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Investigating the effects of sleep, technology use and interpersonal stress towards mental health among university students

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Abstract

Interpersonal stress is a major form of stress among university students, and has implications on sleep quality, which impacts mental health. Digital technologies have seen widespread adoption in recent years, especially after the pandemic; however, its effect on interpersonal stress and mental wellbeing is still unknown. The present study hypothesized that sleep quality, technology use and interpersonal stress has an effect on mental wellbeing and each other. 57 participants successfully complete a questionnaire containing the Pittsburgh Sleep Quality Index (PSQI), the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS), a portion of the Adolescent Perceived Event Scale (A-PES) pertaining to interpersonal stress, and provided one week of technology use statistics (screen time, notifications, unlocks) through the use of the Screen Time application (iOS) or the Digital Wellbeing application (Android). Results suggested that sleep quality, interpersonal stress and mental wellbeing are inter-correlated with each other, while technology use statistics were mostly uncorrelated to each other and to other measures in the study. We propose that differences between objective technology statistics and subjective technology use experiences may have cause inconsistencies with previous literature, in addition to limitations such as low participant numbers and the cross-sectional design of the study.

1 Introduction

Interpersonal stress, stress generated through interpersonal interactions, is a major form of stress among the many types of stressors faced by university students (Fernández González et al., 2015). Coiro et al. (2017) reported a strong positive association between interpersonal stress and symptoms of depression and anxiety within a sample of university students. Thus, decreasing interpersonal stressors may also increase mental wellbeing.

Interpersonal stress may also impact mental health indirectly through affecting sleep. There is a two-way relationship between sleep and social stress (Gordon et al., 2017). Beatty et al. (2011) reported that perceived discriminations is related to disturbed sleep, while Prather et al. (2013) reported that sleep deprivation causes increased stress due to enhanced amygdala activation. This is particularly relevant to university students. Lund et al. (2010) reported that over 60% of students had poor sleep quality, according to scores from the Pittsburg Sleep Quality Index (PSQI). Among those, different forms of stress accounted for 24% of the variance in PSQI scores, including interpersonal stress.

Digital technologies have seen widespread use and adoption in recent years; in 2017, it is reported that the time spent by young people online has doubled in the past (Ofcom, 2017). However, the impact of technology use towards mental health is still debated. Indeed, large-scale studies and meta-analyses only show small correlations between technology use and decreased mental health (McCrae et al., 2017; Orben & Przybylski, 2019). Perhaps, this is because technology use is often just another way of communication through social media. Indeed, Murdock et al. (2015) reported that there was a negative correlation between interpersonal stress and mental health, but only among students who reported higher levels of co-rumination with others via mobile phones. They reported that the use of mobile phones alone was not indicative of interpersonal stress. However, online interaction is drastically different than interaction offline (Lieberman & Schroeder, 2020); and as university students are more likely to be dependent on their smartphones (Smith et al., 2015) and more likely to experience symptoms of depression and anxiety

compared to the general population (Blanco et al., 2008) the rapidly changing relationship between interpersonal stress and mental health becomes more important.

Moreover, the positive effects of technology use give rise to the issue of excessive screen on time, both due to the positive effects of screen on time causing an addiction and the lack of incentives to stop technology use (eg. real-life socialization opportunities) due to the COVID-19 pandemic. Technology use causes sleep issues eg. day-night reversal or reduced sleep) (WHO, 2020). In fact, a meta-analysis by Mei et al. (2018) revealed a strong correlation between technology use and sleep issues, such as reduced sleep and increased sleep onset latency.

Previous research has revealed symptoms of insomnia as a factor bridging the gap between interpersonal stress and mental health (Adams et al., 2020). The COVID-19 pandemic and subsequent measures to control it has reduced in-person socialization opportunities, and thus increasing technology use drastically (Pandya & Lodha, 2021). Given the fact that most interactions between university students are now online, in addition to how technology use causes sleep issues, investigating the role technology plays in the correlation between sleep, interpersonal stress and mental health would give us insights into how students have coped with the shift from offline to online social interaction. Given previous literature, we hypothesized that sleep quality, technology use and interpersonal stress has an effect on mental wellbeing as well as each other.

2 Methods

2.1 Participants

There were 110 participants in total. Participants were recruited through an advertisement from the University of St Andrews. 46 entries had to be removed because they failed to complete one or more sections. A further 7 participants were removed, either because they estimated their screen time or due to participant data exceeding 2 standard deviations above the mean on the number of notifications received. This resulted in a final sample size of 57. Among the entries that were analyzed, 37 (64.9%) identified as female, 13 (22.8%) identified as male, 4 (7.0%) identified as non-binary, and 3 (5.2%) did not disclose their gender identity. The average year of study among the participants is 2.8. Participants studied psychology and neuroscience the most, with 14 people taking at least one psychology or neuroscience module; followed by 11 people taking at least one mathematics and statistics, physics and astronomy and social anthropology module.

2.2 Design

The study used a questionnaire design, and was run online through Qualtrics software. The independent variables are sleep quality, technology use and interpersonal stress; while the dependent variable is mental health.

2.3 Measures

Pittsburgh Sleep Quality Index (PSQI)

Participants were first administered the Pittsburgh Sleep Quality Index (PSQI), as a measure of sleep duration and subjective sleep quality (Buysse et al., 1989). In the questionnaire, participants were asked to respond to 19 different items, which generate seven component scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction; each component has a maximum score of 3. A lower score represented better sleep habits.

Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS)

Participants were then administered the Warwick-Edinburgh Mental Health Scale (WEMWBS), a general measure of mental health. The WEMWBS is a commonly used metric to measure general mental wellbeing with high validity (Tennant et al., 2007). Participants were asked to respond how they felt about 14 positive statements from a scale of 0 (None of the time) to 5 (All of the time), which adds up to a raw score ranging from 5 to 70.

A portion of the Adolescent Perceived Event Scale (A-PES)

Then, participants were then administered 16 questions pertaining to interpersonal stress from the Adolescent Perceived Event Scale, as a measure of interpersonal stress in daily life. The A-PES is a reliable self-reported measure of stress in daily life over the past six months (Compas et al., 1987). Participants were asked to rate interpersonal events on a scale from -4 (extremely bad) to +4 (extremely good).

Technology use statistics

Finally, technology use statistics was collected by participants through three smartphone usage metrics – screen time, notifications and unlocks. The data was collected using the Screen Time application (on iOS) and Digital Wellbeing application (on Android).

Participants were first asked which operating system they were using (either iOS, Android or Other/Neither). iOS or Android users were then directed to the Screen time or Digital Wellbeing application, and asked to fill in 7 days' worth of screen time, notification and unlock statistics. If they answered Other/Neither in the initial question, or if they were unable to access the Screen Time/Digital Wellbeing application, no data was collected from them and their data were not considered for the results. Data from the day of completing the survey was removed. This is because participants completed their questionnaire in different times of the day, and thus may continue to use their smartphones after they have completed the questionnaire.

2.4 Procedure

An anonymous link to an online survey in Qualtrics was distributed among social media networks such as Facebook, Instagram and MS Teams. Participants could be entered into a lucky draw after completing the survey, where up to 5 participants could receive a 20-pound gift voucher. Participants of the survey were first directed to read the information sheet and provide consent to participating in the study. Then, participants were asked to complete the Pittsburg Sleep Quality Index (PSQI), the Warwick-Edinburgh Mental Health Scale (WEMWBS), and a portion of the Adolescent Perceived Event Scale (A-PES). Moreover, they were asked to provide technology use statistics through the Screen Time app (iOS) or Digital Wellbeing app (Android). Finally, participants were debriefed and told the intention of the study.

3 Results

3.1 Plan of analysis

The hypothesis was tested through correlation and hierarchical regression, in order to assess whether sleep, technology use and interpersonal stress is influencing mental health. Correlation analysis was used to assess correlations between different variables used, while hierarchical regression was used to assess whether technology use combined with sleep measures can better predict mental health better compared to sleep measures alone.

3.2 Results

Table 1 shows the descriptive statistics of the measures used in the study. As the distribution of the data is skewed, non-parametric tests were used for analysis when possible.

Table 1. The mean, median and standard deviation of PSQI scores, WEMWBS scores, A-PES scores and technology use statistics among participants (n = 57).

	Mean	Median	S.D.	Inter-quartile range	Skewness
PSQI	8.105	7	4.043	6	0.616
WEMWBS	43.877	42	9.402	17	0.018
A-PES	-9.982	-8	10.202	13	-0.950
Screen time (minutes)/day	373.474	364.833	166.834	247	0.440
Notifications/day	139.401	122	83.477	83.333	1.248
Unlocks/day	103.646	97.333	57.717	70	0.944

A two-tailed Spearman's Rho correlation analysis revealed a moderate negative correlation between PSQI and WEMWBS metrics, $r(114) = -0.530$, $p < 0.001$. There was also a weak negative correlation between PSQI and A-PES metrics, $r(114) = -0.384$, $p = 0.003$; and a weak positive correlation between WEMWBS and A-PES metrics, $r(114) = 0.375$. However, there was no significant correlation between

screen time, notifications and unlocks with the above three metrics and with each other. The Spearman's Rho statistics and p-values are shown in the correlation matrix below.

Table 2. Spearman's rho correlation matrix among PSQI, WEMWBS, A-PES, screen time, notifications and unlocks metrics (n = 57).

Variable	1	2	3	4	5	6
1. PSQI						
2. WEMWBS	-0.530**					
3. A-PES	-0.384*	0.375*				
4. Screen time (minutes)/day	0.183	-0.196	-0.124			
5. Notifications/day	0.192	-0.200	-0.105	0.187		
6. Unlocks/day	-0.023	-0.168	-0.200	0.110	0.449**	

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

Moreover, a three-block hierarchical linear regression analysis was conducted to evaluate whether the independent variables could predict Warwick-Edinburgh mental health scores. Examination of the residual plots indicated that the assumptions of homoscedasticity and lack of multicollinearity were met.

For the first block of analysis, PSQI and A-PES scores were entered into a multiple regression. The results of the first block hierarchical linear regression analysis revealed a weak but statistically significant model ($R^2 = 0.258$, $F(2, 54) = 10.730$, $p < .001$). The adjusted R^2 value of 0.258 in this model suggests that PSQI and A-PES scores explains 25.8% of the variation in WEMWBS scores. However, among the coefficients, only PSQI scores significantly predicted WEBWMS scores in the present regression ($p < .001$). The second block of analysis revealed a different outcome.

For the second block of analysis, the three mobile usage scores (screen time, notifications, unlocks) were added to the analysis. The results of the second block hierarchical linear regression analysis revealed a model that is less statistically

significant ($R^2 = 0.224$, $F(5, 51) = 4.226$, $p = .003$). Additionally, the adjusted R^2 value change of -0.034 to 0.224 in this model suggests that the addition of the mobile usage scores accounts for 22.4% of the variation in WEMWBS scores, which is 3.4% less than the first block of analysis. Similarly, however, among the coefficients, only PSQI scores significantly predicted WEBWMS scores in the present regression ($p = 0.004$). The third block of analysis revealed a similar outcome.

For the third block of analysis, the product of screen time multiplied by PSQI scores was added to the analysis, in order to see how the interactions between the two impact mental wellbeing. The results of the second block hierarchical linear regression analysis revealed a model that is again less statistically significant ($R^2 = 0.219$, $F(6,50) = 3.612$, $p = .005$). Additionally, the adjusted R^2 value change of -0.5 to 0.219 in this model suggests that the addition of the mobile usage scores accounts for 21.9% of the variation in WEMWBS scores, which is 3.4% less than the first block of analysis. Similar to the previous blocks, among the coefficients, only PSQI scores significantly predicted WEBWMS scores in the present regression ($p = 0.039$). The results of the analysis are summarized in Table 3.

Table 3: Summary of coefficients in the three-block regression analysis, and their p-values (n = 57).

Model ^a	Unstandardized		Standardized		
	B	Std. Error	β	t	p
1^b (Constant)	53.906	2.448		22.024	<.001
PSQI	-1.02	0.284	-0.439	-3.598	<.001
A-PES	0.176	0.112	0.191	1.567	0.123
2^c (Constant)	55.694	3.712		15.003	<.001
PSQI	-0.958	0.317	-0.412	-3.023	0.004
A-PES	0.173	0.119	0.188	1.456	0.152
Screen time/day	-0.003	0.007	-0.048	-0.385	0.702
Notifications/day	-0.006	0.017	-0.057	-0.373	0.711
Unlocks/day	-0.004	0.024	-0.024	-0.168	0.867
3^d (Constant)	59.775	6.2		9.641	<.001
PSQI	-1.463	0.692	-0.629	-2.116	0.039
A-PES	0.153	0.122	0.166	1.248	0.218
Screen time/day	-0.015	0.017	-0.271	-0.908	0.368
Notifications/day	-0.011	0.018	-0.095	-0.596	0.554
Unlocks/day	0.004	0.026	0.024	0.151	0.881
screen time/day*PSQI	0.001	0.002	0.37	0.823	0.414

a. Dependent Variable: WEMWBS

b. Predictors: (Constant), A-PES, PSQI

c. Predictors: (Constant), A-PES, PSQI, unlocks/day, screen time/day, notifications/day

d. Predictors: (Constant), A-PES, PSQI, unlocks/day, screen time/day, notifications/day, screen time/day*PSQI

Finally, a linear regression of WEMWBS with A-PES as the predictor was conducted, to evaluate whether the A-PES scores could predict WEMWBS scores. It revealed a model that was statistically significant but weak ($R^2 = 0.097$, $F(1, 55) = 6.993$, $p = .011$), showing that the A-PES can explain 9.7% of the variance in WEMWBS scores. The results are summarized in Table 4.

Table 4: Summary of coefficients in the analysis of WEMWBS against A-PES, and their p-values (n = 57).

Model ^a	Unstandardized		Standardized		
	Coefficients		Coefficients		
	B	Std. Error	β	t	p
1^b (Constant)	46.967	1.663		28.240	<.001
A-PES	0.310	0.117	0.336	2.644	0.011

a. Dependent Variable: WEMWBS

b. Predictors: (Constant), A-PES

4 Discussion

The aim of the study was to investigate whether sleep habits (quality and quantity), technology use and interpersonal stress impacted mental wellbeing, with the hypothesis that all three would have a statistically significant impact on mental wellbeing.

The results found partial support for the alternative hypothesis, and were somewhat consistent with previous work. There was a significant three-way correlation between WEMWBS scores, A-PES scores and PSQI scores. A lower PSQI score (indicating better sleep quality) is correlated with a higher A-PES score (indicating lower interpersonal stress), and a higher WEMWBS score (indicating higher mental wellbeing), similar to previous studies examining sleep and interpersonal stress (Gordon et al., 2017), or interpersonal stress and poor mental health (eg. depression and anxiety) (Coiro et al., 2017). In addition to that, A-PES scores were significantly correlated with WEMWBS scores when alone, but not when put with PSQI scores, suggesting that PSQI scores are much more significantly correlated to WEMWBS scores compared to A-PES scores. Conversely, there is no correlation between technology use statistics with the aforementioned variables, and to each other (with one exception, a positive correlation between notifications/day and unlocks/day), which is different from some studies (Adams & Kisler, 2013), but similar to others (eg. Murdock et al. (2015)).

There may be a few explanations for the present results. In the present day, adolescents interact with the world through their smartphones, and most times mobile phones are not used for media consumption or entertainment instead of active communication on social media.

Moreover, the type of data collected to measure mobile phone usage (ie. raw technology use statistics) may explain the lack of correlation between technology use statistics and the other variables present in the study. (Ellis et al., 2019) reports that objective screen time behaviors do not correlate well to psychometric scales; however, it is also true that perceived interpersonal stress, and therefore mental

health, is dependent on subjective measurements and individual experiences which screen on time cannot capture. For example, one person may find that using their smartphones for long periods of time may be detrimental to their mental health, but another may find no problem with the same situation. This is particularly true because interpersonal stress is often generated when someone perceives they are rejected (Leary, 2015).

The limitations to the study may also partially explain the results. Firstly, the survey was completed during summertime – meaning university students typically have more free time, and are more likely to use their phones more, in addition to having more archaic sleep schedules (due to the lack of commitments normally present during term time.)

In addition to that, the lack of participants and the heavy female bias is a limitation which may explain the results. Compared to previous studies of a similar nature (ie. Adams et al. (2020), the present study is not able to recruit as many participants, thus decreasing the generalizability of the data. Moreover, there is a heavy female bias within the participant data, which may influence the results, due to differing smartphone usage habits and motives between male and female participants (Chen et al., 2017). Finally, the study is cross-sectional (instead of longitudinal), which disallows more objective, long term collection measures for sleep (eg. actigraphy, (Van De Water et al., 2011)) or long-term mood tracking for more reliable data.

In summary, the present study did find partial support for the hypothesis. However, the effects of technology use statistics on sleep habits, interpersonal stress and mental health are still unclear, either due to the lack of participants, or due to objective screen time measures not matching up with subjective experiences. In addition, the present study is able to put into practice the collection of objective smartphone usage statistics directly through system applications. Perhaps, to further pursue this line of research, future research may focus on more understanding the implications of subjective smartphone usage data compared to objective smartphone use statistics.

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