

Adolescent Use of Mobile Phones for Calling and for Sending Text Messages After Lights Out: Results from a Prospective Cohort Study with a One-Year Follow-Up

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Objective: To assess the prevalence of the use of mobile phones by adolescents after lights out and its relationship to tiredness levels after one year.

Design: Prospective cohort study with self-reports and follow up questionnaire after one year.

Setting: Second- and fifth-year secondary school children in 15 schools in Flanders, Belgium.

Participants: 1656 school children; 52.1% boys. Average age was 13.7 years (SD: 0.68) in the youngest group and 16.9 years (SD: 0.83) in the oldest group at baseline.

Main outcome measures: Self-reported tiredness.

Results: Only 38% of the subjects never used their mobile phone after lights out. Multinomial logistic regression showed that using the mobile phone less than once a month increased the odds of being very tired one year later by 1.8 (95% CI 1.2 – 2.8). Those who used it less than once a week were 2.2 times more likely to be very tired (95% CI 1.4 – 3.5). Using it about once a week increased the odds by 3.3 (95% CI 1.9 – 5.7) and

those who used it more than once a week were 5.1 times more likely to be very tired (95% CI 2.5 – 10.4). Overall 35% of the cases of being very tired were attributed to the use of the mobile phone. Use of the phone right after lights out increased the odds of being very tired by 2.2 (95% CI 1.4 – 3.4); between 00:00 and 03:00 the odds were 3.9 times higher (95% CI 2.1 – 7.1), and in those who used it at any time of the night the odds were 3.3 times higher (95% CI 1.8 – 6.0).

Conclusion: Mobile phone use after lights out is very prevalent among adolescents. Its use is related to increased levels of tiredness. There is no safe dose and no safe time for using the mobile phone for text messaging or for calling after lights out.

Keywords: Mobile phone, text messaging, adolescents, lights out

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THE USE OF THE MODERN MEANS OF INTERPERSONAL AND MASS COMMUNICATION HAS BECOME AN ESSENTIAL PART OF BEING YOUNG. CHILDREN'S bedrooms are connected to global networks through internet access and mobile phones.¹ Heavy use of television (TV), internet and computer games have been linked to reduced time in bed² and to sleep disturbances³ although adolescents often claim they need these media as "sleep aids."⁴ Even when they sleep the interplay between media and sleep does not cease. Playing computer games has been shown to shorten REM sleep in adults,⁵ and many adolescents report dreaming about what they saw on TV or in a computer game.⁶ Little is known about the potential impact of the mobile phone on sleep. One brief cross sectional study found that up to a third of 13- and 15-year-old children in Belgium reported receiving incoming messages after lights out at least once a month.⁷ Other existing sleep studies only dealt with biological effects of emissions.⁸ The electromagnetic fields produced by mobile phones, for instance, may have an effect on the sleep electroencephalogram,⁹ and evening exposure to mobile phone emissions may affect melatonin production.¹⁰

Observational studies of mobile phone behaviors of adoles-

cents suggest that they engage in a lot of calling and text messaging behaviors. An Italian study described "ringing," a practice involving one adolescent dialing another whereby the call is interrupted before the other person is able to answer it. The other telephone thus displays the message that a call from a particular number failed, which is a way of telling that person "I was thinking of you." Interestingly, neither person is charged for this communication.¹¹ Even more elaborate is "bombing" in which the number of times the phone rings signals what the caller is trying to convey, a technique adolescents use to tell each other what time they leave for school or to answer messages (by common agreement one ring may mean "yes" and two may mean "no").¹² Much of the use of the mobile phone involves the simple pleasure of being permanently connected to a group of people: one popular pastime is sending "chain messages" to a number of friends.¹² These behaviors appear to be common among all adolescents. A comparison of studies from several countries showed that there are many similarities between mobile phone cultures of young people in several European countries.¹²

The aim of the current study was to chart the extent to which adolescents use their mobile phone for sending and/or receiving text messages and/or calls after lights out and to examine whether this predicted higher levels of tiredness.

METHODS

Participants

Baseline data for the Leuven Study on Media and Adolescent Health (SOMAH) were collected in February 2003 with a follow-up in February 2004 and another follow-up in February 2005. Questions on the use of the mobile phone for receiving and transmitting either calls or text messages were added to the questionnaire of the

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Table 1—Prevalence of Inbound and Outbound Mobile Phone and Text Message Use After Lights Out

	Never, %	1 to 3 times/ month, %	1/week, %	>1/week, %	Daily, %
Receives text messages	44.3	22.1	12.1	14.3	7.3
Sends text messages	48.2	20.6	11.6	13.6	6.1
Receives calls	51.6	21.7	10.0	7.5	3.2
Calls	72.1	14.5	6.7	4.7	2.0

first follow up. Participants were originally selected from a sample of first- and fourth-year students in 15 randomly selected secondary schools in the Flemish Community of Belgium. The first follow-up (providing the baseline for the current study) yielded 2449 participants. Of these 52.1% were boys and 47.9% were girls. Average age was 13.7 years (SD = 0.68) in the younger cohort and 16.9 years (SD = 0.83) in the older cohort. Because students move regularly from one school to another in the same area 28.8% of the subjects were lost to follow-up after one year. The Institutional Ethics Committee of the author approved the study and informed consent was obtained from the legal guardians of the children.

Procedures

PREVALENCE OF MOBILE PHONE USE AFTER LIGHTS OUT

Respondents were queried to indicate on a 5-point scale how frequently they A) received or B) sent text-messages and C) received or D) made phone calls after lights out. Answer categories were 1) Never; 2) One to three times a month; 3) Once a week; 4) Several times a week; 5) Every day. Respondents were queried, in open ended questions, to indicate how many messages they A) received; B) sent; and phone calls they C) received; D) made after lights out. Each behavior referred to nights on which it happened at least once. Answers were given in numbers.

TIME OF INBOUND AND OUTBOUND CALLS AND TEXT MESSAGES

Respondents were queried to indicate at what time of the night they sent or received messages. Second they had to indicate when they either made or received phone calls. Answer categories were A) immediately after lights out; B) between midnight and 3 am; C) between 3 am and 6 am; D) after 6 am; and E) at any time of the night.

OUTCOME VARIABLES

Tiredness was measured one year later using 4 questions and an 11-point scale ranging from -5 (not tired at all) to +5 (very tired) with 0 as the neutral middle. The 4 questions were: "How tired are you" A) Generally; B) In the morning when you get up; C) At school; D) After the weekend.

STATISTICAL ANALYSES

SPSS® 14.0 for windows was used to analyze the data. The 4 variables measuring the frequency of the behaviors loaded on a single factor in a principal components factor analysis (loadings

between 0.81 and 0.89; Eigenvalue: 3.04; Explained variance: 76%; Chronbach's alpha: 0.89). A new variable summarized how frequently subjects used their mobile phone for all 4 behaviors: A) never; B) less than once a month; C) less than once a week; D) about once a week; and E) several times a week or more. A principal components factor analysis showed that the 4 tiredness variables loaded on one factor (loadings between 0.83 and 0.90; Eigenvalue 3.1; Explained variance 77.2 %; Cronbach's alpha 0.90). These four variables were summed as an indicator of overall tiredness that correlated significantly with the Dutch language version of the Shortened Fatigue Questionnaire (Spearman's Rho = 0.56, $P < 0.0001$).¹³ Only about 2% of the subjects in this study could be diagnosed as very tired according to the Dutch scale (which is used in the context of conditions such as chronic fatigue syndrome). The summed 4-item variable developed for this study was used instead to create a collapsed variable which listed as "not tired" those who scored lower than the middle of the scale on average, "somewhat tired" for those who had answered between the middle and the highest three answer categories on average, and "very tired" for those who had answered all 4 questions by indicating one of the 3 highest categories. The relationship between mobile telephone use at baseline and tiredness-category at follow up was estimated using multinomial logistic regression models. Because there was very big concordance between the times at which text messages were received and the times at which calls were made (only 6 subjects reported one behavior but not the other) the text message measure was used as a proxy for both text messaging and calling.

RESULTS

Prevalence of the Use of Mobile Phones after Lights Out

As table 1 shows the mobile phone was used widely after lights out. More than half the respondents sent and/or received text messages at least a number of times per month. About a fifth of them sent and/or received them at least once a week. Receiving phone calls was only marginally less prevalent. Making calls was the least prevalent, but by no means rare; 28.9% made calls at least monthly, while 6.7% did it at least once a week.

When sending or receiving text messages the number of messages was rarely limited to one. Only 18.1% of the subjects received or sent just one message on a night when at least one was sent or received. 15.2% of the respondents who sent or received messages sent or received ≥ 10 messages in one night. When respondents made or received phone calls these were considerably smaller in number. About 86% to 88% made or received a maximum of 2 calls. Only about 8% made or received > 3 calls per night.

Time of Inbound or Outbound Calls and Text Messages

Among those subjects who used their mobile phones, the largest group did so right after lights out (55.6% for text messages and 58% for calls). A considerable number used their phone between 00:00 and 03:00 (20.3% for text messages, 17.3% for calls). The groups that exhibited this behavior after 03:00 (2.6% for text messages, 2.4% for calls) and after 06:00 (3.0% for text messages, 2.0% for calls) were very small, but up to a fifth in each group (18.6% for text messages, 20.2% for calls) used the phone at any time of the night.

Table 2—Levels of Tiredness After One Year: Row Percentages and Odds Ratios of the Multinomial Logistic Regression Analysis for Frequency of Mobile Phone Use and Time of Inbound and Outbound Text Messages

	N	Overall level of tiredness (row %)			Multinomial Logistic Regression			
		Not tired	Somewhat tired	Very tired	Somewhat tired		Very Tired	
					Odds ratio	95% CI	Odds ratio	95% CI
Use of Text messages and Telephone calls†								
Never	645	43.3%	48.2%	8.5%	1.0	-	1.0	-
Less than once a month	387	38.5%	47.5%	14.0%	1.1	0.8-1.5	1.8**	1.2-2.8
Less than once a week	311	35.4%	49.2%	15.4%	1.2	0.9-1.7	2.2***	1.4-3.5
About once a week	174	25.9%	57.5%	16.7%	2.0***	1.4-2.9	3.3***	1.9-5.7
More than once a week	84	21.4%	57.1%	21.4%	2.4**	1.4-4.2	5.1***	2.5-10.4
When do you use text messaging? ‡								
Never	645	44.1%	47.9%	8.0%	1.0	-	1.0	-
Right after lights out	547	33.9%	52.5%	13.6%	1.4*	1.1-1.8	2.2***	1.4-3.4
Between midnight and 3 am	121	28.1%	52.1%	19.8%	1.7*	1.1-2.7	3.9***	2.1-7.1
Any time of the night	121	30.6%	51.2%	18.2%	1.5	1.0-2.4	3.3***	1.8-6.0

*P < 0.05; ** P < 0.001; *** P < 0.0001

† Model Chi-square 32.5, P < 0.0001 (df 6,1292)

‡ Model Chi-square 41.7, P < 0.0001 (df 8,1593)

Outcome After One Year

Table 2 shows the results of 2 multinomial logistic regression analyses. The first analysis shows that the odds of being at least somewhat tired increased with frequency and the odds of being very tired increased even more. Those who used the mobile phone after lights out at least once a month or more were more than 2 times more likely to be in the very tired category than those who never used their mobile phone that way. Those who used their phone about once a week were more than three times more likely to be very tired and those who used it several times a week or more were 5 times more likely to be very tired.

In the second analysis in table 2 the categories “between 3 am and 6 am” and “after 6 am” were omitted because they comprised too few individuals. Use of the mobile phone after lights out at least doubled the odds of being very tired a year later, compared to the group not displaying these behaviors. In those who used their phone any time of the night the odds more than tripled. In those who sent or received messages between 00:00 and 03:00, the odds quadrupled.

Population attributable risk estimates which proportion of the total number of cases of being somewhat or very tired is attributable to mobile phone use (as opposed to never using the mobile phone after lights out). It is obtained by subtracting the cumulative incidence in the no exposure group from the total cumulative incidence and dividing the result by the total cumulative incidence. In the group that was somewhat tired, 7.5% of the cases could be attributed to mobile phone use. In the subjects that were very tired, 35.0% of the cases could be attributed to mobile phone use.

DISCUSSION

A lot of sending and receiving text messages and telephone calls appeared to go on in the bedroom. Only 38% of the adolescents in this study reported that they never used a mobile phone after lights out. Even though the outcome variables were measured a full year after the baseline, intensity of mobile phone use predicted increased tiredness. Being very tired was attributed to

mobile phone use in 35% of the cases. The risk of being very tired more than doubled in those who used their mobile phone less than once a week, it tripled in those who used them weekly and was more than 5 times higher in those who used it several times a week or more.

Calling and text messaging happened at all times of the night. In the majority of cases it happened right after lights out. A lot of it went on between lights out and 03:00 am. A group of about a fifth of the adolescents reported that sending text messages or calling could happen at any time of the night.

This study had several limitations. The most obvious one was that it relied on self-reports. While it has been shown that sleep habits can be studied reliably using self reports in research on healthy populations¹⁴ and on adolescents¹⁵ we do not know how accurately the answers reflected real behaviors. There are two reasons to assume the estimates are telling us something about what goes on. First, the popularity of behaviors described above such as “ringing,” “bombing,” and sending chain messages suggests that the frequencies reported here are not as implausible as they may seem. Second, unless respondents gave random answers the most likely source of bias would have been the need to give socially desirable replies, a typical problem of self-reported data. It seems unlikely that young students perceive *overestimating* these behaviors to be socially desirable. The prevalence estimates are therefore most likely underestimated, which means that misclassification will have led to lower estimates of the effect sizes.

It is customary to warn readers about drawing causal conclusions from this sort of research. The usual addition that the causal order between variables may also be reversed is far from evident here because communication requires at least 2 people. One alternative explanation could have been that adolescents use their mobile phone because they cannot sleep, rather than the other way around. Such an explanation could only apply to *outgoing* calls or messages. This study shows that active 2-way communication is an integral part of nocturnal mobile phone use. Unless this study unveiled numerous little clusters of sleepless adolescents it seems more likely that communicating children keep each other awake than that bad sleepers keep communicating.

In conclusion, this study found that mobile phone use after lights out is widespread. The risk ratios suggest that there is no safe dose: even moderate use doubles the risk of long term tiredness. There is no safe time to send or receive calls or messages either. There is growing awareness of the importance of studying the impact of the modern electronic media on several aspects of adolescent health in general and sleep in particular.¹⁶ The American Academy of Pediatrics has suggested that children's bedrooms ought to be "electronic media-free" rooms.¹⁷ The Academy appeared to be thinking mainly of media such as TV and video games. The present study suggests that there are many more threats to adolescent sleep in the bedroom. As mobile phones become ever more complex (integrating radio, television and MP3 technologies) the attraction to use them after lights out is likely to increase further.

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