

Article

Association between Excessive Use of Mobile Phone and Insomnia and Depression among Japanese Adolescents

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Abstract: Adolescents spend an increasing amount of time on mobile phones. The aim of this study was to assess the relationship between duration of mobile phone use and insomnia and depression in senior high school students. The cross-sectional study was conducted on 295 senior high school students in Japan. Mobile phones were owned by 98.6% of students; 58.6% of students used mobile phones for more than 2 h daily and 10.5% used them for 5 h daily. The risk of insomnia was significantly high in students who used mobile phones for 5 h or more (OR: 3.89 [95% CI: 1.21-12.49]). There was no significant association between depression and duration of mobile phone use. However, individuals who spent 120 min or more using mobile phones for social network services (OR: 3.63 [1.20-10.98]) and online chats (OR: 3.14 [1.42-6.95]) were at risk for depression. Excessive mobile phone use is associated with unhealthy sleep habits and insomnia. Moreover, the excessive use of the social network services and online chats are related to depression rather than duration of mobile phone use. Adolescents should use mobile phones appropriately to avoid sleep disturbances and the impairment of mental health.

Keywords: adolescents; depression; insomnia; mobile phone; Japanese

1. Introduction

In recent times, the distribution of mobile phones among Japanese adolescents has risen. According to the Ministry of Internal Affairs and Communication, among adolescents between the ages of 10 and 17 years in 2011, 2013, and 2015, the distribution rate of mobile phones was 52.6%, 59.5%, and 68.3%, respectively. For instance, in 2015, 96.7% of senior high school students had mobile phones. Many mobile phone users now have the most advanced version, called a smartphone. A smartphone is a useful tool that enables access to the internet and social networks, messaging, viewing videos, and playing games. Therefore, comparatively more hours are spent on a smartphone than on a conventional phone [1]. In 2008, it was reported that less than 40% of adolescents used mobile phones for more than 2 h per day [2]. However, in 2015 approximately 50% of adolescents reportedly used smartphones for more than 3 h per day [3]. In future, the availability of smartphones may increase drastically, and thus we are apprehensive about the long hours spent by young adults on mobile phones.

A mobile phone, although useful for young people, could cause physical [4–6] and psychological [2,7,8] health problems when used excessively. Previous studies have reported that the use of mobile phones in bed at night negatively impacts sleep outcome [2,9,10]. Munezawa et al. found that the use of mobile phones after lights out was associated with short sleep duration, subjective poor sleep quality, excessive daytime sleepiness, and insomnia symptoms [2]. Fossum et al. found that the use of mobile phone for playing games, surfing the internet, and texting in bed correlated positively with insomnia and late chronotype, whilst negatively with morningness [10]. Other studies have reported

that the over-use of mobile phones, evaluated with mobile phone addiction (include smartphone addiction) scales, is associated with poor sleep quality [8,11] and psychological problems [7,12]. Demirci et al. found that depression, anxiety, and daytime dysfunction (assessed with the sleep quality scale), were associated with smartphone addiction [7]. Augner & Hacker investigated psychological variables using the Problematic Mobile Phone Use scale (e.g. non-use leads to negative feelings, mobile phone use leads to negative consequences such as sleeplessness during night) among young people, and found that chronic stress, low emotional stability, and depression were associated with problematic mobile phone use [12].

Individuals who use mobile phones for long hours may be at risk for mobile phone addiction [3], and this may be associated with unfavorable psychological moods [13] and sleep disturbances [14]. Since adolescents spend a considerable amount of time on mobile phones, it is necessary that an awareness is created about the possible health problems caused by excessive use of these devices. However, only few studies have examined the association between long duration of mobile phone use and the associated health problems. The aim of this study was to assess the associations between long hours of mobile phone use and insomnia and depression in senior high school students.

2. Materials and Methods

2.1. Design and sample

A cross-sectional study was conducted using self-reported questionnaires. We recruited participants from one public senior high school in Gifu Prefecture, Japan, between June and July 2014. This school comprised 346 students (1st grade, 120 students; 2nd grade, 117 students; 3rd grade, 109 students). We distributed anonymous questionnaires to these 346 students during classroom hours after their homeroom teacher had explained to them the nature of the study. Participants were informed that participation in the study was voluntary, and their privacy would be protected. Participants responded to the questionnaires after providing an informed consent to participate in the study. Students returned the questionnaires in sealed envelopes to ensure confidentiality of their information. The identity of participants was kept anonymous. Of the 346 students, 332 (96.0 %) agreed to participate in this study. After excluding 37 questionnaires with incomplete information on mobile phone use, insomnia or depression, data from 295 (88.9 %) completed questionnaires were analyzed. This study was approved by the research and ethics committee of the School of Medicine at the Graduate School of Nagoya University.

2.2. Measurements

The self-administered questionnaires included questions on 1) personal data, 2) lifestyle, 3) social support, 4) mobile phone use, 5) insomnia, and 6) depression.

2.2.1. *Personal data*: Personal data included sex, age, and school grade.

2.2.2. *Lifestyle*: Questions related to lifestyle included participation or otherwise in school club activities (sports club/culture club/none), consuming breakfast (eat daily/occasionally not eat), conversing with family (talk daily/occasionally not talk), wake-up time (earlier at 6:00/at 6:00-7:00/later at 7:00), bedtime (earlier at 23:00/at 23:00-24:00/at 24:00-25:00/later at 25:00), and hours spent sleeping (<5 h/5 to <6 h/6 to <7 h/≥7 h).

2.2.3. *Mobile phone use*: Students were asked whether they owned mobile phones (either the conventional phone/smartphone/none). Furthermore, information such as total hours of mobile phone use during a typical day (none/< 1 h/1 to < 2 h/2 to < 3 h/3 to < 4 h/4 to < 5 h/≥ 5 h), amount of time spent on e-mails, social networking sites (SNS) (e.g. Facebook, Twitter, Instagram), online chat (e.g. Line, Skype, Kakao Talk), internet search, game, and video during a typical day were requested (none/< 30 min/30 to < 60 min/60 to < 120 min/≥ 120 min).

2.2.4. *Depression measurements*: Depression was evaluated using the Japanese version of the Center for Epidemiological Studies-Depression (CES-D) scale, which is a 20-item self-administered questionnaire [15]. CES-D, developed by Radloff [16], is widely used in many countries to assess depressive symptoms of general populations, and its reliability and validity have been demonstrated. This scale assesses the frequency of depressive symptoms experienced within the previous week (0: rarely or none of the time; 1: some or little of the time; 2: occasionally or a moderate amount of time;

and 3: most or all of the time). The range of these scores is from 0 to 60, where a higher score indicates more severe depression. In our study, the cut-off value of 16 points was used to identify a sample of depressed students.

2.2.5. Insomnia measurements: Insomnia was evaluated using the Japanese version of the Athens Insomnia Scale (AIS) [17]. This scale is a useful tool to assess the presence of insomnia [18]. This scale consists of 8 items: difficulty with sleep induction, awakening during the night, early morning awakening, total sleep time, overall quality of sleep, problems with sense of well-being, and functioning, and sleepiness during the day. Each item is rated on a scale of 0 (no problem) to 3 (serious problem), and the range of total score is from 0 to 24. An AIS score of 6 is the optimum cutoff based on the balance between sensitivity and specificity derived by comparison with the ICD-10 diagnosis of insomnia [18]. Therefore, in our study, the cut-off value of 6 points was utilized to identify insomnia, and a score of 4-5 points was regarded as indicating a tendency toward developing insomnia.

2.2.6. Social support measurements: Social support was evaluated using the Japanese brief version of the Multidimensional Scale of Perceived Social Support (MSPSS), which is a 7-item self-administered questionnaire [19,20]. This scale measures perceived social support from family, friends, and a significant other. Each item is rated on a 7-point Likert scale, and the total score is calculated by averaging the scores for all items. The scores range from 1 to 7 and a higher score indicates better social support.

2.3. Statistical Analysis

Differences between mobile phone use and insomnia, depression, and other survey items were statistically tested with Mantel-Haenszel test for trend and Kruskal-Wallis test. Associations between mobile phone use and insomnia or depression were examined using multiple logistic regression analyses. The dependent variable was insomnia (0 = no problem [AIS score < 6] and 1 = insomnia [AIS score ≥ 6]) or depression (0 = no problem [CES-D score < 6] and 1 = depression [CES-D score ≥ 16]). An odds ratio (OR) was calculated from the logistic regression, adjusting for age, sex, and factors associated with the dependent variable. *P*-values < 0.05 were considered statistically significant. All statistical analyses were performed using SPSS 20.0J for Windows.

3. Results

Characteristics of students in this study are shown in Table 1. The 295 students included 173 (58.6%) boys and 122 (41.4%) girls, and the mean (standard deviation: SD) age was 16.2 (0.9) years. The prevalence of owning mobile phone was 98.6% (n=291), and owning a smartphone was 92.9% (n=274). According to the results obtained regarding the total hours of mobile phone use during a typical day, 58.6% used mobile phones for more than 2 h, 31.5% used them for more than 3 h, and 10.5% used them for 5 h per day. The time spent using other features via mobile phone was as follows: 20.4% used SNS for more than 60 min, and 45.1% used online chats for more than 60 min. An average of 120 min per day was spent on online chat by 22.0% of adolescents. The prevalence of tendency toward insomnia was 23.1% (n = 68) and the prevalence of insomnia was 27.1% (n = 80). The prevalence of depression was 38.3% (n = 113).

Table 1. Characteristics of students

Parameters	Mean	SD
Age	16.2	0.9
Athens Insomnia Scale (range 0-20)	4.1	3.2
CES-D (range 2-47)	16.2	8.5
	n	%
School grade		
1 st	102	35.1
2 nd	96	33.0
3 rd	93	32.0
Sex		
men	173	58.6
women	122	41.4

Owning mobile phone		
smartphone	274	92.9
the conventional phone	17	5.8
none	4	1.4
Total hours of mobile phone use (hours/day)		
none	8	2.7
< 1 h	32	10.8
1 to <2 h	82	27.8
2 to <3 h	80	27.1
3 to <4 h	38	12.9
4 to <5 h	24	8.1
≥5 h	31	10.5
E-mail (minutes/day)		
none	144	49.1
<30 min	85	29.0
30 to <60 min	33	11.3
60 to <120 min	16	5.5
≥120 min	15	5.1
SNS (minutes/day)		
none	114	38.8
<30 min	72	24.5
30 to <60 min	48	16.3
60 to <120 min	40	13.6
≥120 min	20	6.8
Online chat (minutes/day)		
none	18	6.1
<30 min	77	26.1
30 to <60 min	67	22.7
60 to <120 min	68	23.1
≥120 min	65	22.0
Internet search (minutes/day)		
none	33	11.2
<30 min	148	50.3
30 to <60 min	83	28.2
60 to <120 min	20	6.8
≥120 min	10	3.4
Video games (minutes/day)		
None	53	18.0
<30 min	75	25.4
30 to <60 min	98	33.2
60 to <120 min	49	16.6
≥120 min	20	6.8
Viewing of videos (minutes/day)		
none	40	13.6
<30 min	97	32.9
30 to <60 min	81	27.5
60 to <120 min	38	12.9
≥120 min	39	13.2
Insomnia		
no problem	147	49.8
tendency toward insomnia	68	23.1
insomnia	80	27.1
Depression		
no problem	182	61.7
depression	113	38.3

Data are expressed as mean (SD) and frequency (%).

CES-D is the Center for Epidemiological Studies-Depression scale.

The relationship between the total number of hours of mobile phone use per day and lifestyle, social support, insomnia, and depression is described in Table 2. The female sex ($p < 0.001$), non-participation in the school's club activities ($p < 0.001$), late bedtime ($p = 0.001$), short hours of sleep ($p = 0.006$), and occasionally skipping breakfast ($p = 0.007$) were significantly associated with longer

hours of mobile phone use. Insomnia and depression were significantly associated with longer total hours of mobile phone use ($p = 0.013$ and $p = 0.022$, respectively).

Table 2. The relationship between total hours of mobile phone use (h/day) and lifestyle, social support, insomnia, and depression

	< 1 h		1 to <3 h		3 to <5 h		≥5 h		p
	mean	SD	mean	SD	mean	SD	mean	SD	
Age	16.3	1.1	16.1	0.9	16.3	1.0	16.3	0.7	0.486
Athens Insomnia Scale	3.6	3.9	4.0	3.2	3.9	2.3	5.2	3.3	0.050
CES-D	14.0	7.2	16.0	8.5	15.8	7.9	21.2	9.6	0.013
Social support	5.6	1.3	5.4	1.1	5.6	1.1	5.6	1.3	0.731
	n	%	n	%	n	%	n	%	p
Insomnia									
no problem	24	60.0	84	51.9	28	45.2	11	35.5	0.013
tendency toward insomnia	8	20.0	35	21.6	21	33.9	4	12.9	
insomnia	8	20.0	43	26.5	13	21.0	16	51.6	
Depression									
no problem	27	67.5	105	64.8	37	59.7	13	41.9	0.022
depression	13	32.5	57	35.2	25	40.3	18	58.1	
Sex									
men	32	80.0	102	63.0	31	50.0	8	25.8	0.000
women	8	20.0	60	37.0	31	50.0	23	74.2	
Participation in school club activities									
sports club	21	52.5	75	46.6	21	33.9	6	19.4	< 0.001
culture club	15	37.5	57	35.4	25	40.3	13	41.9	
none	4	10.0	29	18.0	16	25.8	12	38.7	
Bedtime									
earlier at 23:00	10	25.0	30	18.5	4	6.5	3	9.7	0.001
at 23:00-24:00	17	42.5	75	46.3	29	46.8	9	29.0	
at 24:00-25:00	9	22.5	38	23.5	24	38.7	10	32.3	
later at 25:00	4	10.0	19	11.7	5	8.1	9	29.0	
Wake-up time									
earlier at 6:00	10	25.0	43	26.7	15	24.2	8	25.8	0.719
at 6:00-7:00	23	57.5	80	49.7	32	51.6	16	51.6	
later at 7:00	7	17.5	38	23.6	15	24.2	7	22.6	
Hours spent sleeping									
<5 h	3	7.7	15	9.3	4	6.6	7	22.6	0.006
5 to <6 h	12	30.8	37	23.0	20	32.8	14	45.2	
6 to <7 h	16	41.0	64	39.8	26	42.6	7	22.6	
≥7 h	8	20.5	45	28.0	11	18.0	3	9.7	
Consuming breakfast									
consume daily	36	90.0	135	83.9	53	85.5	19	61.3	0.007
occasionally not consume	4	10.0	26	16.1	9	14.5	12	38.7	
Conversing with family									
converse daily	32	80.0	140	86.4	57	91.9	27	87.1	0.206
occasionally not converse	8	20.0	22	13.6	5	8.1	4	12.9	

Data are expressed as mean (SD) and frequency (%).

p values by Kruskal-Wallis test and Mantel-Haenszel test for trend.

CES-D is the Center for Epidemiological Studies-Depression scale.

Table 3 shows the relationship between mobile phone use and insomnia or depression, especially in relation to its use for e-mail, SNS, online chat, internet search, video games, or viewing of videos. Insomnia was significantly associated with longer minutes of mobile phone use for SNS ($p = 0.003$), online chat ($p = 0.010$), and internet search ($p < 0.001$). Similarly, depression was significantly associated with longer minutes of mobile phone use for SNS ($p = 0.020$), online chat ($p = 0.018$), and internet search ($p = 0.002$).

Table 3. The relationship between the mobile phone use (e-mail, SNS, chat, internet search, video games, and viewing of videos) and insomnia or depression.

		E-mail (minutes/day)										
		none	< 30 min	30 to <60 min	60 to <120 min	≥120 min	p					
Insomnia												
no problem		72	50.0	40	47.1	18	54.5	9	56.3	6	40.0	0.974
tendency toward insomnia		30	20.8	25	29.4	5	15.2	4	25.0	4	26.7	
insomnia		42	29.2	20	23.5	10	30.3	3	18.8	5	33.3	
Depression												1.000
no problem		91	63.2	51	60.0	18	54.5	11	68.8	10	66.7	
depression		53	36.8	34	40.0	15	45.5	5	31.3	5	33.3	
		SNS (minutes/day)										
		none	< 30 min	30 to <60 min	60 to <120 min	≥120 min	p					
Insomnia												
no problem		63	55.3	41	56.9	22	45.8	15	37.5	6	30.0	0.003
tendency toward insomnia		26	22.8	15	20.8	13	27.1	8	20.0	6	30.0	
insomnia		25	21.9	16	22.2	13	27.1	17	42.5	8	40.0	
Depression												0.020
no problem		75	65.8	48	66.7	30	62.5	21	52.5	8	40.0	
depression		39	34.2	24	33.3	18	37.5	19	47.5	12	60.0	
		Online chat (minutes/day)										
		none	< 30 min	30 to <60 min	60 to <120 min	≥120 min	p					
Insomnia												
no problem		9	50.0	44	57.1	38	56.7	36	52.9	20	30.8	0.010
tendency toward insomnia		2	11.1	19	24.7	13	19.4	15	22.1	19	29.2	
insomnia		7	38.9	14	18.2	16	23.9	17	25.0	26	40.0	
Depression												0.018
no problem		13	72.2	53	68.8	40	59.7	45	66.2	31	47.7	
depression		5	27.8	24	31.2	27	40.3	23	33.8	34	52.3	
		Internet search (minutes/day)										
		none	< 30 min	30 to <60 min	60 to <120 min	≥120 min	p					
Insomnia												
no problem		20	60.6	85	57.4	34	41.0	5	25.0	2	20.0	< 0.001
tendency toward insomnia		7	21.2	30	20.3	25	30.1	2	10.0	4	40.0	
insomnia		6	18.2	33	22.3	24	28.9	13	65.0	4	40.0	
Depression												0.002
no problem		24	72.7	97	65.5	49	59.0	7	35.0	4	40.0	
depression		9	27.3	51	34.5	34	41.0	13	65.0	6	60.0	
		Video games (minutes/day)										
		none	< 30 min	30 to <60 min	60 to <120 min	≥120 min	p					
Insomnia												
no problem		24	45.3	38	50.7	52	53.1	23	46.9	10	50.0	0.806
tendency toward insomnia		14	26.4	21	28.0	19	19.4	10	20.4	4	20.0	
insomnia		15	28.3	16	21.3	27	27.6	16	32.7	6	30.0	
Depression												0.202
no problem		34	64.2	48	64.0	64	65.3	25	51.0	11	55.0	
depression		19	35.8	27	36.0	34	34.7	24	49.0	9	45.0	
		Viewing of videos (minutes/day)										
		none	< 30 min	30 to <60 min	60 to <120 min	≥120 min	p					
Insomnia												
no problem		22	55.0	49	50.5	42	51.9	15	39.5	19	48.7	0.213
tendency toward insomnia		9	22.5	22	22.7	21	25.9	9	23.7	7	17.9	
insomnia		9	22.5	26	26.8	18	22.2	14	36.8	13	33.3	
Depression												0.132
no problem		26	65.0	63	64.9	52	64.2	20	52.6	21	53.8	
depression		14	35.0	34	35.1	29	35.8	18	47.4	18	46.2	

Data are expressed as frequency (%). p values by Mantel-Haenszel test for trend.

Table 4 shows the associations between mobile phone use and insomnia or depression, using multiple logistic regression analyses. Multiple logistic regression analyses were conducted after

adjusting for age, sex, and factors associated with insomnia or depression. The risk of insomnia was significantly higher in students who used mobile phones for 5 h or more, than in students who reportedly used phones for less than 1 h (OR: 3.89, 95% confidence interval (CI): 1.21-12.49), after adjusting for age, sex, conversing with family, and social support. In addition, 120 min or more of mobile phone use for online chat was associated with an increased risk of insomnia (OR: 2.81; 95% CI: 1.28-6.15), in comparison with mobile phone use of less than 30 min. The risk of depression was significantly increased in students used mobile phones for SNS, for 120 min or more, compared with students who used them for less than 30 min (OR: 3.63; 95% CI: 1.20-10.98), after adjusting for age, sex, conversing with family, social support, and hours spent sleeping. Moreover, 120 min or more of mobile phone use for online chat (OR: 3.14; 95% CI: 1.42-6.95) was significantly associated with an increased risk of depression, in comparison with usage of less than 30 min. There was no significant association between depression and total hours of mobile phone use.

Table 4. The associations between mobile phone use and insomnia or depression using multiple logistic regression analyses

	Insomnia †			Depression ‡		
	OR	95% CI	p	OR	95% CI	p
Total hours of mobile phone use (hours/day)						
< 1 h	reference			reference		
1 to <3 h	1.30	0.52–3.28	0.575	0.98	0.41–2.34	0.961
3 to <5 h	1.00	0.34–2.93	0.996	1.26	0.47–3.37	0.645
≥5 h	3.89	1.21–12.49	0.023	2.21	0.69–7.06	0.181
SNS (minutes/day)						
<30 min	reference			reference		
30 to <60 min	1.67	0.75–3.70	0.210	1.38	0.62–3.06	0.435
60 to <120 min	3.18	1.40–7.22	0.006	1.90	0.83–4.35	0.128
≥120 min	2.57	0.89–7.43	0.082	3.63	1.20–10.98	0.023
Chat (minutes/day)						
<30 min	reference			reference		
30 to <60 min	1.10	0.49–2.44	0.824	1.96	0.92–4.18	0.082
60 to <120 min	1.52	0.69–3.38	0.302	1.56	0.71–3.44	0.272
≥120 min	2.81	1.28–6.15	0.010	3.14	1.42–6.95	0.005
Internet search (minutes/day)						
<30 min	reference			reference		
30 to <60 min	1.44	0.76–2.74	0.262	1.17	0.62–2.20	0.628
60 to <120 min	4.83	1.68–13.88	0.003	1.38	0.45–4.24	0.573
≥120 min	3.04	0.74–12.46	0.123	3.89	0.91–16.64	0.067

Data are expressed as odds ratio (OR) and 95% confidence interval (CI) of logistic regression analysis.

p value by multiple logistic regression analysis.

† adjusting for age, sex, talking with family, and social support.

‡ adjusting for age, sex, talking with family, social support, and hours spent sleeping.

4. Discussion

The present study examined the relationship between mobile phone use and insomnia and depression. We found that excessively long hours of mobile phone use was associated with insomnia; this was particularly demonstrated in students who reported of using mobile phones for 5 h or more (OR: 3.89; 95% CI: 1.21-12.49) compared with usage of less than 1 h. On the other hand, no association was observed between total hours of mobile phone use and depression. However, interestingly, long hours spent on SNS or online chat via mobile phone were associated with depression; this was demonstrated in students who reportedly spent 120 min or more on SNS (OR: 3.63; 95% CI: 1.20-10.98) and online chat (OR: 3.14; 95% CI 1.42-6.95), compared with usage of less than 30 min.

Our study found that excessive long hours of mobile phone use was a risk factor for insomnia, after adjusting for age, sex, and related factors. To our knowledge, two studies have examined the association between sleep disturbances and duration of mobile phone use. One study reported that, among adolescents in Hong Kong, long duration of mobile phone use correlated with short sleep duration, poor sleep quality, and excessive daytime sleepiness [21]. Another study that investigated the use of mobile phones among Japanese high school students, reported that long duration of mobile

phone use was associated with short sleep time and fatigue [13]. Both reports support our finding of an association between long hours of mobile phone use and sleep disturbances. We speculate that unhealthy sleeping habits due to excessive mobile phone use may have affected the present result. In the present study, use of mobile phones for long hours was associated with late bedtime and short sleep time. Among adolescents using mobile phones for 5 h or more daily, 61.3% reported a bedtime of midnight or later, and 67.8% reported of sleeping for less than 6 h. Disturbance in sleep habits is a risk factor for insomnia [22]. The present result suggested that excessive mobile phone use caused impaired sleep habits, and hence, contributed to insomnia. Another potential mechanism for insomnia might be related to mobile phone use before bedtime. Since a mobile phone can be carried anywhere and used at any time and place, adolescents who use mobile phones over long hours may use it till late at night and in bed; however, this was not examined in the present study. Exposure to bright light from electronic devices disturb the circadian rhythms and ultimately, sleep [10,23,24]. Previous studies have reported that the use of electronic devices before bedtime [14], and especially the use of mobile phone in bed [2,9,10], is associated with sleep disturbance such as short sleep duration, poor sleep quality, excessive daytime sleepiness and insomnia symptom. Thus, our results may reflect the negative impact of mobile phone use at night before sleeping. Adolescents should prevent inappropriate use of mobile phone such as using them for excessively long hours and using in bed at night.

In the present study, we did not find an association between total hours of mobile phone use and depression. However, we found that long hours spent on SNS and online chat via mobile phone were at risk factors for depression, after adjusting for age, sex, and related factors. The present results suggest that excessive use of the SNS and online chat via mobile phone are key factors related to depression than total hours of mobile phone use. The SNS (e.g. Facebook, Twitter or Instagram) and online chat (e.g. Line, Skype, Kakao Talk) are popular online communication tools among adolescents [25]. Some earlier studies have demonstrated that their use is associated with mental health problems [26-29]. Additionally, it is reported that internet addiction can be predicted by the use of SNS and chat rooms [26,27]; the use of SNS was associated with psychological distress, suicidal ideation and attempts [28,29]. Sampasa-Kanyinga & Lewis reported that using SNS for more than 2 h every day was independently associated with poor self-rating of mental health and experiences of high levels of psychological distress and suicidal ideation [29]. SNS and online chat enable to communicate and interact with a large number of people. Through SNS and online chat, young users expect to acquire the favorable outcome of social relationships online, and they spend more time on them [30]. However, they do not always achieve favorable outcomes. In fact, the use of these avenues undermines well-being and life satisfaction [31], and increases risk of cyberbullying victimization [28]. Public health professionals should educate the public about the negative consequences of excessive online communication via mobile phone, thereby, preventing impairment to the mental health of adolescents.

The present study had some limitations. Our subjects were limited to participants in a single senior high school in central Japan; one cannot generalize results from this study to represent other areas and countries. Another limitation was that information obtained regarding the amount of time spent on mobile phones was subjective, being investigated using a self-administered questionnaire, and therefore, may not be a true representation of the actual situation. Finally, some results obtained may have been because this was a cross-sectional study. Longitudinal assessments however may provide evidence of a causal relation between the use of mobile phone and insomnia and depression. A longitudinal study such as a cohort study is required in the future.

5. Conclusions

In conclusion, the present study found that adolescents who spent 5 h or more on mobile phone use were at risk for insomnia. Moreover, adolescents who reportedly spent 120 min or more using mobile phone use for SNS and online chat were at a risk for depression. However, no association was observed between total hours of mobile phone use and depression. Adolescents must obtain

information about the appropriate use of mobile phones and apply this knowledge, in order to avoid sleep disturbances and the impairment of mental health.

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