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Research Submission

The Potential Impact of Internet and Mobile Use on Headache and Other Somatic Symptoms in Adolescence. A Population-Based Cross-Sectional Study

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Objective.—The purpose of this cross-sectional study was to determine whether migraine or tension-type headaches are associated with abuse of the internet and/or mobile phones and to explore whether headache and the abuse of the two technologies are associated with sleep disturbances and other self-reported somatic symptoms.

Background.—In the last several years, estimates indicate the increasing pervasiveness of the internet and other technologies in the lives of young people, highlighting the impact on well-being.

Design.—A population-based cross-sectional study was conducted between February 2013 and June 2014.

Method.—The initial sample was composed of 1004 Italian students (aged 10–16 years) recruited within public middle schools not randomly selected in central Italy. The final convenience sample consisted of 841 students (Males = 51.1%; Females = 48.9%) who were included in the analysis. Data were collected using self-reported measures.

Results.—Headache was reported by 28.0% of the total sample. A significant relationship was determined with gender ($\chi^2(1) = 7.78$, $P < .01$), with female students being overrepresented in the headache group. Approximately 39.6% of subjects were non-abusers of both technologies, internet and mobile. Mobile only abusers were approximately 26.0% of the study population; internet only abusers were approximately 14.9%; and abusers of both media were 19.5%. No significant relationship was found between students with and without headache with respect to the abuse of internet and mobile phone categories (headache was, respectively, the 26% in no abusers, the 30% in internet abusers, the 29% in mobile abusers, and the 29% in internet and mobile abusers, $P = .86$). Additionally, also by excluding the no headache group, the relationship between the two groups of headache (migraine and tension type headache) and the abuse of media (tension type headache was the 31% in no abusers, the 43% in internet abusers, the 49% in mobile abusers, and the 29% in internet and mobile abusers) is not statistically significant ($P = .06$). No significant relationship emerged between headache and the internet and mobile phone addiction groups (headache was the 28% in no addiction group, the 35% in mobile addiction group, the 25% of internet addiction group, and the 28% in mobile and internet addiction group, $P = .57$) as well as no significant relationship was found when only the different headache types were considered (tension type headache was the 39% in no addiction group, the 40% in mobile addiction group, the 32% in internet addiction group, and the 31% in mobile and internet addiction group, $P = .71$). Daily internet users reported higher median scores for somatic symptoms than the occasional internet users in the no-headache group (Kruskal-Wallis χ^2 (1) = 5.44, $P = .02$) and in the migraine group (Kruskal-Wallis χ^2 (1) = 6.54, $P = .01$).

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Conclusions.—Results highlighted the potential impact of excessive internet and mobile use, which ranges from different types of headache to other somatic symptoms. Further studies are needed to confirm these findings and to determine if there is a need for promoting preventive health interventions, especially in school setting.

Key words: headache, somatic symptoms, internet, mobile phone, adolescents

Abbreviations: H headache, I internet, M migraine, MPs mobile phones, SD sleep disturbance, SS somatic symptoms, TTH tension type headache

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Internet (I) and mobile phones (MPs) have revolutionized communication worldwide: "the Internet is now an integral, even inescapable part of many people's daily lives."[1] In the last years, research has directed increasing attention to those behaviors of abuse and addiction that are not related to the abuse of a substance but are associated with the excessive use of new technologies, such as the I and MPs.[2,3] The current generation draws heavily on the I for learning, social, and leisure activities. Children and adolescents appear to be less self-regulated and more susceptible to media influence.[4] Several findings raise health concerns for young people, given the greater risk of excessive and often unsupervised access to the World Wide Web.[5] Excessive use of the computer is considered to have a negative impact on physical health, leading to somatic symptoms (SS), such as headache (H), musculoskeletal pain, fatigue, and sleep disturbance (SD).[6-9]

Epidemiological self-report surveys among adolescent community samples showed prevalence rates of I-addiction ranging from 1.98 to 35.8%[10]; however, the conceptualization and definition of I-addiction is still debated by academics and clinicians.[11] The increase in I use has been followed by a corresponding increase in MP ownership among R adults and among young people: the number of MP users, including ever-younger age groups (6–19 years old), is increasing significantly.[12-14] The increased use of MPs has been correlated to the insurgence of symptoms, such as H, SD, memory loss, dizziness, fatigue, tinnitus, attention and concentration problems, and vertigo.[12,14] A recent Swedish study revealed that girls are likely to use MPs more frequently than boys and report a higher number of health complaints.[13]

Debate continues regarding concerns about the potential adverse health impacts associated with MP use. Several studies have specifically revealed how the electromagnetic field emitted by MPs has important side effects such as H,[15,16] decreased memory performance,[17] attention disorders, and difficulty concentrating.[18] Experiments that have exposed healthy adults to MP signals under blind placebo-controlled conditions suggest that exposure to this form of electromagnetic radiation is not causally linked to symptom onset.[19] Another double-blind, sham-controlled provocation study gave no evidence that radio frequency fields from GSM MP may cause head pain or discomfort or influence physiological variables.[20] Currently, the causal relationship between H associated with MP use is undetermined.[14]

Other studies noted that the abuse of I and MPs may also negatively affect nocturnal sleep,[8] particularly in females. Reduction in hours of sleep is associated with a variety of negative health, developmental and performance outcomes.[21] Although H and SD are the most commonly studied symptoms associated with I and MP-abuses[22,23] there is a lack of knowledge regarding the relationship between different H types and high combined use of both technologies, as well as the association with related SD and other SS in childhood and adolescence. H is common at all ages and increases throughout childhood and young adulthood.[24,25] Although epidemiological studies confirmed H

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frequency in non-clinical pediatric population, few studies[24] investigated the prevalence of migraine (M) or tension type headache (TTH), distinguishing the subtypes according to the second edition of International Classification of Headache Disorders Criteria (ICHD-II) revised with ICHD-III criteria.[26,27]

MAIN OBJECTIVES

With the aim of extending the existing literature on primary H among the general adolescent population, we intend to determine whether adolescents suffering from H tend to report higher levels of I and/or MP-abuse than those with No-H. A second objective we are interested in studying is if I and/or MP-abuse is more highly correlated with M or TTH in adolescents. A third objective is to determine whether adolescents with H (M vs TTH) and high levels of I and/or MP-abuse or who are at risk for addiction report SD related to I use, as well as associated SS, for both technologies.

METHODS

Participants.—The initial sample consisted of 1004 Italian students (Males = 512; 51%; Females = 492; 49%) with an age ranging from 10 to 16 years (M = 12.25; SD = 1.03) recruited within public middle schools in central Italy. Students who did not complete all questionnaires (n = 76, 7.6%) were excluded from the final sample. This is a convenience sample and the two schools instituted were not randomly sampled from a population of school institute. The aims of the study were illustrated to the headmasters and teachers of each school, indicating that the study was addressed to evaluating internet/mobile phone uses and somatic symptoms. All people involved in the study were enrolled on volunteer basis and only after the informed consent was signed by their parents. Participants were excluded only on the base of clinical considerations. The methods are not published anywhere else.

Inclusion and Exclusion Criteria.—Inclusion criteria were that participants be (1) 10–16 years old and (2) middle school-children. Students reporting to be under pharmacological therapy (n = 21, 2.1%), and/or having an already diagnosed infections or other medical illness (n = 57, 5.7%) and/or being under psychological therapy (n = 9, 0.01%) were excluded from the final sample. The final sample was composed of 841 pre-adolescents and adolescents (96% Caucasian). This study was reviewed and approved by the Ethics Committee of the Medicine and Psychology Faculty, Sapienza University of Rome (Italy).

Measures.—The presence or the absence of H was investigated with a questionnaire used to detect the characteristics of attacks. Participants were classified within one of the four H groups ("No-H" vs "M and probable-M" vs "TTH" vs "M and TTH") on the basis of the four ICHD-II criteria revised with the ICHD-III beta version for both M and TTH.[26,27] I usage and habit were assessed through a check-list questionnaire. Students were asked to specify the average number of hours they use the I per week with the question: On average, how many hours per week do you connect to the I? This average number is successively transformed in average of daily use. Students also report if they use the I on daily basis or occasionally with the question: On average, do you connect to the I every day or during the weekend, or when you are on vacation or on holiday? To differentiate two styles in using the I: on a regular daily basis (intensive use) or occasionally (ie, spending much of the weekend on the I) (Table 1). This questionnaire also assesses SD which are described in literature as related to intensive I use. The number of symptoms representing SD ("difficulty of initiating and maintaining sleep," "awakenings during the night," "waking up early in the morning," "excessive somnolence during the day") were used in this study as a separated index.[28]

MP use was assessed with the following question: On average, how many hours per day do you have the mobile switched on? On the basis of responses given to both MP and I questionnaires, the participants were divided into four groups (Table 1).

Addiction risk to a technology was evaluated with the I and MP scales[29] that have been specifically developed to mirror and complete The Shorter

Table 1.—Division of Participants into Four Groups Based on Their Questionnaire

Participants' Groups	Abuse Threshold on I and MP Questionnaires	Participants' Groups	SPQ Cut-Off "Risk of Addiction"
N-IAb† and N-MPAb‡	I <2 h/day; MP <10 h/day	Not at risk for IAd and MPAd††	I <27; MP < 28.3
IAb§	I >2 h/day	At risk for IAd	I >27
MPAb¶	MP >10 h/day	At risk for MPAd	MP >28.3
IAb and MPAb	I >2 h/day; MP >10 h/day	At risk for IAd and MPAd	I >27; MP >28.3

†Internet non-abusers.
‡Mobile phone non-abusers.
§Internet abusers.
¶Mobile phone abusers.
††Mobile phone addiction.

PROMIS Questionnaire (SPQ)[30] scales for addictions. Considering the cut-off for the Italian sample, participants were divided into four groups (Table 1).

SS referring to the last 2 weeks were assessed using the Children's Somatization Inventory (CSI).[31,32] The CSI cut-off score ($\geq$4 symptoms)[33] was used to investigate SS frequency and its co-occurrence with H.

Procedure.—Adolescents were involved in the study as a part of health-promoting project. All participants were recruited within public middle schools in central Italy between February 2013 and June 2014. Written informed consent was obtained both from parents and adolescents before their enrollment in the study. Subsequently measures were briefly presented to the participants of the classes involved giving instructions on their compilation. The administration lasted 30–40 minutes. Students filled out the questionnaires individually and anonymously in their classrooms during lesson time.

Analysis Strategy.—Results concerning H distribution within the general sample and as function of the gender and age-groups were considered. The distributions of H satisfying the four criteria of ICDH-III for M or probable-M or in comorbidity with TTH were then considered as separate indexes from those relating students satisfying ICDH-III criteria for TTH or probable TTH. Subsequently, the co-occurrence of H and I and/or MP abuse was considered by taking into account three different aspects of media abuse: the duration of use (hours per day) of I and MP was considered to classify students into one of four distinct groups: "Non-abuser" vs "I-abuser" vs "MP-abuser" vs "I-abuser and MP-abuser"; the daily vs occasional use of I; and the risk for I and/or MP addiction. Also in this case, students were categorized into four distinct groups: "not at risk for addiction" vs "at risk for MP-addiction" vs "at risk for I-addiction" vs "at risk for I and MP addiction." We are interested to ascertain if the three H groups (M only, TTH only and M + TTH) have different rates of prevalence across I and/or MP abuse, across the type of I use and across the risk for addiction. Successively we verified if the four groups of I or MP abusers with probable M (or TTH, or both M and TTH) differ in terms of number of SS with respect to the No-H group. Descriptive statistics will be used to describe the prevalence of sample characteristics. The significance of the co-occurrence of two characteristics (ie, H and I abuse) will be estimated with the chi-square test, while differences in prevalence of symptomatology in three or more subgroups of interests will be tested as the difference in rank sum test (known as Kruskal-Wallis χ^2 test). Effect size estimates for the chi-square statistics will be given in the form of phi. All statistical tests were performed with critical alpha for the null hypothesis was fixed to 0.05. For chi-square tests the alternative hypothesis is one-tailed, while in all other statistical tests is two-tailed. When the statistical test is not significant, we provide just the *P*-value and its effect size. All analysis were performed with R statistical software.

Table 2.—Distribution of Headache Groups and Descriptive Statistics of CSI Scores as Function of Headache Groups and of Internet and/or Mobile Abuse and Risk for Addiction

		No-Headache (N = 605, 71.9%)		Migraine (N = 148, 17.6%)		TTH§§ (N = 88, 10.5%)	
	Total	*n* (%)	*Me(IQR)*¶¶	*(%)*	*Me(IQR)*¶¶	*n (%)*	*Me(IQR)*¶¶
Gender							
Boys	430	328 (54.2%)	0 (0–1)	65 (43.9%)	7 (4–8)	37 (42.1%)	8 (7–8)
Girls	411	277 (47.8%)	0 (0–1)	83 (56.1%)	0 (0–1)	51 (57.9%)	7 (5–8)
Age-group							
10–12	507	364 (60.2%)	.80 (1.70)	93 (62.8%)	6.98 (2.74)	50 (56.8%)	7.88 (2.10)
13–15	334	241 (39.8%)	.81 (1.69)	55 (37.2%)	7.13 (2.56)	38 (43.2%)	8.21 (1.68)
IAb† and/or MPAb ‡							
Nonabuser	333	245 (40.5%)	0 (0–1)	61 (41.2%)	7 (4–8)	27 (30.7%)	7 (6.5–8)
IAb	125	88 (14.5%)	0 (0–1)	21 (14.2%)	7 (6–8)	16 (18.2%)	8 (6–10)
MPAb	219	156 (25.8%)	0 (0–1)	32 (21.6%)	7 (4–8)	31 (35.2%)	8 (7–9.5)
IAb and MPAb	164	116 (19.2%)	0 (0–1)	34 (23.0%)	7.5 (6–9)	14 (15.9%)	8 (6 −10)
Frequency of I use							
Occasional	416	307 (50.7%)	0 (0–1)	63 (42.6%)	7 (4–8)	46 (52.3%)	8 (7–9)
Daily	425	298 (49.3%)	0 (0–1)	85 (57.4%)	7 (5–9)	42 (47.7%)	8 (6–9)
I and MP risk for addiction							
Not-at-risk for addiction	493	352 (58.2%)	0 (0–1)	84 (56.8%)	7 (4–8)	57 (64.8%)	8 (6–10)
At risk for MPAd§	44	29 (4.8%)	0 (0–1)	9 (6.1%)	8 (7–8)	6 (6.8%)	8 (8–8)
At risk for IAd¶	167	126 (20.8%)	0 (0–1)	28 (18.9%)	8 (4 - 8)	13 (14.8%)	7 (6–9)
At risk for IAd and MPAd	137	98 (16.2%)	1(12)	27 (18.2%)	7 (5.5–9)	12 (13.6%)	8.5 (7–10)
CSI††							
>4 SS‡‡	553	553 (91.4%)		0 (0.0%)		0 (0.0%)	
<4 SS	288	52 (8.6%)		148 (100.0%)		88(100.0%)	

†Internet abusers.
‡Mobile phone abusers.
§Mobile phone addiction.
¶Internet addiction.
††Children's Somatization Inventory.
‡‡Somatic symptoms.
§§Episodic tension type headache.
¶¶CSI median and inter-quartile range (first and third quartiles).

RESULTS

Headache General.—As shown in Table 2, 28.1% of the students (n = 236, M = 102, 12.1%; F = 134, 16.0%) reported H. A significant relationship was found with gender ($\chi^2(1) = 7.78$, $P < .01$, $\varphi = 0.099$), demonstrating that female students were more greatly represented in the H group. No relationship was found between the absence/presence of H and age groups (10–12 y.o. vs 13–15 y.o.; $P \approx 1.00$, $\varphi = 0.002$). Typical symptoms of M or probable-M or M complicated by TTH symptomatology were reported by 17.6% of subjects while participants reporting only TTH or probable-TTH were 10.5% of the study population (Table 2).

The distribution of the two types of H showed a non-significant relationship with respect to gender ($\chi^2(1) = 0.02$, $P = .88$, $\varphi = 0.018$), and the two age groups (10–12 y.o. vs 13–15 y.o.; $\chi^2(1) = 0.54$, $P = .46$, $\varphi = 0.057$). As our main objectives are directed toward the general population, from this point on, all statistics are referred to three groups composed as following: (1) the first group is made up of students who resulted negative to the ICHD-III criteria; (2) the second group is composed of students positive to or typical symptoms of M or M complicated by TTH symptomatology or probable-M or probable-M complicated by TTH symptoms;

Table 3.—Differences in Adolescents With or Without Headache

	Headache (Presence vs Absence)				Migraine vs TTH¶			
Characteristics	χ^2	df	*P*	φ	χ^2	df	*P*	φ
IAb† and MPAb‡	0.76	3	.86	0.030	7.38	3	.06	0.177
Types of internet use	1.23	1	.27	0.041	1.72	1	.19	0.094
Addiction	2.03	3	.57	0.050	1.40	3	.71	0.078
CSI§ groups	625.87	1	<.01	0.865	92.89	1	<.01	0.623

†Internet abusers.
‡Mobile phone abusers.
§Children's Somatization Inventory.
¶Episodic tension type headache.

(3) the third group of interest is composed of students positive to TTH or probable-TTH criteria.

Headache, Internet/Mobile Abuse, and Addiction.—With respect to the first hypothesis we observed no significant relationship between students with and without H with respect to the abuse of I and MP categories ($\chi^2(3) = 0.76$, $P = .86$). To further explore the no significant relationship we also differentiated between the types of headache. No significant relationship emerged with the I and MP-abuse groups ($\chi^2(6) = 8.23$, $P = .22$). However, by excluding the No-H group, a significant relationship ($\chi^2(3) = 7.38$, $P = .06$) emerged between the two groups of H and the I-abuse and MP-abuse groups, with MP-abuse being over-represented in the TTH group. No significant relationship was found between presence/absence of H and the different types of I use (daily vs occasional) (Table 3).

The relationship among the groups evaluating the risk for I-addiction and/or MP-addiction with the H groups was explored. The presence/absence of H was not associated with the addiction groups nor were the two types of H after exclusion of the No-H group (Table 3).

Headache, Internet/Mobile Abuse or Addiction, and Associated Somatic Symptoms.—Considering the second hypothesis a significant relationship was found between students suffering from H and scoring above the CSI cut-off (n = 236, 28.1%) and those with No-H and scoring above the CSI cut-off (n = 52, 6.2%) (Table 3).

Notably, among the students below the CSI cut-off there were no students suffering from H symptoms.

The median CSI score (Table 2) of students with M and with TTH was statistically higher ($\chi^2(2) = 522.85$, $P < .01$) than that of students without H. Specifically the median CSI score of students with TTH was significantly higher ($\chi^2(1) = 9.86$, $P < .01$, $r = 0.87$) than that of those with M. The CSI scores of the students with and without H were subsequently compared for each of the four abuser groups. The H group scored significantly higher than the No-H in the Non abuser, MP-abuser, I-abuser, and in the I and MP-abuse groups.

CSI scores (Table 2) were successively considered separately for each of the four groups at risk to develop an addiction for media, and compared across the H groups. Significant differences emerged for the "No-addiction-group," for the "I-addiction" and also for the "I-addiction and MP-addiction" groups.

Turning to our third hypothesis, SD were not significantly different across the H groups even if the probability of the test was slightly above the critical values ($\chi^2(2) = 5.68$, $P = .06$), with the group of students with M reporting the highest sleeping disturbance score (Me = 0, IQR = 0–0) compared to TTH (Me = 0; IQR = 0–0).

The median number of symptoms representing SD for the four abuse groups were compared across the two H groups. No significant differences emerged for all comparisons (respectively: for no-abuse $P = .83$, $r = 0.161$; for mobile-abuse $P = .69$, $r = 0.016$; for internet-abuse $P = .27$, $r = 0.091$; for internet and mobile abuse $P = .12$, $r = 0.011$). The same results were found when the median number of symptoms representing SD within the four addiction groups were compared across the two H groups (respectively: for no-addiction $P = .28$, $r = 0.219$; for mobile-addiction $P = .50$, $r = 0.004$; for internet-addiction $P = .52$, $r = 0.082$; for internet and mobile addiction $P = .19$, $r = 0.153$).

DISCUSSION

The preliminary results of this study were presented at the International Headache Congress held in Boston in 2013.[34] These final study's findings have allowed a broadening of the existing knowledge on the primary H, focusing on the relationship between I and MP-abuse/addiction, different types of H, SS, and SD.

Several epidemiological studies have assessed the prevalence of H in childhood and adolescence but few utilizing ICHD criteria.[35] Consequently the estimated prevalence rates of primary H (M and TTH) vary considerably. This discrepancy is probably due to a difference in classification, methodology, population sample, and cultural and geographical aspects.[25,36] In the current adolescent population-based study, the prevalence of H using ICHD-III criteria was reported as 28.0% of the sample with a female preponderance (17.6% M; 10.5% TTH). These findings are similar to those reported by cross-sectional studies that have applied the ICHD criteria in schoolchildren,[25,37] but our prevalence rates are lower than those reported by other investigations without the application of IHS criteria.[38]

The prevalence of I-abusers (14.9%) is consistent with the estimated prevalence of high or problematic I use.[10,39] With regard to MP-addiction, it is important to note that there is a conceptual vagueness regarding the definition of abuse and/or addiction referring to MP use. Studies show varying prevalence of use at different ages in different countries and depending on the instruments used and the characteristics of the population studied.[40] In our study, the prevalence of MP-abusers (26.0%) is similar to the estimated prevalence ranging from 0 to 38% reported by others on MP users.[40] A higher rate of MP-abuse than I-abuse might support surveys and studies from different countries indicating that the use/abuse of MPs in young people is increasing rapidly and starting at a younger age.[11] Probably the MP is more convenient, as it satisfies the various functions (eg, writing texts, watching movies, listening to music, and surfing on the I).

Several studies reported higher rates in I use for boys with evidence of a male preponderance in I-addiction[10] and an excessive use of MPs for girls.[13] However, we did not find any significant gender difference for I and MP abuse as has been reported by other studies.[9] The use of MPs was almost as universal as the I but, to the best of our knowledge, studies assessing the prevalence of H as well as I and MP simultaneously have not been conducted in adolescents. In the present study, abusers of both media are 19.5%, suggesting a link between computer and MP use,[6] but this condition has yet to be investigated adequately in population-based studies. Finally, when considering the relationship between I and MP addiction and H, no prevalence for any H types were found. Probably we can hypothesize that in our sample of school-aged adolescents a percentage of them did not respond reporting the truth correctly as a result of social and cultural pressures. Considering the adverse effects of excessive use of technology by young people, our aim in this study was also to provide an overview of some health concerns that may arise from the excessive I/MP use. These findings showed as a considerable percentage (34.2%) indicated a high number of SS ($\geq$4 symptoms). Adolescents with M and TTH are more likely to experience other physical symptoms as a risk for somatization reporting the higher average scores than No-H. In addition, students considered to be MP-abusers and with "M and TTH" exhibited high levels of SS. These results are consistent with those of other studies in which H has been reported to be

associated with high MP use in the general population of adolescents and young adults[12–14] but no studies have explored the relationship between different types of H and MP-abuse or addiction. For this reason it has been claimed that the relationship between H outbreak and real MP use is currently undetermined.[14,19]

To date, the relationship between H types vs I/MP-abuse with referred physical symptoms has not been reported in population-based studies that may facilitate a comparison with our findings.

Among young people with high use of I and MPs, SD have been commonly observed.[13,41] In this sample symptoms related to a high use of I indicating SD were significantly different across the H types with M reporting the highest mean scores for more irregular sleep patterns and more episodes of SD than TTH. These results are consistent with other studies that have identified that excessive use of technology has an impact on the quality and quantity of sleep.[6,7,22,23]

CONCLUSION

Our results highlighted the potential physical effects of excessive I and MP use, which range from different types of H to other SS, including SD, but also a risk for addiction, as is observed with other substances.[23] This study has a number of limitations that should be addressed. First, the results were largely based on participants' self-report exploring H, I, and MP use/abuse/addiction, related symptoms and other SS, and as such may involve human error. Second, the age and knowledge of the participants, and their understandings about the exact definitions of the symptoms might affect their answers. Third, social desirability response bias may also have affected the results. We suggest further studies to confirm the findings by using structural clinical interviews. Therefore, interpretation of the results should be made with caution.

There is a need to explore further the extent and the effects of the I and MP use in various age groups and to plan intervention measures. Close attention should be paid to students who suffer from H and other associated SS and who use technologies excessively. Given the growing number of adolescents using the I and MPs, increased efforts should be made to promote preventive health interventions, especially in school settings.

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