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Adolescent sleep, distress, and technology use: weekday versus weekend

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Background: In adolescents, technology use at bedtime is linked to disrupted sleep and psychological distress. Adolescents are known to sleep later on weekends compared to weekdays but whether this leads to greater technology use, and, hence, additional psychological distress is not known. At greater risk maybe adolescents with a late compared to early chronotype, that is a preference for late versus early sleep onset and offset times. **Method:** Self-reported measures of sleep timing, chronotype (early, neither early nor late, late), technology medium (social media/texting, TV/streaming, and gaming), and psychological distress (DASS-21) were collected from 462 students attending one Australian high school. **Results:** Technology use at bedtime was greater on weekends and especially in adolescents with a late chronotype. Social media/texting on weekends was predictive of delayed sleep onset times ($\beta = .120$), and shorter sleep ($\beta = -.172$). Shorter sleep on weekdays but not on weekends was associated with greater psychological distress. Technology medium and chronotype were not predictive of psychological distress. **Conclusions:** This study confirmed that technology use and its impact on sleep differed on weekdays compared to weekends and that a late chronotype was associated with greater technology use. However, neither technology medium nor chronotype was found to affect psychological distress. While greater autonomy may be granted to adolescents over the weekend regarding sleep behaviour, young people, parents, and clinicians should be mindful of the link between technology use and sleep.

Key Practitioner Message

- During adolescence, there is a natural delay in the 'body clock' leading to later sleep onsets and offsets.
- A delayed circadian system is associated with insufficient sleep and psychological distress.
- In adolescents, technology use at bedtime is associated with poor sleep and psychological distress.
- In adolescents, technology use is higher on weekends compared to weekdays.
- Technology use and the impact of technology use on sleep is greater on weekends than on weekdays.
- Technology should be evaluated on both weekdays and weekends as an independent factor predicting poor sleep.
- Weekend technology use may contribute to the interaction between overall technology use, poor sleep, and psychological distress.
- Guidelines on sleep hygiene must consider the impact of technology at bedtime on sleep and psychological distress.

Keywords: Sleep; technology; weekend; adolescent; mental health; chronotype; distress

Introduction

An emerging literature now exists suggesting adolescents' technology use at night disrupts sleep which, in turn, is linked to psychological distress (Agostini & Centofanti, 2021; Bartel, Richardson, & Gradisar, 2018; Brown et al., 2018; Costello et al., 2002). However, this literature typically fails to consider the difference between weekdays and weekends, and mostly relies on averaged weekly estimates. The use of these averages does not allow for the exploration of changes in either sleep or technology use across the week, such as weekdays versus weekends, and therefore an exploration of the possible consequences for psychological distress. Notably, most adolescents fail to meet recommended guidelines for sleep (8–10 hr) on school days and tend to compensate for any shortfall by catching up on weekends with later bed- and wake-times, and longer total sleep times (Crowley, Wolfson, Tarokh, & Carskadon, 2018; Gariepy et al., 2020; Hirshkowitz et al., 2015), a phenomenon also known as 'social jet lag' (Henderson, Brady, & Robertson, 2019; Wittmann, Dinich, Merrow, & Roenneberg, 2006). Studies examining social jet lag typically report that social jet lag is associated with psychopathology (Becker, Sidol, Van Dyk, Epstein, & Beebe, 2017; Sun, Ling, Zhu, Lee, & Li, 2019) and dysregulated mood (Kim, Noh, Kim, & Kwon, 2022; Koo et al., 2021; Park et al., 2015). However, mixed findings have been reported regarding weekend versus weekday sleep and mood. For example, Zhang et al. (2017) found that mood disturbance was associated with shorter sleep on weekdays but longer sleep

on weekends (e.g. oversleeping). Possible factors contributing to the weekday-to-weekend variation in sleep include unscheduled use of time, socialisation, and extracurricular activities (Agostini, Carskadon, Dorrian, Coussens, & Short, 2017; Khor, McClure, Aldridge, Bei, & Yap, 2021; Tashjian, Mullins, & Galvan, 2019). The literature examining technology use at night, sleep, and psychological distress should be expanded to include an investigation of weekday versus weekend differences.

A contributing factor to disturbed sleep in adolescents is technology use at bedtime. Most adolescents own an Internet-enabled device (Odgers & Jensen, 2020) and technology use, defined in the current study as bedtime use of computers, phones, TV, or gaming devices has been associated with both disturbed sleep and greater psychological distress (Alonzo, Hussain, Stranges, & Anderson, 2021; Correa et al., 2022; Stanković et al., 2021). Technology use at night is known to disrupt and displace sleep (Crowley et al., 2018; Gradisar & Crowley, 2013), increase arousal (Alonzo et al., 2021; Kelly, Zilanawala, Booker, & Sacker, 2018), and possibly alter circadian timing through screen light exposure (Bartel, Gradisar, & Williamson, 2015). Despite the above evidence, the frequency of technology use at bedtimes in adolescents on weekday versus weekends is not well documented. There is, however, a convergent literature examining technology use more broadly in adolescents. For example, daily screen time is reported to be higher on weekends (Toh et al., 2019), while regardless of day, greater technology use is associated with shorter sleep (Orben & Przybylski, 2020) and worse mood (Barthorpe, Winstone, Mars, & Moran, 2020).

A second possible contributing factor to disturbed sleep in adolescents is interaction between circadian type and technology use at bedtime. Commencing at puberty, there is a well-documented delay in timing of the circadian system and corresponding delay in sleep-onset and wake-up (Tarokh, Short, Crowley, Fontanellaz-Castiglione, & Carskadon, 2019). This delay can be extenuated in adolescents who have a late chronotype which has a genetic basis but is also influenced by age, light exposure, and cultural and social cues (Rodriguez Ferrante, Goldin, Sigman, & Leone, 2022). It is proposed that adolescents with a late chronotype may be at greater risk of disturbed sleep from technology use on weekends simply because they stay awake later. Adolescents with a late chronotype tend to be at a higher risk of problematic smartphone use (Randjelovic, Stojiljkovic, Radulovic, Stojanovic, & Ilic, 2021) and mental health problems (Dagys et al., 2012; Taylor & Hasler, 2018). Understanding better the interaction between chronotype, technology use, sleep, and mental health would help inform sleep hygiene instructions, and guidelines for children, schools, and clinicians, and take into account inter-individual differences in chronotype.

Demographics are also known to impact sleep and technology use in adolescents, namely age and gender. As age increases over adolescence, there is a progressive delay in sleep timing and a shortening of sleep length (Carskadon, 2011; Crowley et al., 2018). Age is also accompanied by increased digital technology use (Bruni et al., 2015; Richardson et al., 2021). Gender differences in sleep are also well documented with female adolescents typically waking earlier, sleeping less, and having an earlier chronotype (Forest, Gaudreault, Michaud, & Green-Demers, 2022; Laberge et al., 2001; Lee, McEnany, & Weekes, 1999). Gender differences moreover are evident in technology use and the preferred technology medium with females reporting greater social media and mobile phone use (Bruni et al., 2015; Correa et al., 2022), and males gaming (Twenge & Martin, 2020). Males are also reported to spend more time using digital technologies (Twenge & Martin, 2020). In consideration of the sleep and technology use changes with age, it would be informative to separately examine younger and older adolescents. In consideration of the gender differences, it would be informative to include gender as a factor in analyses.

The aims of the present study are, first, to examine whether the 'digital diet' of adolescents at bedtime differs between weekday and weekend nights and, second, to examine the interplay between psychological distress and weekday compared to weekend sleep and technology use, and the influence of individual factors such as gender, chronotype, and age.

Method

Participants and procedure

Students from Years 7–12 (aged 12–18 years) attending an independent (private, high social-economic-status), co-educational school in Adelaide, South Australia participated in the study. Under teacher supervision, they completed an online questionnaire in class which was hosted on REDCap (Harris et al., 2019). Data were collected at the beginning of term two, April 2021. The study was approved by the University of South Australia Human Research Ethics Committee (#203753).

Measures

Sleep. Sleep was assessed using the School Sleep Habits Survey (SHSS) (Wolfson & Carskadon, 1998). Participants were asked to estimate to the nearest five minutes on the most recent school weekday night (Mon–Thur) and, likewise, weekend night (Fri–Sat): (a) bedtimes, (b) lights-out times, (c) sleep-onset times, (d) final wake-up times. Chronotype was assessed by the item 'one hears about "morning people" and "evening people." Which one of these do you consider yourself to be?' rated on a 5-pt scale (1 = definitely a morning type to 5 = definitely an evening type) (Wolfson & Carskadon, 1998). Data for Sunday night were omitted from the study as it is typically constrained by later sleep onset times but earlier wake-up times for schooling and therefore not representative of either weekday or weekend sleep. The validity of the SSHS has been established against objective sleep measures including actigraphy and sleep diary in adolescent populations (Short, Gradisar, Lack, Wright, & Chatburn, 2013).

Psychological distress. The Depression Anxiety Stress Scale-21 (DASS-21) was used to assess general psychological distress (Lovibond & Lovibond, 1996). Participants were asked to self-report the frequency of items in the preceding week using a 4-pt scale (0 = *not at all* to 3 = *most of the time*). The DASS-21 generates scores for three psychological states (depression, anxiety, and stress) and a composite total score representing an overall negative affectivity (Henry & Crawford, 2005) and higher scores representing poorer mental health, or higher psychological distress (Shaw, Campbell, Runions, & Zubrick, 2017; Tran, Tran, & Fisher, 2013). The DASS-21 has been validated in Australian adolescents (Lovibond & Lovibond, 1996; Shaw et al., 2017) and demonstrates strong reliability and validity (Henry & Crawford, 2005).

Technology use. Three technology use behaviours were assessed: viewing content (watching movies/TV/streaming), social engagement (social media/texting), and gaming

(video/computer). Participants were asked how many minutes they spent on these activities on a typical school weekday and, likewise, weekend night while waiting to sleep. As suggested by Prinstein, Nesi, and Telzer (2020), rather than focusing on screen time we examined the presence of technology use behaviours. To assess the presence of technology use behaviours, responses were dichotomised into whether adolescents indicated that they had engaged or not engaged in viewing content, social engagement, or gaming.

Data analysis

Data were analysed using SPSSv26. As sleep and technology use are reported to differ between younger and older adolescent children, the Year 7–9 (Mean 13.2 years, *SD* = 0.9) and Year 10–12 (Mean 15.8 years, *SD* = 0.8) age groups were separately analysed. One-way ANOVA tests were used to examine the effect of Gender (Male, Female) on Chronotype (Early, Neither, Late). Two-way between-factor ANOVA tests were used to test the effect of Gender and Chronotype on DASS-21 scores. Three-way between-factor ANOVA tests were used to examine the effect of Chronotype, Gender and Day (Weekday, Weekend) on sleep. Significant interactions were tested using Tukey HSD post hoc tests, with an alpha level of .05. The *p*-values were not adjusted for multiple comparisons given the small number of comparisons. Hierarchical linear regressions were used to examine the factors predicting technology uses, sleep on weekday and weekend nights, and psychological distress.

Results

From a sample of 602 students, 59 were excluded because of missing data and a further 81 boarding students were excluded because boarding house rules prohibited digital device use at bedtimes. A final sample of 462 students was divided into younger (Years 7–9; typically aged 12–14; *n* = 229) and older (Years 10–12; typically aged 15–18, *n* = 233) adolescent age groups.

The mean (*SD*) sleep, DASS-21 values and per cent of technology use values according to technology-medium for young adolescents and older adolescents age groups are reported in Tables 1 and 2, respectively.

Sleep

The ANOVA results examining the effect of Gender, Day, and Chronotype on sleep are reported in Tables 3 and 4 for younger and older adolescents, respectively. The young adolescent age group ANOVA results revealed a significant main effect for Day on total sleep time ($F = 13.3$), sleep onset latency ($F = 5.8$), sleep onset time ($F = 11.7$) and final wake-up time ($F = 73.4$) and a significant main effect for Chronotype on sleep onset time ($F = 13.9$) and final wake-up time ($F = 5.7$). The older adolescent age group ANOVA results revealed a significant main effect for Day on total sleep ($F = 41.7$), sleep onset ($F = 41.4$), and wake-up ($F = 217.7$) times. Likewise, Chronotype significantly impacted sleep onset ($F = 7.5$) and wake-up ($F = 18.4$).

The frequency of chronotype for each age group is reported in Table 5. Additional one-way ANOVA analyses revealed that Chronotype frequency did not significantly differ according to gender for either early ($F = 1.6$, $p = .208$) or late ($F = 0.91$, $p = .340$) adolescents.

Technology use

The ANOVA results examining the effect of Gender, Day, and Chronotype on technology use are reported in Tables 3 and 4 for younger and older adolescents, respectively. In younger adolescents, there was a

Table 1. Young adolescents: mean (*SD*) sleep and psychological distress values and frequency of technology use by medium

	Male						Female					
	Early chronotype (*n* = 31)		Neither chronotype (*n* = 22)		Late chronotype (*n* = 67)		Early chronotype (*n* = 23)		Neither chronotype (*n* = 15)		Late chronotype (*n* = 71)	
Dependent variables	Wk Day	Wk End	Wk Day	Wk End	Wk Day	Wk End	Wk Day	Wk End	Wk Day	Wk End	Wk Day	Wk End
Sleep												
Total sleep time	533.62 (47.17)	573.93 (147.56)	539.75 (81.60)	548.75 (114.20)	513.84 (58.72)	518.78 (143.46)	532.83 (63.76)	575.71 (64.02)	475.53 (79.58)	581.13 (224.52)	491.60 (70.04)	536.52 (169.91)
Sleep onset latency	53.71 (67.93)	21.54 (138.60)	56.43 (52.37)	38.81 (40.27)	48.52 (46.39)	41.90 (45.58)	29.57 (36.18)	24.09 (44.98)	42.80 (38.74)	40.11 (27. 97)	62.58 (54.94)	54.82 (128.36)
Sleep onset time	21:41 (0:58)	21:55 (2:28)	22:02 (1:01)	22:35 (1:33)	22:21 (0:58)	23:24 (1:24)	21:33 (0:55)	22:16 (1:28)	22:37 (1:19)	22:21 (3:34)	22:49 (1:09)	23.31 (2.08)
Final wake-up time	6:29 (0:54)	31:32 (1:16)	7:05 (0:39)	7:45 (1:08)	6:53 (0:34)	8:04 (1:49)	6:25 (0:37)	31:50 (1:27)	6:33 (0:36)	8:02 (1:38)	7:00 (0:34)	8:33 (2:09)
Technology medium												
Social media/texting	26.7%	31.0%	47.4%	47.4%	46.9%	54.7%	43.5%	39.1%	46.7%	57.4%	75.0%	83.3%
TV/streaming	39.3%	50.0%	63.2%	68.4%	66.2%	70.0%	30.4%	60.9%	42.9%	78.6%	66.7%	77.8%
Gaming	10.3%	22.2%	23.8%	40.0%	33.3%	42.2%	4.3%	8.6%	6.7%	20.0%	22.1%	28.6%
Psychological distress												
Total DASS-21	14.4 (9.9)		11.8 (12.2)		12.4 (9.7)		16.2 (13.7)		20.6 (14.6)		20.5 (14.4)	

Wk Day, weekday; Wk End, weekend.

Table 2. Old adolescents: Mean (*SD*) sleep and psychological distress values and frequency of technology use by medium

	Male						Female					
	Early chronotype ($n = 23$)		Neither chronotype ($n = 24$)		Late chronotype ($n = 69$)		Early chronotype ($n = 21$)		Neither chronotype ($n = 17$)		Late chronotype ($n = 79$)	
	Wk Day	Wk End	Wk Day	Wk End	Wk Day	Wk End	Wk Day	Wk End	Wk Day	Wk End	Wk Day	Wk End
Sleep												
Total sleep time	470.81 (79.36)	506.14 (96.53)	478.75 (61.19)	535.83 (66.36)	463.52 (75.12)	525.30 (94.57)	466.67 (82.72)	526.75 (191.91)	443.75 (82.57)	513.13 (85.63)	465.66 (68.08)	510.34 (98.26)
Sleep onset latency	48.86 (96.24)	35.23 (88.97)	35.71 (53.11)	46.00 (56.86)	54.04 (58.34)	55.59 (66.34)	59.52 (66.64)	25.95 (174.77)	48.53 (36.94)	50.00 (57.61)	69.81 (108.65)	68.55 (80.40)
Sleep onset time	22:50 (1:26)	23:16 (1:21)	23:01 (1:13)	23:59 (1:32)	23:17 (1:10)	00:20 (1:23)	22:40 (1:17)	23:07 (3:18)	23:08 (1:16)	23:34 (1:25)	23:21 (1:04)	00.17 (1:17)
Final wake-up time	6:34 (0:40)	7:42 (1:14)	7:06 (0:30)	9:03 (1:16)	7:00 (0:44)	9:05 (1:35)	8:27 (0:41)	7:42 (0:52)	8:40 (0:34)	8:06 (1:31)	7:08 (0:34)	8:51 (1:23)
Technology medium												
Social media/texting	61.9%	71.4%	50.0%	55.0%	77.9%	80.9%	66.7%	76.2%	82.4%	87.5%	87.0%	91.0%
TV/streaming	54.5%	71.4%	70.0%	80.0%	78.8%	84.6%	45.0%	70.0%	64.7%	64.7%	72.2%	82.1%
Gaming	18.2%	27.3%	22.2%	26.8%	26.1%	38.8%	5.0%	5.0%	5.8%	11.8%	23.1%	29.1%
Psychological distress												
Total DASS-21	16.7 (15.8)		15.6 (14.2)		14.3 (13.0)	21.1 (11.6)			20.9 (13.8)		20.4 (13.5)	

Wk Day, weekday; Wk End, weekend.

significant main effect for Day for TV/streaming ($F = 29.8$), and for gaming ($F = 16.7$). Gender was significant for social media/texting ($F = 4.8$), and gaming ($F = 5.1$). Chronotype was significant for all three modalities: social media/texting ($F = 8.6$), TV/streaming ($F = 6.6$), and gaming ($F = 4.4$). Day by gender ($F = 7.8$), and day by chronotype ($F = 3.3$) were significant for TV/streaming. In older adolescents, Day was significant for all modalities: social media/texting ($F = 10.3$), TV/streaming ($F = 13.3$), gaming ($F = 10.7$), while gender was significant for social media/texting ($F = 6.3$), and gaming ($F = 5.8$). Chronotype was significant for social media/texting ($F = 4.1$), and TV/streaming ($F = 4.3$). Day by chronotype was significant ($F = 3.4$) for TV/streaming.

Psychological distress

The mean (*SD*) total DASS-21 scores according to age group for Gender by Chronotype are reported in Tables 1 and 2, respectively. ANOVA analyses in young adolescents revealed that while gender was a significant predictor ($F = 8.46$, $p = .004$, Partial Eta^2 = .043), chronotype ($F = 0.13$, $p = .883$, Partial Eta^2 = .001), and the interaction ($F = 1.16$, $p = .314$, Partial Eta^2 = .012), was not. For older adolescents, gender was significant ($F = 5.71$, $p = .018$, Partial Eta^2 = .027), while chronotype ($F = 0.22$, $p = .803$, Partial Eta^2 = .002) and the interaction ($F = 0.06$, $p = .938$, Partial Eta^2 = .001) were not.

Regression results

Technology use. Regression analyses revealed on both weekdays and weekends that a late chronotype was associated with greater technology use (all $\beta > .15$), while female gender was predictive of greater social media/texting but less gaming (Table 6).

Weekend and weekday sleep. Regression analyses revealed that TV/streaming was associated with later final wake-up times on weekdays ($\beta = .11$), while social media/texting was associated with shorter total sleep times on weekends ($\beta = .11$; Table 7).

Psychological distress. Regression analyses revealed that older age, female gender and a shorter total sleep time on weekdays were significant predictor of psychological distress (Table 8). Neither weekday nor weekend technology use was predictive of psychological distress.

Discussion

The main finding from this study is that the relationship between technology use and sleep was different on weekends compared to weekdays. Specifically, social media/texting was predictive of shorter sleep duration on weekends but not weekdays while TV/streaming was predictive of a later wake time on weekdays but not weekends. Contrary to expectations however, an interaction between chronotype and technology use was not observed, and neither of these factors were predictive of worse psychological distress.

This study contributes to the emerging literature regarding weekday versus weekend differences in technology use and their impact on sleep. Consistent with earlier studies and regardless of technology medium, technology use was more common on weekends (Toh

Table 3. Year 7–9 adolescents: ANOVA results (*F*-values (partial eta^2))

	Day	Gender	Chronotype	Day by gender	Day by chronotype	Gender by chronotype	Day by chronotype by gender	Post hoc results
Sleep								
Total sleep time	13.3 (.062)***	0.1 (.001)	2.9 (.028)	3.7 (.018)	0.7 (.007)	0.1 (.001)	0.9 (.009)	Weekday < Weekend
Sleep-onset latency	5.5 (.025)*	0.5 (.002)	2.7 (.025)	0.1 (.001)	1.0 (.009)	1.5 (.014)	0.6 (.005)	Weekday < Weekend
Sleep-onset time	11.7 (.051)***	0.7 (.003)	13.9 (.113)***	0.5 (.002)	2.8 (.025)	0.2 (.001)	1.9 (.017)	Weekday < Weekend Early < Late Chronotype
Final wake-up time	73.4 (.267)***	0.4 (.002)	5.7 (.054)**	3.6 (.018)	0.4 (.004)	0.5 (.005)	0.3 (.003)	Weekday < Weekend Early < Late Chronotype
Technology use medium								
Social media/texting	2.1 (.010)	4.8 (.023)*	8.6 (.026)***	<0.1 (<.001)	1.3 (.012)	1.2 (.012)	0.7 (.006)	F > M Early < Late Chronotype
TV/streaming	29.8 (.129)***	<.01 (<.001)	6.6 (.062)**	7.8 (.037)**	3.3 (.032)*	0.1 (.001)	2.2 (.022)	Weekday < Weekend, Early < Late Chronotype
Gaming	16.7 (.074)***	5.1 (.024)*	4.4 (.040)*	.8 (.004)	1.1 (.010)	0.2 (.001)	0.1 (.001)	Weekday < Weekend F < M Early < Late Chronotype

Partial Eta^2: .01 = small, .06 = medium and 0.14 = large effect size. F, female; M, male.
*p < .05; **p < .01; ***p < .005.

Table 4. Year 10–12 adolescents: ANOVA results (*F*-values (Partial Eta^2))

	Day	Gender	Chronotype	Day by gender	Day by chronotype	Gender by chronotype	Day by chronotype by gender	Post hoc results
Sleep								
Total sleep time	41.5 (.167)***	0.5 (.002)	0.1 (.001)	0.3 (.001)	0.2 (.002)	0.4 (.004)	1.1 (.010)	Weekday < Weekend
Sleep-onset latency	0.7 (.003)	0.4 (.002)	1.7 (.015)	0.5 (.002)	1.3 (.012)	0.2 (.001)	0.1 (.001)	
Sleep-onset time	41.3 (.159)***	0.3 (.001)	7.5 (.065)***	0.7 (.003)	3.2 (.029)*	0.1 (.001)	0.4 (.004)	Weekday < Weekend Early < Late Chronotype
Final wake-up time	217.7 (.510)***	3.3 (.015)	18.4 (.150)***	0.6 (.003)	4.8 (.044)**	1.8 (.017)	0.9 (.008)	Weekday < Weekend Early < Neither = Late chronotype
Technology use medium								
Social media/texting	10.3 (.045)**	6.3 (.028)*	4.1 (.037)*	<.1 (<.001)	1.1 (.010)	1.5 (.013)	<.1 (<.001)	Weekday < Weekend F > M Early < Late Chronotype
TV/streaming	13.3 (.058)***	1.3 (.006)	4.3 (.039)*	0.1 (.001)	3.4 (.030)*	0.1 (.001)	0.4 (.003)	Weekday < Weekend Early < Late
Gaming	10.7 (.047)***	5.8 (.026)*	2.8 (.025)	3.2 (.015)	0.5 (.004)	0.6 (.006)	0.1 (.001)	Weekday < Weekend M > F.

Partial Eta^2: .01 = small, .06 = medium and 0.14 = large effect size. F, female; M, male.
*p < .05; **p < .01; ***p < .005.

Table 5. Per cent chronotype by age and gender

	Year 7–9			Year 10–12		
Gender	Early ($n = 54$)	Neither ($n = 37$)	Late ($n = 138$)	Early ($n = 44$)	Neither ($n = 41$)	Late ($n = 148$)
Male	25.8%	18.3	55.8	19.8	20.7	77.6
Female	21.1%	13.8	65.1	17.9	14.5	67.5

Table 6. Regression analysis: predictors of technology use

	Social media/texting				TV/streaming				Gaming			
	Weekday		Weekend		Weekday		Weekend		Weekday		Weekend	
Step	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2
Step 1		.10***		.10***		.02*		.01		.01		.02*
Year Level	.25***		.24***		.12*		.10*		−.02		−.03	
Gender	.17***		.19***		−.05		.02		−.11**		−.16**	
Step 2		.01		.002		<.01		.01		.01		.01
Psychological distress	.06		.03		.06		.07		.07		.07	
Step 3		.10***		.10***		.05***		.03**		.03**		.03**
Chronotype	.25***		.24***		.21***		.17**		.16**		.16**	

*$p < .05$; **$p < .01$; ***$p < .005$.

Table 7. Regression analysis: predictors of weekday and weekend night sleep variables

	Total sleep time		Sleep onset latency		Sleep onset time		Final wake-up time	
Step	β	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2
Weekday night								
Step 1		.111***		.01		.20***		.11***
Year level	−.24*		.01		.26***		.07	
Gender	.02		−.03		−.04		−.01	
Chronotype	−.09***		.05		.24***		.27***	
Step 2		.114***		.08***		.12***		<.01
Psychological distress	.38***		.28***		.34***		−.07	
Step 3		.007		<.01		.02**		.02*
TV/streaming	−.03		.03		.08		.11*	
Social media/texting	−.07		.02		.11*		.07	
Gaming	−.13		.02		.01		.02	
Weekend night								
Step 1		.263		.04**		.16***		.11***
Year level	.003		.02		.16***		.17***	
Gender	.04		−.01		−.06		−.02	
Chronotype	−.03		.14**		.26***		.26***	
Step 2		.004**		.06***		.05***		.01
Psychological distress	−.15***		.22***		.25		.08	
Step 3		.025*		.01		.03*		.01
TV/streaming	−.01		.08		.09		.09	
Social media/texting	−.17**		.02		.12*		−.07	
Gaming	−.01		.04		.03		.02	

*$p < .05$; **$p < .01$; ***$p < .005$.

et al., 2019). The one exception was the frequency of reporting social media/texting in the younger adolescent group which was similar across weekdays and weekends. These findings point to the value of contrasting weekends and weekdays in future studies. They also point to the need of including weekday versus weekend technology use advice in future sleep hygiene instructions for adolescents.

In addition to the examination of differences in weekday versus weekend sleep and technology use, the present study examined chronotype. As expected and consistent with previous findings, a late chronotype predominated which was associated with later sleep onset and wake-up times on weekdays and even later times on weekends (Bauducco, Richardson, & Gradisar, 2020; Rodriguez Ferrante et al., 2022; Wittmann et al., 2006).

Table 8. Regression analysis: predictors of psychological distress

	Psychological distress	
Step	β	ΔR^2
Step 1		.06***
Year level	.10**	
Gender	.24***	
Chronotype	<.01	
Step 2		.16***
Weekday night total sleep time	−.40***	
Weekend night total sleep time	−.036	
Step 3		.01
Weekday TV/streaming	.02	
Weekday Social media/texting	.06	
Weekday Gaming	.02	
Weekend TV/streaming	.05	
Weekend Social media/texting	.07	
Weekend Gaming	.05	

*$p < .05$; **$p < .01$; ***$p < .005$.

Also consistent with early findings, a late chronotype was associated with a more frequent technology use (Bağcı & Horzum, 2022; Bruni et al., 2015; Brushe et al., 2022; Randjelovic et al., 2021). Specifically, a late chronotype for both age groups was associated with a higher frequency of social media/texting and TV/streaming, and in the younger age group, a late chronotype was also associated with a higher frequency of gaming. Despite expectations however, the only significant interaction observed between day type, chronotype, and technology use was for TV/streaming which for both age groups was more frequent in late chronotypes on weekends.

Contrary to expectations technology use was not found to predict psychological distress. This is contrary to most (Bartel & Gradisar, 2017; Bartel, Scheeren, & Gradisar, 2019) but not all (Tang, Werner-Seidler, Torok, Mackinnon, & Christensen, 2021) studies. Also contrary to expectations and previous findings, a late chronotype was not predictive of psychological distress (Koo et al., 2021). However as expected, older age and female gender were associated with worse psychological distress (Patalay & Fitzsimons, 2018), and worse psychological distress was associated with worse sleep (Alonzo et al., 2021). The failure to observe significant relationships with technology and psychological distress may be explained by the low DASS-21 scores for participants in the present study which for both age groups demonstrated little variability with mean scores in the normal range with only 12.9% of adolescents having scores indicative of clinical concern (e.g. DASS-21 score > 33; Tran et al., 2013).

Consistent with previous findings, regression analyses revealed that older age (year level) on both weekdays and weekends was predictive of shorter sleep and later sleep onset and final wake-up times and, as well, of greater social media/texting and TV/streaming (Bartel et al., 2018; Correa et al., 2022). However, the expected gender differences in the timing and duration of adolescent sleep were not observed (Tremaine, Dorrian, & Blunden, 2010), but as expected female gender was predictive of greater social media/texting and male gender of greater gaming (Scott, Biello, & Woods, 2019; Spicer et al., 2021).

The present study has several limitations. The study relied on data from a homogenous sample of students drawn from a single private school, which may not be representative of the broader adolescent population. It is also noted that adolescent technology use is constantly evolving, and there are no longer clear categorical differences between types of media engagement (e.g. TikTok) and that current technology uses will need updating (Nesi, 2020; Odgers & Jensen, 2020). Furthermore, these data were cross-sectional, limiting conclusions concerning causation. We also relied on sleep and technology use estimates collected at one time-point. A diary methodology examining sleep and technology use over multiple days would be instructive in future studies (Bolger, Davis, & Rafaeli, 2003). A further limitation is that sleep and psychological distress are known to vary with the academic year (Campbell, Soenens, Beyers, & Vansteenkiste, 2018; Sara et al., 2022). The present study examined sleep, technology use, and psychological distress early in the school year, and in future studies, it would be informative to assess these factors at multiple time points including exam times and holidays. It would also have been informative if additional measures of chronotype were collected as the study relied on a single item to classify adolescents. Furthermore, age and maturational development are not identical, and the latter rather than the former is reported to more strongly relate to changes in sleep timing (Bauducco et al., 2020; Rodriguez Ferrante et al., 2022; Roenneberg, 2012). As such, the inclusion of measures of maturational development would be informative in future studies. Despite these limitations, the present sample was of sufficient size to suggest that estimates were a reasonable reflection of sleep and technology use in this school population.

In summary, the present study demonstrated that adolescent technology use varied between weekdays and weekends with a subsequent effect on the timing and duration of sleep with social media/texting at bedtime associated with later sleep onset times on weekdays and both later sleep onset times and shorter sleep on weekends. By contrast, we found little evidence that technology use on either weekdays or weekends was associated with psychological distress.

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Ethical Approval

Ethics Approval was granted by University of South Australia Human Research Ethics Committee on April 19 2021 (Application ID: 203753).

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