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Nighttime Phone Use and Past Exposure to Cyberbullying and Their Impact on Sleep and Psychological Wellbeing in Australian Children Aged 7 to 19 Years

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Abstract: Background: Cyberbullying and nighttime phone use are independently detrimental to sleep and psychological wellbeing, but whether in combination they might be more disruptive remains unknown. Methods: Students aged 7–19 years (N = 53,734) completed a survey measuring sleep duration, nighttime phone use, cyberbullying, and psychological distress. Results: Across stratification variables of gender (F/M) and age group (primary/secondary-school-aged children), bivariate ordered probit regression revealed that being cyberbullied and nighttime phone use were independent predictors of both increased psychological distress and obtaining <8 h sleep. Nighttime phone use was observed to moderate the relationship between cyberbullying and sleep in both primary- and secondary-school-aged girls and boys and, likewise, between cyberbullying and psychological distress, especially in secondary-school-aged boys. Notably, the moderation effect was such that the impact of nighttime phone use was lower in children who were compared with those who were not cyberbullied. This may be a ceiling effect due to the high number of cyberbullied children reporting shortened sleep and higher levels of psychological distress. Discussion: The present findings point to a possible role of nighttime phone use as a moderator of the effect of cyberbullying on sleep and psychological wellbeing. There is a need for future studies to better explore more directly the effects of cyberbullying during the nighttime.

Keywords: information communication technology; mobile phone; cell phone; bedtime; sleep; anxiety; depression

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1. Introduction

The ubiquity of small-screen devices, such as smartphones and tablet devices, has exposed children to online harassment which has led to a new form of bullying, i.e., cyberbullying. Definitions vary, but cyberbullying is commonly described as any behaviour performed through electronic media involving hostile or aggressive communications repeated over time intended to inflict harm, anger, shame, or discomfort on a victim who cannot easily defend themselves [1,2]. Cyberbullying, in contradiction to traditional bullying, has several unique aspects. This includes behaviours such as persistent harassment, flaming (online fighting), exclusion, outing and trickery, masquerading, cyberstalking, fraping (posting content without permission), doxing (publishing private or identifying information without consent), and catfishing (creating fake profiles or identities) [3]. The most well-recognised medium for cyberbullying is commentary on social media. However, it can also take other forms such as sharing unauthorised photographs and videos, impersonating the victim or others and posting fake messages, creating private groups or events to exclude victims from social groups or activities, and sending text messaging using phone

services or direct messaging apps [4]. Of concern in children is the impact of cyberbullying on psychological wellbeing.

Cyberbullying is known to impact psychological wellbeing in children and has been associated with an increased risk of psychological distress, suicide, and mood disorders [3–8], while children with pre-existing psychological wellbeing problems or a prior history of being bullied at school are more likely to be cyberbullied [9]. Although causal pathways have not been well established in children who have been cyberbullied, several factors are thought to be involved in the aetiology of psychological disorders. These include perpetrator anonymity, which is thought to promote feelings of powerlessness; the nonspecificity of place and time, which is thought to make it more difficult for victims to escape persecution leading to feelings of loneliness and isolation [6–8]; the greater audience reach and rapid dissemination of harmful digital content, which can breach trust and privacy leading to humiliation and loss of self-esteem while also promoting fear and safety concerns leading to social exclusion [10,11]; and because of the difficulty of removing digital content, harmful material can be repeatedly accessed and shared, preventing timely closure [12].

Cyberbullying is now a recognised problem in children. Estimates vary with definitions, but 4–20% of children are reported to have experienced at least one episode of cyberbullying in the previous year [9,13–15]. The lifetime prevalence in Australian children of cyberbullying is estimated at 7.0%, lower than the lifetime prevalence for traditional bullying (25.1%) but still representing a meaningful proportion of children [16].

An insidious feature of cyberbullying is that abuse can occur at all hours, including at night. A downstream effect of cyberbullying is disrupted sleep [17–22]. This can be partly explained by the indirect effect of cyberbullying on sleep through psychological wellbeing. Findings from longitudinal studies indicate that cybervictimisation predicts increased ruminations and, in turn, poor sleep [22], similarly, increased anxiety and, in turn, poor sleep [21] and, likewise, depression and social anxiety and, in turn, poor sleep [17]. A further complicating factor is the bidirectional relationship between psychological wellbeing and sleep, with poor sleep conversely predicting future psychopathology [23–26] and, thereby, further increasing child vulnerability to external events such as cyberbullying.

A gap in our understanding of the impact of cyberbullying on sleep and psychological wellbeing is whether timing is important. Specifically, whether the effects might be possibly amplified if cyberbullying occurs at night. This possibility might place children who use digital devices at night at greater vulnerability to cyberbullying and any downstream effects. Of note is that most studies examining cyberbullying and sleep have examined digital device use at bedtime and not after sleep onset, i.e., during the nighttime period itself. This is a time of day when children are potentially more socially isolated from family and supports and when mental reserves are typically lower and emotional reactivity heightened (especially negative reactivity) [27,28].

A notable feature of modern life in children is the pervasiveness of digital devices. As a consequence, the impact of digital device use such as smartphones on child behaviour has received considerable attention including a burgeoning literature examining the impact on sleep. It is thought that taking digital devices to bed may impact sleep through several pathways. Although digital devices can aid sleep, they can also raise arousal levels, inhibiting sleep onset, and extended use may displace and restrict sleep time, messages/alerts at night may fragment sleep, and screen light can be alerting with light exposure in the evening, possibly delaying the timing of the circadian system and hence the timing of sleep onset [29–31]. However, much of the literature examining the association between digital device use and sleep has focused on excessive screen time, particularly at bedtime which, confusingly, is often referred to as nighttime use. What is less well appreciated and less well documented is the increased frequency of digital device use in children after sleep onset. This limitation and the need for future research to investigate associations post sleep onset were recently highlighted in a theoretical review exploring the bidirectional relationship between sleep and technology use [32].

Digital device use at and after bedtime is a growing issue in children and is reported to be a contributing factor to sleep deficits such as shorter sleep and poorer sleep quality [33–36]. US data collected in 2015 revealed that 70% of adolescents had sent text messages on their smartphone between 10 p.m. and 6 a.m. [37]. Similarly, data collected in Italy in 2015 revealed that 50% of adolescents and 25% of preadolescents had used their phones to text after 9 p.m. [38]. In a 2019 study, 40% of adolescents were reported to have used their mobile phones within five minutes of going to sleep, and 36% reported waking up to check their phones at least once during the night [39]. Over 2013–2018, research by our group on 252,195 Australian children found that a third of preadolescents, half of early adolescents, and nearly all late adolescents reported receiving or sending text messages and calls between the hours of 10 p.m. and 6 a.m. at least once per week [40]. Current nighttime smartphone usage is likely to be higher. It is also likely to be at ever younger ages, with statistics from the Australian Communications and Media Authority showing that 46% of Australian children aged 6 to 13 years in 2020 used a mobile phone, with 33% of children in this age range not only accessing but owning a mobile phone [41]. Similar to the findings in adolescents, evidence is now emerging of the negative impact of digital device overuse on sleep and psychological wellbeing in young children [42,43]. However, and similar to the limitation previously noted in adolescents, the impact of digital device use during the night after bedtime in young children is also unclear. The trend towards greater digital device use at ever earlier ages points to the need for a broader examination of digital device use after sleep onset and studies beyond adolescence to younger age groups.

In addition to its impact on sleep, digital device use at night in children is also associated with poor psychological wellbeing [44–47], with psychological deficits particularly prevalent in problematic smartphone users [48]. The association between digital device use at night and psychological wellbeing is likely to be partly mediated by the impact of digital device use on sleep [49] but, nonetheless, presents a further vulnerability to cyberbullying.

Several factors are thought to explain digital device use at night. These include the fear of missing out, the need for touch (screen touching), and to help with emotional regulation (especially anxiety and depression) [50–52]. A further factor is that high levels of digital device use during the daytime may be habit forming, leading to greater use at night. Indeed, evidence suggests that greater daytime use is associated with greater use after sleep onset [53]. If excessive, digital device use can become problematic, leading to a behavioural addiction mirroring many of the features of an addiction disorder, such as problematic gambling [54]. Excessive smartphone use is reported to presage social media addiction, greater nighttime social media use and, in turn, poor sleep. In particular, adolescents who spend more time on their smartphone consuming social media are at a higher risk of social media addiction [55] which, in turn, is associated with greater nighttime social media use and worse sleep quality [46]. These factors are further reported to increase the risk of aggressive behaviour [46]. The association between poor sleep and aggression in children is well recognised [56] and thought to be secondary to several factors, including sleep-related emotional dysregulation, reduced ability to inhibit aggressive impulses, and sleep-related reduction in prosocial behaviour [46,57]. Although not well explored, evidence from longitudinal studies suggests that poor inhibition and externalised negative behaviours, such as aggression, are, in turn, associated with an increased risk of cybervictimisation [58,59]. Finally, intraindividual factors may also make some children more likely to engage in digital device use at night. For example, poor executive functioning and anxiety are reported to predict nighttime phone use, nighttime phone awakenings, and problematic sleep [60].

Two key demographic variables have been extensively examined as predictors of cybervictimisation, namely gender and age. Regarding gender, findings have been mixed. On balance, the most consistent finding is a higher prevalence rate in girls, which has been reported by some [61–65] but not all studies [16,66–68], including one study in Australian children [16]. Despite the mixed results, it is thought that girls, especially early adolescents, may be more vulnerable than other child cohorts to the impact of nighttime mobile phone

use on sleep and thus any downstream effects on psychological wellbeing. It is notable that girls have a higher level of nighttime phone use and at an earlier age, are greater users of social media, and are more likely to report problematic smartphone use and, possibly as a consequence, worse psychological wellbeing [38,48,69–77]. Previous research by our group also found that the frequency of nighttime phone use and obtaining less than 8 h of sleep per night not only peaked in early adolescence but was more evident in young girls [40]. An explanation for the gender gap is unclear and, moreover, possible pathways have not been fully tested. However, a possible explanation is that exposure to social media may occur at an earlier age in girls placing them at greater risk for socio-emotional disorders at a developmental stage where they are less prepared cognitively, behaviourally, and neurobiologically [78]. Consistent with this assumption, longitudinal findings in 10–21-year-olds indicate that sensitivity to social media not only occurs at a younger age in girls compared with boys but also underlies the much lower life satisfaction ratings reported by girls at one-year follow-up [79]. A further explanation is that outside of the digital environment, boys are more likely to experience physical bullying, while girls are more likely to experience psychological or relational bullying [80], which is more easily enabled in the digital environment [77].

Turning to cybervictimisation and child age, evidence of an association is mixed [81]. On balance, there may be a small increase with age with a peak in early adolescence [12,64,67,82]. Notably, most studies examining age have tended to report an increase over childhood, but consistent with the increasing penetration of digital devices at even younger ages, high prevalence rates are now reported in even young children [83], suggesting that any age differences may be smaller than previously thought. The impact of gender and age on the interplay between digital device use during the night, sleep, and psychological wellbeing is not well understood and warrants further attention.

The ubiquity of digital devices has meant that they now play an important role in children's lives, providing an opportunity to network, socialise, and present an idealised self to the world, but they also present risks [84]. One of the risks is that digital device use at night may make children vulnerable to cyberbullying and any downstream effects on sleep and psychological wellbeing. Understanding this interplay may help inform recommendations for sleep and psychological interventions.

The aim of this study is therefore to examine the association between nighttime phone use, cyberbullying, sleep, and psychological distress in childhood. The following research questions will be explored: (i) whether nighttime phone use directly increases the risk of poor sleep and psychological distress, (ii) if being cyberbullied directly increases the risk of poor sleep and psychological distress, and (iii) whether nighttime phone use moderates the relationship between cyberbullying and sleep and, likewise, psychological distress (Figure 1). To permit a better examination across the age span of childhood, it is proposed to examine the relationships in child (7–11 years) and adolescent (12–19 years) cohorts and separately in female and male children.

We hypothesise that nighttime phone use, or being cyberbullied, will both directly increase the odds of poor sleep and psychological distress. We further propose that the risk of poor sleep and psychological distress will be higher for victims of cyberbullying who more frequently engage in nighttime phone use. Based on the existing literature, we hypothesise that older age and female gender will be associated with more frequent reports of psychological distress, poor sleep, nighttime phone use, and cyberbullying.

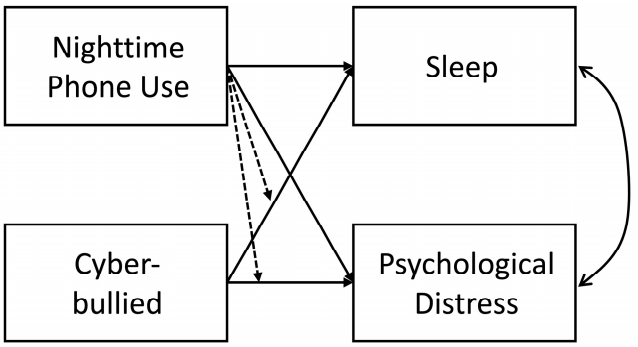

Figure 1. Proposed model of nighttime phone use as a moderator of the effects of cyberbullying on sleep and psychological distress. Solid lines represent proposed direct effects of cyberbullying and nighttime phone use on sleep and psychological distress (aims [i] and [ii]). Dashed lines represent proposed moderation effects of nighttime phone use on the relationship between cyberbullying and sleep and cyberbullying and psychological distress (aim [iii]).

2. Materials and Methods

This study used a cross-sectional research design to explore the interplay between mobile phone use at night, sleep, history of cyberbullying, and psychological distress using survey data collected from Australian schoolchildren.

2.1. Participants

This study is based on archival data provided by Resilient Youth Australia. This dataset contained responses to an omnibus questionnaire examining resilience and well-being (8 demographic items, 61 risk and protective behaviour items, and 8 optional risky behaviour items). The questionnaire was administered between March and December 2019 to students aged 7–19 years attending school grades 3–12. Students were recruited from 918 participating schools from all states and territories of Australia (Victoria = 68.3%, Queensland = 20.1%, South Australia = 0.5%, Tasmania = 0.4%, Western Australia = 1.4%, Northern Territory = 0.7%, New South Wales = 5.5%, Australian Capital Territory$\leq$ 0.1%, and not reported = 2.9%). The sample included children attending state and private schools, from a mix of suburban and regional areas, and included a representative sample of children from all Socio-Economic Indices for Areas of Relative Advantage and Disadvantage (SEIFA IRSAD) levels (i.e., lowest (1) to highest SES (10)) [85]. We excluded from the dataset children who selected for gender either 'other' (n = 289) or 'prefer not to say' (n = 1407), as this is the focus of another research study.

2.2. Materials

Psychological distress was assessed using the four-item Patient Health Questionnaire-4 (PHQ-4), which contains two items each assessing depression and anxiety (Table 1) [86]. Children were asked, "Over the last 2 weeks, how often have you been bothered by the following problems?". The PHQ-4 is minimally burdensome and has been found to be a valid measure of depression and anxiety in the general population [86]. In the present study, so that higher scores indicated greater deficits, the questionnaire was administered using a reversed coding to that of the original, with 0 = Never to 3 = Nearly every day (range = 0–12). Accordingly, a PHQ-4 score < 6 was considered to fall in the normal range, 6–8 borderline, and $\geq$9 clinically significant [43]. The Cronbach alpha for the PSQ-4 scale was 0.80, and McDonald's Omega was 0.81. Preliminary Confirmatory Factor Analysis revealed a single PHQ-4 factor with items loadings all > 0.40 and good model fit indices (χ^2 = 1275, p < 0.001; CFI = 0.983, TLI = 0.949 and RMSEA 0.108). Single questions were used to assess nighttime phone use, sleep duration, and frequency of cyberbullying, with lower values indicating greater deficits (Table 1).

Table 1. Questions and Response Scales for Nighttime Phone Use, Sleep, and Cyberbullying.

Question	Response			
Nighttime phone use (During the last week, how many times have you sent or received messages at night) [a]	5+	3–4	1–2	0
Sleep (I get at least 8 h of sleep most nights)	Never	Sometimes	Often	Always
Cyberbullying (In the last school term I have been bullied at school).	Daily	Weekly	Once a Term	Never
Patient Health Questionnaire-4 (Over the last 2 weeks, how often have you been bothered by the following problems?)	Not at all	Several days	More than half the days	Nearly every day
Feeling nervous, anxious, or on edge	0	1	2	3
Not being able to stop or control worrying	0	1	2	3
Feeling down, depressed or hopeless	0	1	2	3
Little interest or pleasure in doing things	0	1	2	3

Note: [a] From 10 p.m. to 6 a.m. for primary school students (year levels 3–6); from midnight to 6 a.m. for secondary school students (year levels 7–12). The total PHQ-4 scores were calculated by summing individual item scores.

2.3. Procedure

The Resilience Survey was administered to school children via an online web-based application during class time. The survey was completed under teacher supervision and data were entered by students using mobile devices or laptops as convenient. Individual anonymity was protected by creating one universal login for all participants and by setting a minimum number of responses required before reporting the results for any student cohort. More detailed information on how the data are stored and secured can be found at the Resilient Youth Australia website: https://www.resilientyouth.org/it-security-policy (Accessed on 24 May 2024).

The data utilised in this study are archival data, initially collected in the course of administering the Resilience Survey by Resilient Youth Australia. The survey was undertaken on behalf of school educators to inform decisions regarding the wellbeing of students and employees, to identify strengths and challenges for a student cohort, assess the efficacy of school initiatives, reduce inequalities in various student populations, help determine effective allocation of scarce educational resources, satisfy the school's legal obligations in respect of duty of care, and improve classroom instruction techniques. When a principal chooses to establish an evidence base upon which to make decisions for the continuous improvement of the wellbeing of their students and employees, their own school's ethics policies and procedures apply. It is the responsibility of each school to have in place any necessary parental consent or provide any necessary required disclosures to parents and carers prior to survey commencement. All schools are provided a Principal's Checklist, Parents/Caregivers' Information Letter, and a script for preparing students prior to surveying. All students are informed that their responses are anonymous, only aggregated data and no individual data are reported, the survey is optional, the survey data may be made available upon request to credentialed third parties for research purposes, there is no advantage or disadvantage in completing the survey, and that students may stop at any point for any reason without penalty. Approval to use the archival data provided by Resilient Youth Australia was approved by the University of South Australia Human Research Ethics Committee (#204388).

2.4. Statistical Analysis

Data analysis was conducted using RStudio (version 24.04) and Stata (version 15). Given expected age and gender differences in the variables of interest [22,26,33–40], all analyses were stratified by age group (primary- and secondary-school-aged children) and gender (male and female). The age cut-offs also reflect the nighttime phone use criteria used for primary- versus secondary-school-aged children (see Table 1).

Nighttime phone use was entered into the models as a categorical variable (0 = never, to 3 = ≥5 times per week), as was obtaining 8 h sleep (0 = never, to 3 = always). Responses on the PHQ-4 were clustered into 'normal to mild' and 'moderate to severe' categories to create a dichotomised variable for analyses (normal-mild [PHQ-4 scores of 0–5] = 0; and moderate-severe [PHQ-4 scores of 6–12] = 1). These categories were based on clinical

cut-off scores for the PHQ-4 indicating psychological distress [43]. Given the relatively low proportion of respondents reporting daily or weekly cyberbullying, cyberbullying was dichotomised for analyses (not at all in the last term = 0; and ≥once in the last term = 1).

In order to examine the relationship between variables in the proposed model (Figure 1), polychoric correlations (appropriate for ordinal variables) were conducted. The model was tested using bivariate ordered probit regression. This approach is suited to models where there are two correlated, ordinal dependent variables. Models specified PHQ-4 score (normal–mild/moderate–severe) and getting 8 h sleep (never/sometimes/often/always), with predictors of cyberbullying (not at all in the last term/≥ once in the last term), nighttime phone use (0 times/1–2 times/3–4 times/≥5 times), and a cyberbullying by nighttime phone use interaction effect. Models specified the first level of each variable as the reference category (nighttime phone use = 0 times, cyberbullied = no). Significant cyberbullying by nighttime phone use interaction effects were further explored using post hoc contrasts comparing nighttime phone use (0 vs. 1–2, 3–4, 5+ times) within cyberbullied groups (yes/no). Regression Coefficients with Standard Errors (SE) and *p*-values are presented along with model χ^2 and ρ, the correlation between residuals of the models for PHQ-4 and sleeping 8 h.

3. Results

Respondents included 22,337 primary- (7–11 years, girls = 50.2%) and 31,397 secondary-school-aged children (12–19 years, girls = 60.3%). Due to school anonymity, we are not able to report on the distribution of faith, independent, and state–government schools. In 2019, Australian Government statistics reported that 3,948,811 students (1,102,020 primary schools and 829,565 secondary schools) attended 9503 schools from grades 1–12, with 48.7% girls attending primary school and 40.2% secondary school [85]. Our sample of 55,734 students attending grades 3–12 in 918 schools represents about 14% of the Australian school population and 10% of schools. The ratio of girls and boys attending primary school in the present sample was comparable to the national ratio. By contrast, the percentage of girls in the present sample attending secondary school was greater than national estimates.

3.1. Prevalence of Cyberbullying, Nighttime Phone Use, Sleeping 8 h, and Psychological Distress

Approximately 12% of primary-school-aged girls and 17% of primary-school-aged boys reported having been cyberbullied at least once in the last school term. In secondary-school-aged children, the proportion who reported being cyberbullied was 15% in girls and 14% in boys. Approximately 34% of primary-school-aged girls and boys reported nighttime phone use at least once a week. In secondary-school-aged children, these proportions increased to 66% in girls and 58% in boys. Never obtaining 8 h sleep was reported by approximately 6% of primary-school-aged girls and 8% of primary-school-aged boys. In secondary-school-aged children, the proportion of children who reported never obtaining 8 h sleep increased to 17% in girls and 13% in boys. A moderate–severe level of psychological distress was reported by 20% of primary-school-aged girls and boys. In secondary-school-aged children, these proportions increased to 38% in girls and 23% in boys. Figure 2 presents the proportions of all response categories per gender by age cohort.

The frequency of nighttime phone use, 8 h sleep, and PHQ-4 symptom category in children according to gender and whether they reported cyberbullying or not is given in Table 2. The distribution of outcome variables by gender was similar. However, in children, and especially girls, who were compared with those who were not cyberbullied, a higher proportion reported more frequent nighttime phone use, <8 h of sleep, and PHQ-4 scores in the moderate-to-severe range.

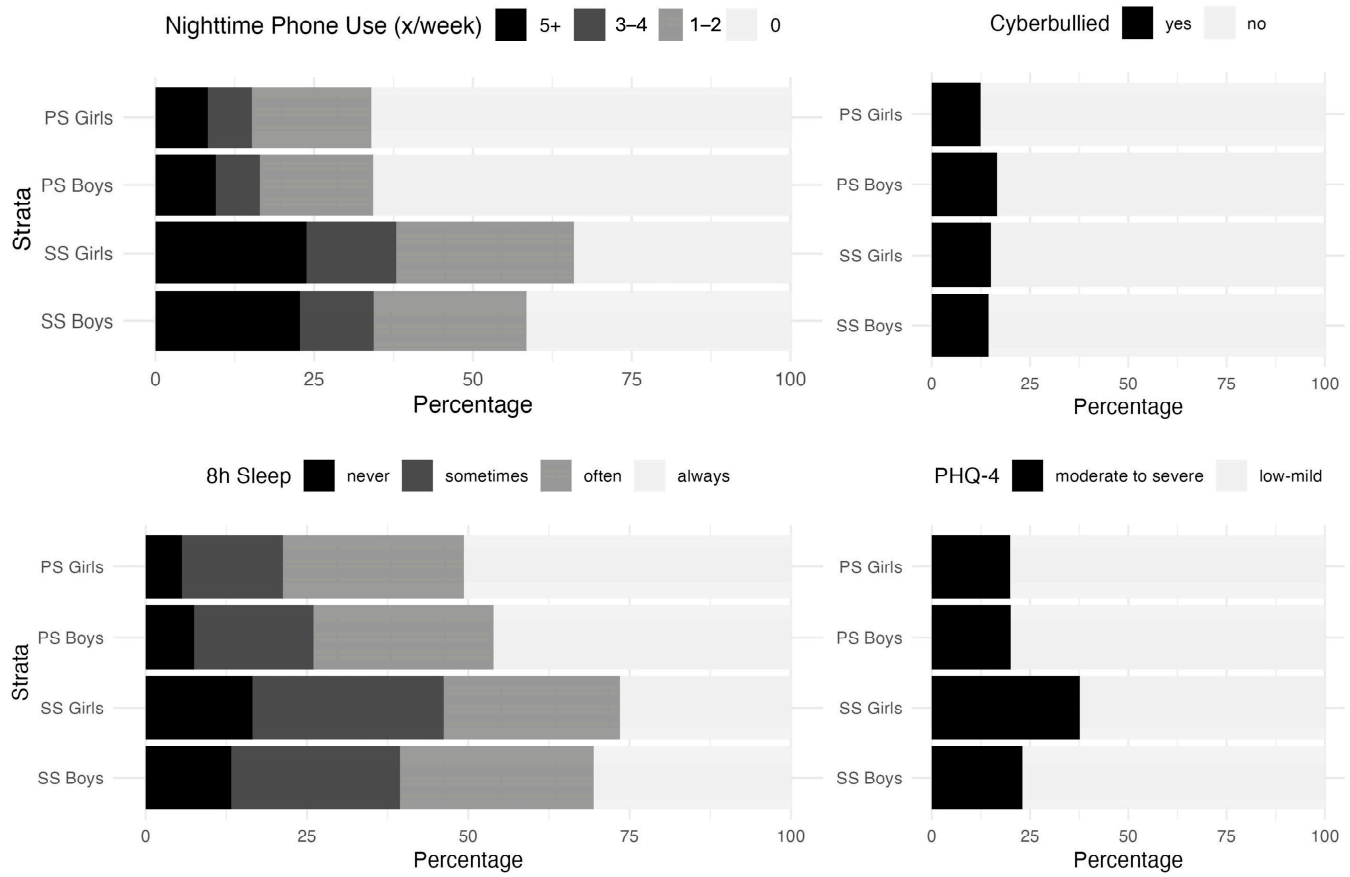

Figure 2. Percentage of response categories per variable. Graphs show percentage of response categories for obtaining 8 h sleep (**top left panel**), nighttime phone use (**top right panel**), psychological distress (**bottom right panel**), and being cyberbullied (**bottom left panel**) for primary- (PS) and secondary (SS)-school-aged girls and boys.

Table 2. Response Outcomes: Percentage of Children According to Gender and Cyberbullying Status.

Outcome Variable	Girls		Boys	
	Non-Cyber-bullied	**Cyberbullied**	**Non-Cyber-bullied**	**Cyberbullied**
Primary School Aged (*n*)	(9824)	(1388)	(9279)	(1846)
Nighttime phone use				
0 per night	70.1	37.2	70.6	41.0
1–2 per night	17.8	26.1	16.5	24.8
3–4 per night	5.8	15.1	5.4	14.5
5+ per night	6.3	21.6	7.5	19.8
I get at least 8 h of sleep most nights				
Never or Rarely	4.6	12.6	6.3	13.6
Sometimes	14.5	24.0	17.3	24.4
Often	28.1	27.6	28.5	25.2
Always or Almost Always	52.8	35.8	47.9	36.7
Patient Health Questionnaire-4				
Normal-to-Mild Range	83.1	57.9	83.4	62.5
Moderate-to-Severe Range	16.9	42.1	16.6	37.5

Table 2. *Cont.*

Outcome Variable	Girls		Boys	
	Non-Cyber-bullied	**Cyberbullied**	**Non-Cyber-bullied**	**Cyberbullied**
Secondary School-Aged (*n*)	(16,081)	(2842)	(10,672)	(1802)
Nighttime phone use				
0 per night	37.0	18.1	44.9	21.9
1–2 per night	28.3	26.1	23.9	24.6
3–4 per night	13.4	18.3	10.4	18.9
5+ per night	21.4	37.5	20.7	34.5
I get at least 8 h of sleep most nights				
Never or Rarely	14.8	26.3	11.9	21.7
Sometimes	28.9	33.8	25.7	28.7
Often	28.2	22.2	30.6	26.9
Always or Almost Always	28.1	17.7	31.9	22.7
Patient Health Questionnaire-4				
Normal-to-Mild Range	66.7	37.8	80.4	56.7
Moderate-to-Severe Range	33.3	62.2	19.6	43.3

3.2. Relationship between Cyberbullying, Nighttime Phone Use, Psychological Distress, and Sleep Variables

Polychoric correlations for ordinal data are summarised in Table 3. Correlation effect sizes were small to medium, with a consistent pattern across age and gender strata. No evidence of multicollinearity was detected. Correlations between Psychological Distress and Sleep 8 h, the dependent variables for the regression analyses, ranged from −0.43 to −0.29.

Table 3. Polychoric correlations for Cyberbullying, Nighttime Phone Use, Psychological Distress, and getting 8 h Sleep by age and gender strata and overall.

		Nighttime Phone Use	**Cyberbullied**	**Psychological Distress**
Primary School Girls	Cyberbullied	0.43		
	Psychological Distress	0.24	0.40	
	Sleep 8 h	−0.24	−0.25	−0.34
Primary School Boys	Cyberbullied	0.39		
	Psychological Distress	0.17	0.36	
	Sleep 8 h	−0.21	−0.20	−0.29
Secondary School Girls	Cyberbullied	0.28		
	Psychological Distress	0.28	0.39	
	Sleep 8 h	−0.44	−0.21	−0.43
Secondary School Boys	Cyberbullied	0.29		
	Psychological Distress	0.19	0.37	
	Sleep 8 h	−0.35	−0.18	−0.38
Overall	Cyberbullied	0.32		
	Psychological Distress	0.28	0.37	
	Sleep 8 h	−0.40	−0.21	−0.41

Note: Bivariate ordered probit regression models for two, correlated, ordinal dependent variables (PHQ-4 and Sleep 8 h) are shown in Table 4, and pyramid plots showing these two variables across nighttime phone use and cyberbullying by age and gender strata are illustrated in Figure 3.

Across all strata, there was a significant effect ($p < 0.001$) of nighttime phone use on PHQ-4 scores (Table 4). Overall, compared with reporting no nighttime phone use, higher levels of reported frequency were associated with concomitant increases in PHQ-4 scores. The percentage of respondents who reported moderate-to-severe PHQ-4 scores doubled from 20% with no nighttime phone use, compared with 42% for use 5+ times per week. Across all strata, reporting cyberbullying was associated with significantly higher ($p < 0.001$)

PHQ-4 scores (Table 4). The percentage of respondents who reported moderate-to-severe PHQ-4 scores was 2.5 times as large, increasing from 22% with no cyberbullying compared with 49% for those who were cyberbullied.

Table 4. Bivariate Ordered Probit Regression with Psychological Distress (PHQ-4) and Sleep 8 h as Dependent Variables with Effects of Cyberbullying, Nighttime Phone Use, and a Cyberbullied by Nighttime Phone Use Interaction Effect.

			PHQ-4			Sleep 8 h		
			Coef	**SE**	***p***	**Coef**	**SE**	***p***
Primary School Girls [a]	Nighttime Phone Use (times per week)	2	0.21	0.04	<0.001	−0.19	0.03	<0.001
		3–4	0.30	0.06	<0.001	−0.40	0.05	<0.001
		5+	0.45	0.06	<0.001	−0.59	0.05	<0.001
	Cyberbullied	Yes	0.72	0.06	<0.001	−0.45	0.05	<0.001
	Interaction Effect	Yes, 2	−0.10	0.09	0.289	0.11	0.08	0.176
		Yes, 3–4	−0.07	0.12	0.558	0.21	0.10	0.041
		Yes, 5+	−0.15	0.11	0.178	0.19	0.91	0.036
Primary School Boys [b]	Nighttime Phone Use (times per week)	2	0.11	0.04	0.007	−0.17	0.03	<0.001
		3–4	0.18	0.07	0.008	−0.41	0.05	<0.001
		5+	0.33	0.05	<0.001	−0.48	0.04	<0.001
	Cyberbullied	Yes	0.67	0.05	<0.001	−0.32	0.04	<0.001
	Interaction Effect	Yes, 2	−0.13	0.09	0.135	0.02	0.07	0.822
		Yes, 3–4	−0.03	0.11	0.806	0.23	0.09	0.012
		Yes, 5+	−0.23	0.10	0.019	0.14	0.08	0.084
Secondary School Girls [c]	Nighttime Phone Use (times per week)	2	0.21	0.03	<0.001	−0.47	0.02	<0.001
		3–4	0.39	0.03	<0.001	−0.83	0.03	<0.001
		5+	0.59	0.03	<0.001	−1.10	0.02	<0.001
	Cyberbullied	Yes	0.69	0.06	<0.001	−0.31	0.05	<0.001
	Interaction Effect	Yes, 2	0.01	0.08	0.866	0.05	0.07	0.401
		Yes, 3–4	−0.13	0.08	0.112	0.21	0.07	0.004
		Yes, 5+	−0.04	0.07	0.549	0.10	0.06	0.110
Secondary School Boys [d]	Nighttime Phone Use (times per week)	2	0.07	0.04	0.059	−0.28	0.03	<0.001
		3–4	0.10	0.05	0.033	−0.57	0.04	<0.001
		5+	0.40	0.04	<0.001	−0.83	0.03	<0.001
	Cyberbullied	Yes	0.71	0.07	<0.001	−0.31	0.06	<0.001
	Interaction Effect	Yes, 2	0.14	0.09	0.143	−0.10	0.08	0.226
		Yes, 3–4	−0.11	0.11	0.317	0.29	0.09	0.001
		Yes, 5+	−0.27	0.09	0.002	0.28	0.07	<0.001

Note. Bivariate ordered probit regression models (for two ordinal, correlated dependent variables) are stratified by gender and age group. Dependent variables are Psychological Distress (0 = mild, 1 = moderate–severe) and Sleep 8 h (0 = never, 1 = sometimes, 2 = often, 3 = always). The table shows Regression Coefficients (Coef) and their Standard Errors (SE) with *p*-values for z-tests of Coefficients. Coefficients > 0 indicate that as the categories for the independent variable increase, so do the categories for the dependent variable. Conversely, coefficients < 0 indicate that as the categories for the independent variable increase, the categories for the dependent variable decrease (and vice versa). [a] Model $\chi_7^2 = 521.2$, $p < 0.001$, ρ (correlation between residuals of the models for PHQ-4 and Sleep 8 h) = −0.30; [b] Model $\chi_7^2 = 421.3$, $p < 0.001$, $\rho = -0.25$; [c] Model $\chi_7^2 = 1339.6$, $p < 0.001$, $\rho = -0.36$; [d] Model $\chi_7^2 = 571.8$, $p < 0.001$, $\rho = -0.34$.

For primary- and secondary-aged girls, the cyberbullied by nighttime phone use interaction effect was not significant. For primary- ($p = 0.019$) and secondary- ($p = 0.002$) school-aged boys the interaction effect was significant (Table 4). Post hoc comparisons for nighttime phone use (0 vs. 1–2, 3–4, 5+ times per week) are shown in Table 5. For primary and secondary school boys who were cyberbullied, comparisons were significant (0 < 1–2, 3–4, 5+). For those who did not report cyberbullying, comparisons were only significant between 0 and 5+ for secondary school boys. For primary school boys who did not report being cyberbullied, the percentage of moderate-to-severe PHQ-4 scores increased from 15% for those who did not use the phone at nighttime to 24% for those who reported using it 5+ times (a difference of 9%). For those who reported being cyberbullied, the increase

was from 36% to 40% (a difference of 4%). For secondary school boys, the increase for those who were not cyberbullied was also larger (12%) than for those who did not report cyberbullying (5%).

Table 5. Post hoc Comparisons following Bivariate Ordered Probit Regression with Psychological Distress (PHQ-4) and Sleep 8 h as Dependent Variables: Illustrating Cyberbullied by Nighttime Phone Use Interaction Effects.

			Nighttime Phone Use (Times per Week)			
	Strata	**Cyberbullied**	**0**	**5+**	**Diff**	**Post-Hoc**
PHQ-4 mod–severe	PS Boys	No	15%	25%	10%	0 < 1–2, 3–4, 5+
		Yes	36%	40%	4%	
	SS Boys	No	17%	29%	12%	0 < 1–2, 3–4, 5+
		Yes	40%	45%	5%	0 < 5+
Sleep 8 h always	PS Girls	No	57%	35%	−22%	0 > 5+
		Yes	43%	29%	−14%	0 > 5+
	PS Boys	No	52%	35%	−17%	0 > 3–4, 5+
		Yes	42%	32%	−10%	0 > 5+
	SS Girls	No	45%	12%	−33%	0 < 1–2, 3–4, 5+
		Yes	34%	11%	−23%	0 < 1–2, 3–4, 5+
	SS Boys	No	43%	17%	−26%	0 > 3–4, 5+
		Yes	33%	22%	−11%	0 > 5+

Note: For post-hoc comparisons, those given in the table were significant at $p < 0.05$. PS = primary school and SS = secondary school aged.

Across all strata, there was a significant effect ($p < 0.001$) of nighttime phone use on sleep 8 h scores (Table 4). Overall, compared with reporting no nighttime phone use, higher levels of reported frequency were associated with concomitant reductions in the frequency of obtaining 8 h of sleep. The percentage of respondents who reported always obtaining 8 h of sleep reduced from 49% with no nighttime phone use, compared with 18% for use 5+ times per week. Across all strata, reporting cyberbullying was associated with a significantly lower ($p < 0.001$) frequency of obtaining 8 h sleep (Table 4). The percentage of respondents who reported always obtaining 8 h sleep reduced from 38% with no cyberbullying, compared with 26% for those who were cyberbullied.

Across all strata, there were significant ($p < 0.012$) cyberbullied by nighttime phone use interaction effects (Table 4). For primary school girls, post hoc comparisons for nighttime phone use (0 vs. 1–2, 3–4, 5+) were significant for 0 vs. 5+ per week regardless of cyberbullying status (Table 5). For those who did not report cyberbullying, the difference in the percentage of those reporting always obtaining 8 h sleep reduced from 57% of those who did not use the phone at nighttime compared with 35% for those who reported using it 5+ times (a difference of 22%). For those who reported being cyberbullied, the reduction was 14%. For primary school boys, post hoc comparisons were significant for 0 vs. 3–4 and 0 vs. 5+ times per week for those who did not report cyberbullying, and for 0 vs. 5+ times per week for those who reported cyberbullying. The reduction in those who reported always obtaining 8 h sleep was larger for those who did not report (0 vs. 5+ times: 17%) compared with those who did report (0 vs. 5+ times: 10%) cyberbullying. For secondary school girls, post hoc comparisons were significant for all levels regardless of cyberbullying status. The reduction in those who reported always obtaining 8 h sleep was larger for those who did not report (0 vs. 5+ times: 33%) compared with those who did report (0 vs. 5+ times: 23%) cyberbullying. For secondary school boys, post hoc comparisons were significant for 0 vs. 3–4 and 0 vs. 5+ times per week for those who did not report cyberbullying, and for 0 vs. 5+ times per week for those who reported cyberbullying. The reduction in those who reported always obtaining 8 h sleep was larger for those who did not report (0 vs. 5+ times: 26%) compared with those who did report (0 vs. 5+ times: 11%) cyberbullying (Table 4).

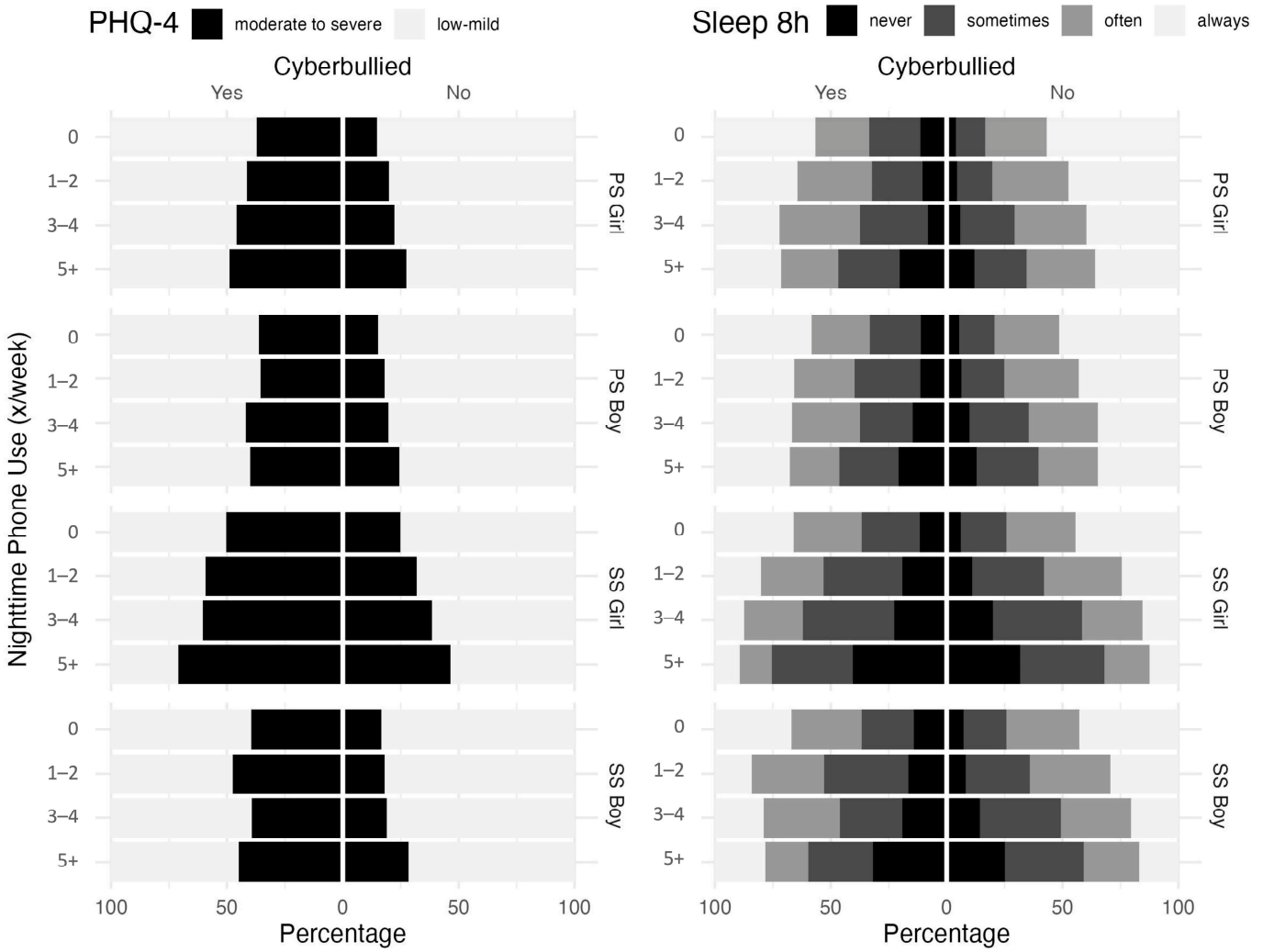

Figure 3. Psychological distress and obtaining 8 h sleep by nighttime texting for age and gender strata split by whether respondents reported being cyberbullied. Pyramid plots in the left panel show psychological distress (mild–normal/mod–severe), and plots in the right panel show obtaining 8 h sleep (never/sometimes/often/always). Vertical axes show nighttime texting (0/2/3–4/5+ times per week) for age group (primary (PS)/secondary (SS) school aged) and sex (girls/boys) strata. The left side of each pyramid shows participants who reported that they were not cyberbullied, and the right side shows those who reported that they experienced cyberbullying.

4. Discussion

The overarching aim of this study was to examine the association between nighttime phone use, cyberbullying, sleep, and psychological distress across childhood and gender. Cyberbullying was relatively frequent, with approximately 15% (n = 7878) of children in this study experiencing cyberbullying in the last term, with a higher frequency in boys during primary school but girls during secondary school. Our findings were consistent with our hypothesis that secondary-school-aged girls would be at higher risk of cyberbullying, as well as with existing research that has found that cyberbullying peaks in early adolescence for girls, where it exceeds levels observed in boys [87]. The proportion of children who reported being cyberbullied in the current study, which was completed in 2019, exceeds the estimated lifetime prevalence of cyberbullying of 7% in Australian children based on mid-2017 estimates [16].

Nighttime phone use was prevalent. Over a third of primary-school-aged children and more than 60% of secondary-school-aged children reported having used their phone at night at least once in the past week. The same proportion of boys and girls reported

nighttime phone use in primary school, although as hypothesised and consistent with previous studies, rates were higher in girls in secondary school [38,69,70,74]. Of the children who experienced cyberbullying, almost three-quarters reported using their phone at night, whereas of those who had not been cyberbullied, less than half reported nighttime phone use.

Approximately a quarter of primary-school-aged children and over two-fifths of secondary-school-aged children reported that they never or only sometimes obtained 8 h of sleep, indicating that a reasonably high proportion and absolute number of children do not meet the recommended sleep guidelines of 9–11 h for primary-school-aged children and 8–10 h for secondary-school-aged children [88]. A gender-by-age interaction was also apparent for sleep length. In primary-school-aged children, the proportion of boys and girls who reported never obtaining 8 h sleep was similar. By contrast, never obtaining 8 h sleep was more common in secondary-school-aged girls compared with boys. This pattern mirrors similar findings in Australian children over the 2014–2018 period [40].

Consistent with existing literature, and as hypothesised, gender differences in psychological distress also emerged, with a higher proportion of secondary-school-aged girls compared with boys reporting moderate-to-severe psychological distress [89,90]. By contrast, no gender differences were evident in primary-school-aged children. These findings mirror those for sleep.

As further hypothesised and regardless of age group and gender, children who experienced cyberbullying were less likely to report sleeping more than 8 h per night and more likely to report moderate-to-severe psychological distress. These results are not surprising and align with existing research on children [91–93]. As further hypothesised, nighttime phone use was directly associated with a lower likelihood of sleeping more than 8 h per night and increased moderate-to-severe psychological distress. These findings align with previous studies on children reporting phone use after sleep onset disturbs sleep [33,34], with negative effects on psychological wellbeing [17,21,22,73].

Despite expectations, the hypothesis that psychological distress would be worse in cyberbullied children who more frequently engaged in nighttime phone use was only partly supported. Specifically, nighttime phone use was not observed to significantly moderate the relationship between cyberbullying and psychological distress in either primary- or secondary-school-aged girls. However, a significant moderation effect was observed in primary- and especially secondary-school-aged boys such that nighttime phone use increased the frequency of psychological distress. Counterintuitively, the moderation effect was greater in boys who were not compared with those who were cyberbullied, especially secondary-school-aged boys. It is unclear why nighttime phone use had more of a moderation effect on psychological distress in boys who were not cyberbullied. It is possible that cyberbullying in boys was occurring at times other than at night, and through devices other than phones. This information was not captured in the current study. A further explanation is that social connectedness is an important buffer against mental distress in adolescents, which is mostly mediated through social media, and especially in girls [94,95]. It is possible that gender differences in social media use/messaging may make boys less vulnerable to cyberbullying at night via phone use. Finally, and more likely, it may be a ceiling effect, as a high proportion of children who were cyberbullied reported high levels of psychological distress, and therefore, the proportion of moderate-to-severe children on the binary scale was already closer to the maximum.

Similar to the findings for psychological distress, nighttime phone use was observed to significantly moderate the relationship between cyberbullying and sleep in both primary- and secondary-school-aged girls and boys. As previously, the moderation effect was stronger in children who were not compared with those who were cyberbullied. This again may be due to a ceiling effect similar to that observed for psychological distress.

Several limitations are present in this study and fall into three broad categories. The first of the broad categories concerns measurement limitations. This includes the reliance on archival data with single items for assessing sleep and cyberbullying and a brief 4-item

measure of psychological distress. In future studies, it would be useful to include more comprehensive measures. More specifically, regarding the assessment of sleep, it would be useful to include objective measures of sleep, such as actigraphy [96] and, moreover, it would be instructive to extend the number of sleep domains and include additional measures of sleep quantity (e.g., duration), structure (e.g., sleep onset time), and sleep quality (e.g., feeling rested in the morning). Of note is that sleep structure and sleep duration correlate poorly and can be considered separate constructs with sleep quality compared with duration reportedly more predictive of psychological deficits in children [97]. An often neglected third sleep domain is circadian timing, the addition of which may also be informative in future studies [98]. Indeed, problems such as social jet lag (i.e., the difference between sleep timing on school versus weekend days) and delayed sleep phase syndrome have been shown to be more predictive of psychological deficits than sleep quantity and quality [99,100]. A final measurement limitation is the reliance on self-reported data with their inherent biases, including potential misinterpretations of what constitutes cyberbullying due to a definition not having been provided to children at the time of assessment.

The second broad set of limitations are contextual and temporal. First, we did not directly ask children if they had a phone in their bedroom. As such, it is unclear if children responded that they never used their phone at night because they did not have a phone or they did not take a phone into the bedroom because of good sleep hygiene. On balance, the latter limitation is likely to have inflated the 'nil' nighttime phone use response and led to an underestimation of the relationship between phone use at night and obtaining 8 h sleep. Second, due to the cross-sectional nature of this study, we are unable to determine causation. Third, the varying timeframes for responses across variables may have also limited the strength of associations. However, we note a potential temporal relationship suggestive of a causative association with the item assessing the frequency of cyberbullying (last term) preceding the assessment of psychological wellbeing (last two weeks) and nighttime phone use (last week). Finally, these data were collected prior to the onset of the COVID-19 pandemic. Given changes in technology use, sleep, and psychological wellbeing following the pandemic, it is likely that postpandemic findings may reveal different patterns of results from those observed in the present study. For example, technology usage in children during the pandemic has been estimated to have increased by 15%, with 62% of this increase attributed to greater smartphone use [101]. This trend is likely to have had a flow effect on child and adolescent development.

The third broad set of limitations concern the assessment of cyberbullying. We were unable to determine what percentage of cyberbullying was directly related to nighttime phone use versus other electronic mediums, which may have been in the bedroom (such as laptops, tablets, or smart watches). In addition, we were not able to determine if the timing of cyberbullying events was coincident with nighttime phone use. In future studies, the timing of cyberbullying events and whether the effect of day versus nighttime cyberbullying is more impactful on psychological wellbeing requires attention.

Despite the limitations, this study has several strengths. The present study utilised a very large sample of children from all states and territories of Australia. Further, responses were directly collected from children, who are possibly better sleep historians than their parents [102,103]. In addition, most studies into nighttime phone use, cyberbullying, and sleep have focused on adolescent populations; thus, the current study is an important step in exploring these relationships in a large sample of young children. It revealed that nighttime phone use and cyberbullying are risk factors for psychological distress in primary-school-aged students as young as seven years old.

This study aimed to test whether (i) nighttime phone use increased the frequency of poor sleep and psychological distress, (ii) if a higher proportion of cyberbullied children reported poor sleep and higher psychological distress, and (iii) whether nighttime phone use moderated the relationship between cyberbullying and sleep and, likewise, between cyberbullying and psychological distress. All three expectations were confirmed.

The present findings highlight the importance of clinicians addressing nighttime digital device use with child and adolescent clients who present with psychological distress or sleep issues. The challenge for health practitioners is how best to advise parents, children, schools, and the general community while taking gender and age differences into account. Godsell and White [104] have highlighted the need for community education regarding sleep hygiene and digital devices, and the development of resources to help parents, children, communities, and schools become 'sleep messengers' and rule setters, thereby promoting healthy child sleep. There is strong evidence that limiting digital device use at night results in positive sleep gains [105]. However, given the ubiquity of digital device use, simply advising against all digital device use may not be a constructive recommendation. Notably, digital device use may have some positives in children such as maintaining friendships and reducing isolation [106–108], which may benefit children who are vulnerable to cyberbullying. Future studies need to investigate how the protective benefits of digital devices can be leveraged in vulnerable children, and gender and age differences need to be explored. Despite the potential benefits, given that reducing digital device use at night is positive for sleep and psychological wellbeing, there is a need for future studies to examine the effectiveness of strategies at reducing digital device use in children who have been cyberbullied and if this results in gains.

5. Conclusions

In conclusion, the findings from the present study suggest that nighttime phone use is directly associated with shorter sleep and increased psychological distress and, more so, in children who have been cyberbullied. Moreover, nighttime phone use was found to moderate the relationship between cyberbullying and psychological distress, amplifying deficits, especially in secondary-school-aged boys and to a lesser extent primary-school-aged boys. Likewise, nighttime phone use was found to moderate the relationship between cyberbullying and sleep in all age and gender cohorts. Notably, the moderation effect was such that the impact of nighttime phone use was stronger in children who had not experienced cyberbullying. The relatively weaker effect of nighttime phone use in children who were cyberbullied is likely to be explained by the presence of a ceiling effect due to the higher frequency of shortened sleep and psychological distress. The present findings point to the value of managing digital device use at night as a strategy for addressing cyberbullying vulnerability and improving sleep health.

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Informed Consent Statement: Informed consent was obtained by participating schools from all subjects involved in the study including permission to use archival data for research and publication.

Data Availability Statement: The data that support the findings of this study are available from https://resilientyouth.org/ (Accessed on 24 May 2024). Restrictions apply to the availability of these data, which were used under licence for this study.

Conflicts of Interest: K.L., J.D., and S.C. sit on the Scientific Advisory Panel for Resilient Youth Pty Ltd. P.W. is the founder and advisor, and A.W. is the Director of Resilient Youth Australia Pty Ltd.

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