (with one participant stating “the pull of social media in particular”).

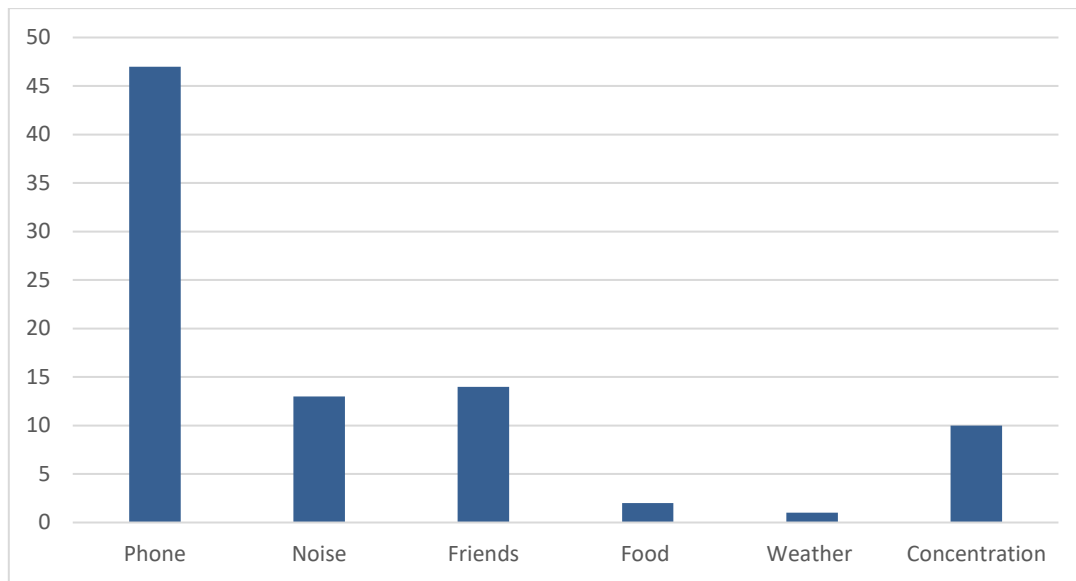


Figure 3: Distractions

## Discussion and Conclusions

### Overview

The purpose of this study was to investigate the relationship between bedtime smartphone use and sleep quality among a sample of undergraduate students. Of the 54 participants who completed the online survey questionnaire, participant screen time was comparable to the UK average of a little over four hours but too much time spent on smartphones in the evening was also associated with a later bedtime. The average bedtime of participants was around midnight and 38.9% felt they generally had trouble sleeping. Using smartphones before bedtime, with exactly half of the participants spending over an hour on their smartphones right before they went to sleep, was associated with negative sleep outcomes including feelings of tiredness in the morning, irritability, frustration, being upset or anxious and feeling depressed, representing various impacts on physical and mental health. During bedtime smartphone use, fewer than half of the participants used the night-time brightness setting which may present small benefits for those individuals with insomnia (Burkhart & Phelps, 2009; Lawrenson et al., 2017; Ishizawa et al., 2021). While retaining some access to television as a common form of bedtime entertainment, smartphones were generally being used for social media, messaging, phone calls and games, with the use of Snapchat, Instagram and TikTok dominating activity. From investigating the main use of devices and participant distractions, as mentioned earlier, one participant felt that the pull of social media certainly distracted them the most, suggesting that social media is both cause and effect. Consistent with previous

research it was found that general and bedtime smartphone use had a negative impact on sleep quality resulting in shorter sleep duration and disrupted sleep patterns. Outcomes were also consistent with the mechanism of sleep displacement mentioned earlier where individuals lose track of time and so displace the time for sleeping (Exelmans & Van den Bulck, 2016). While there are no rules against using a mobile device while attending university, of course, research has shown that large numbers of students can also be distracted in lectures during the day creating its own problems (e.g. 67% of a sample of 265 students reported by Attia et al., 2017).

### *Recommendations*

The findings of this study contribute to developing our understanding of the importance of sleep and how it can be impacted by smartphone usage among student groups and some students more than others. The data offer crucial insights into this topic to help inform interventions aimed at reducing inappropriate and distracting smartphone use and improving sleep quality which, in turn, could improve the physical and mental health and wellbeing of students as well as potentially improve academic performance (Stores et al., 2023). These results could be used by university services to highlight the significance of the link between all variables. For example, the study's findings may provide information on how universities can promote smartphone etiquette or provide workshops that may be beneficial for raising awareness around the responsible use of smartphones. Data showed a consistent relationship between smartphone use and poorer sleep quality, demonstrating that these devices can have a negative impact on how students respond, including a later bedtime and feelings of tiredness in the morning. The data also lead to questions about the factors that contribute to excessive smartphone use.

### *Limitations and suggestions for future research*

There are some limitations to acknowledge in this study. Sampling resulted in a particularly low number of men relative to women participants with no opportunity to compare smartphone use between groups. Furthermore, the overall sample size cannot be taken as typical of the population of students as a whole, with a low response rate increasing the risk of bias which jeopardises the generalisation of findings more widely (Holbrook et al., 2000). Future research might probe further why students have particularly late bedtimes across year groups and courses in detail, probe attitudes towards smartphone use itself and to consider impact on physical and mental health and wellbeing and academic performance in detail. Other more reliable measures for future work might also include the use of the full Pittsburgh Sleep Quality Index (PSQI) which could not be adopted here for ethical reasons. Furthermore, Curcio et al. (2006) noted some of the difficulties when it comes to self-reporting sleep patterns due to the unreliable nature of recall and social desirability bias (Furnham, 1986). This can often lead to participants over or under-reporting their sleep habits and the factors involved. Of course, bedtime smartphone use cannot solely be attributed to feelings of tiredness as undergraduate students also

tend to have other demands in their life including study habits, lifestyle patterns, having to work, commuting and family and caring responsibilities.

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