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ORIGINAL ARTICLE

Mobile phone use and health symptoms in children

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Background/purpose: To investigate the mobile phone (MP) use for talking in relation to health symptoms among 2042 children aged 11–15 years in Taiwan.
Methods: A nationwide, cross-sectional study, using the computer assisted telephone interview (CATI) technique, was conducted in 2009 to collect information on children's utilization of MPs and the perceived health symptoms reported by their parents.
Results: The overall prevalence of MP use in the past month was estimated at 63.2% [95% confidence interval (CI) = 61.1–65.3%]. MP use was associated with a significantly increased adjusted odds ratio (AOR) for headaches and migraine (1.42, 95% CI = 1.12–1.81) and skin itches (1.84, 95% CI = 1.47–2.29). Children who regularly used MPs were also considered to have a health status worse than it was 1 year ago (β = 0.27, 95% CI = 0.17–0.37).
Conclusion: Although the cross-sectional design precludes the causal inference for the observed association, our study tended to suggest a need for more cautious use of MPs in children, because children are expected to experience a longer lifetime exposure to radiofrequency electromagnetic fields (RF-EMF) from MPs.

Conflicts of interest: The authors have no conflicts of interest relevant to this article.

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Introduction

The main difference between today's children and adults concerning the use of mobile phones (MPs) is the longer lifetime exposure of children when they grow older, i.e., children are starting to use MPs at an early age. Due to competition between network providers, the use of MPs is becoming cheaper and cheaper, leading to an increased use of MPs not only in adults, but also in children and adolescents. In an earlier review,[1] reported percentages of MP use among children aged 15–19 years in developed nations in 2002, indicated that the prevalence of MP users ranged from 42% to 52% in North America to >90% in the UK and Nordic countries. In 2007, a Swedish study disclosed that 79.1% of children aged 7–14 years reported MP access and 26.7% of them talked for ≥2 minutes/day.[2] Furthermore, the use of the modern means of interpersonal and mass communication has become an essential part of being young. Children are connected to global networks through internet access and MPs.[3,4] Like many nations, since 2007 Taiwan has a MP penetration rate of >100%,[5] i.e., there are more subscribers than inhabitants. However, little is known concerning the current prevalence of MP use in young adolescents in Taiwan.

Most of the existing evidence concerning MP use and adverse health effects comes from retrospective studies and studies of adults.[6,7] Longitudinal studies as well as studies in children and adolescents are scarce.[6] Given the fact that children and adolescents are still in the developmental process, there is concern over the question of whether children are more sensitive to electromagnetic fields (EMF) than adults.[8] This is also one of the reasons why the World Health Organization (WHO) research agenda set in 2006 emphasizes the need for studies on children and their radiofrequency EMF (RF-EMF) exposures.[9] This agenda states that research is needed to document the rapidly changing patterns of wireless communication use because such a large proportion of the young population is exposed.[2,9]

Whether there is a chronic effect from exposure to MP use is still under debate. Preece et al[10] examined the effect of a standard MP exposure at 902 MHz on cognitive function in 18 children aged 10–12 years. Exposures were set at 0 W (baseline), 0.025 W, or 0.25 W from a standard Nokia 3110 MP handset mounted on a plastic headset in normal use position. They found a tendency for reaction time to be shorter during exposure to radiation than in the sham (baseline) condition. However, such findings were not replicated in a later study concluding that a standard 902 MHz global system for mobile communication (GSM) MPs has no significant effect on children's cognitive function as measured by response speed and accuracy in children aged 10–14 years.[11] In a questionnaire survey of 2000 Swedish adolescents aged 15–19years,[12] a number of health complaints, including tiredness, stress, headache, anxiety, concentration difficulties, and sleep disturbances, were frequently reported in regular MP users, and regular users of wireless phones had health symptoms more often and reported poorer perceived health than less frequent users. A recent German study with a random sample of >3000 children and adolescents investigated the possible association between RF-EMF and chronic wellbeing in young people using personal dosimetry for 24 hour exposure.[13] The study found that half of the children and nearly every adolescent owned a MP which was used only for short durations per day. In spite of that, no statistically significant association between measured RF-EMF exposure levels and chronic symptoms was observed in this study.

Limited information is available regarding the prevalence of MP use in young Taiwanese people. Additionally, it is still inclusive concerning the potential chronic health symptoms resulting from MP use. We thus conducted this national telephone survey to investigate the use of MPs in Taiwanese children aged 11–15 years (i.e., Grade 5–9) and to explore the cross-sectional relationship between MP use and perceived health symptoms in children.

Materials and methods

Selection of study participants

In Taiwan, there are 365 districts in 25 cities/counties and each district has a varying number of households. Based on the Statistical Yearbook of Taiwan,[14] there were a total of 1,501,914 children (boys: 782,666; girls: 719,248) aged 11–15 years (i.e., Grade 5–9) registered at the end of 2009. These children were inhabitants of 1,000,957 households located in 365 districts. The study children were sampled with two stages. To best represent the distribution of households occupied by children aged 11–15 years, at the first stage the probability proportional to size (PPS) technique was used to determine that a total of 40 districts in 25 cities/counties of the nation should be identified.[15] The number of districts required in each city/county ranged from one to five. At the second stage, a simple random sampling (SRS) method was used to select the districts to be approached in each city/county. We limited our target population to children aged 11–15 years, primarily due to a higher likelihood of starting MP use at this age group. Exclusion of older children aged >15 years was due to the fact that some older children might live in dormitories of senior high schools in Taiwan and their MP use patterns might not be known to their guardians. Selection of guardians as the interviewees of this survey was mainly due to the consideration that children may not be fully aware of the legitimacy of the study, which is a central element of ethical concern.

The area codes and the first four digits of telephone numbers are unique for households in each district. Given that one of the primary research objectives in this survey was to estimate the prevalence [and 95% confidence interval (CI)] of MP use in Grade 5–9 children, it was estimated that 2040 children are required to yield an estimated prevalence with an error of 0.1 at a 95% level of confidence and an expected prevalence of 0.5.

We employed the computer assisted telephone interview (CATI) system to perform household selections in each of the 40 selected districts, using a random digit dialing (RDD) technique. According to the size of the child population aged 11–15 years, the predetermined total number of eligible children in each district ranged from 73 to 1170. Based on the

household registration, we managed to select the study sample in each district to resemble the distributions of age, sex, and guardian's education in the child population in that district. The guardian's education level was classified into ≤12 years versus >12 years of education. To achieve such age, sex, and guardian's education representative children sample, we continuously performed the RDD procedure until the predetermined number of eligible children in each age-sex-guardian's education-specific stratifications ($n = 20$) was acquired. The CATI procedure selected and reached a total of 8194 households located in the 40 districts, representing some 0.82% of the households in Taiwan. Those households were occupied by 11,799 children aged 11–15 years. Among those contacted, guardians from 2042 households completed the telephone interviews, representing a response rate of 24.9% (2042/8194). The interview took around 10 minutes. Reasons for unsuccessful interview included failure to complete interview, mainly because the guardians felt that the interview is too time-consuming (28.6%), declining to be interviewed before the interview began (19.9%), no one answering the phone (19.3%), and no eligible guardians were available for interview (7.5%) in 2 consecutive days.

Procedure of CATI

The CATI was performed between May 2010 and September 2010 by five interviewers standardized to conduct telephone interviews. All phone calls were made between 5:00 PM and 10:00 PM to maximize the chance of reaching the eligible households and to increase the likelihood of acceptance to be interviewed. Once the phone call reached a household in the study district, the people who answered the call were asked to determine if the household reached was occupied by any child aged 11–15 years. If more than one eligible child lived in the same household, all eligible children were ranked in an ascending order by age, and an SRS method using a computer random digit generator was performed by the interviewer to determine the index child. The guardians qualified to answer the phone call included mothers, fathers, grandmothers, grandfathers, and other carers living together. The above order of guardians was also used as the priority to be interviewed. The qualifications for the guardians interviewed ended up with 70.2%, 19.1%, 8.7%, and 2.0% for mothers, fathers, grandparents, and other carers, respectively in our sample. There were no significant variations in children's socio-demographic characteristics described in Table 1 across categories of interviewees. The research and CATI protocol of this telephone survey was reviewed and approved by the National Taipei University of Nursing and Health Sciences Institute Review Board (Taipei, Taiwan).

Measurement

Socio-demographic characteristics collected for the index child included age and sex, type of school attended (public or private), and living area (North, Central, South, or East (including remote islands). Children who had their own MPs and had been using MPs for at least 1 month prior to the interview on a regular basis were considered MP users.

Table 1 Characteristics of study children and prevalence of mobile phone users in study children ($n = 2042$).

	n	Mobile phone use		
		Yes	Weighted prevalence	(95% CI)
Sex				
Boy	1116	701	62.7	(60.0–65.6)
Girl	926	591	63.8	(60.7–66.8)
Grade				
5	430	191	45.0	(40.1–49.9)
6	336	202	59.2	(53.9–64.5)
7	471	322	67.9	(63.7–72.1)
8	350	249	70.9	(65.9–75.5)
9	455	328	71.7	(67.5–75.7)
School				
Public	1802	1132	62.8	(60.5–65.0)
Private	240	160	66.5	(60.2–72.6)
Living area				
North	972	607	62.8	(59.6–65.9)
Central	467	323	69.3	(65.0–73.3)
South	489	287	58.3	(54.0–62.5)
East	86	57	63.8	(53.7–73.2)
Remote islands	28	18	64.3	(37.1–84.7)
Guardian's education				
<12 y	241	11.8		
≥12 y	1801	88.2		
Total (children)	2042	1292	63.2	(61.1–65.3)

CI = confidence interval.

Those who used their parents' MPs were also considered as MP users if they can bring parent's MPs away from home during day time.

We also asked the guardians a number of questions concerning the MP use pattern by their children over the past month, including reasons for MP use, frequency of MP use in 1 week, daily average minutes of talking on the MP in 1 week, and the time period within which children often used their MPs for calling or receiving during a day over the past week. We excluded the use of MPs for texting from the analysis, as MPs are usually away from the head while texting. The health symptoms investigated in this study included excess daytime sleepiness, headaches and migraine, insomnia (i.e., difficulty in initiating sleep in 30 minutes), and skin itches. The guardians were asked if the index child had suffered from the above health outcomes regardless of whether an ambulatory care visit or admission occurred over the past month. Inclusion of the above health outcomes is mainly due to the fact that MPs are normally used close to the head, and part of the RF-EMF energy from the handset is absorbed into the head and the brain; it has been suggested that these fields may have effects on neuronal activity and cognitive function in humans.[16,17] Moreover, the guardians were asked to assess the children's health status. Three questions were raised: (1) Are you worried about your child's health? (2) Do you think your child's health is worse than it was 1 year ago? (3) Do you think that your child is more vulnerable than other children of the same age to sickness? Each question was rated from one to five, with a higher score being indicative of poorer

health status. The above three questions were originally used in a previous study that assessed the general health of school children who attended elementary schools with high-voltage (HV) power lines hovering over the campus.[18] The questionnaire used in the telephone interview was evaluated by a panel of six experts (3 epidemiologists, 2 environmental health scientists, and 1 pediatrician) for its content validity. All four interviewers were trained and standardized to further ensure the reliability of the questionnaire.

The potential confounders considered in this study included children's age, sex, residential area (North, Central, South, East, and remote islands), guardians' educational level ($\leq$12 years vs. >12 years), and density of HV transmission lines (HVTL) in each district, which is calculated as the ratio of area (in km^2) for the region within 100 m distance away from the transmission lines ($\geq$69 kV) to the total area of that particular district.[19] Controlling for density of HVTL was due to the fact that previous studies reported relationships between exposure to higher extreme-low-frequency (<300 Hz) EMFs and the health symptoms analyzed in this study.[20]

Statistical analysis

We first calculated the overall and socio-demographic characteristics specific prevalence of MP use by weighing the district specific prevalence, where the weight was estimated by the proportion of child population (11–15 years) of a particular district to the total national children's population. The 95% CI of binomially distributed prevalence was calculated under the normal approximation. The logistic regression model with the Generalized Estimation Equation (GEE) method that accounts for correlation in the error term due to clustering of individuals living in the same district to obtain robust standard error estimates was used to estimate the covariate adjusted odds ratio (AOR) and corresponding 95% CI for various health symptoms in relation to MP use.[21] To assess the association of MP use with a child's health status, we performed multiple linear regression models also with the GEE method. The statistical significance level of analyses was set at an α level of 0.05, and all the analyses were performed with the SPSS software (version 17; SPSS Inc., Chicago, IL, USA).

Results

The overall prevalence of MP use for Taiwanese children aged 11–15 years was estimated at 63.2% (95% CI = 61.1–65.3%). The prevalence showed a small sex difference, but presented evident age and geographic variations. The prevalence increased steadily from 45% for 11-year-old children to 71.7% for children aged 15 years. Children living in the Central area showed the highest prevalence (69.3%), whereas those from the South area had the lowest prevalence at 58.3%. We also noted that children who attended private schools had a higher prevalence of MP use than public school students.

Some 71.1% of guardians reported that the main reason for their children to use MPs was because of safety considerations. However, 27.6% admitted that peer pressure was the main reason for their children to own MPs. Forty-five percent of children used MPs for calling or receiving every day, 30.7% talked >2 days/week, and 18.9% used MPs 1–2 days/week. More than half (45%) of children had used MPs for calling or receiving daily, 34.8% reported daily MP use of 21–40 minutes, and 4.4% of children used MPs for at least 1 hour every day. During weekdays, children often (41.7%) talked on MPs in the evening. The MP use pattern during the weekend was somewhat different; children often used their MPs for calling or receiving in the afternoon (33.3%), and then in the evening (24.6%). Of the children studied, 9.8% frequently used MPs for calling or receiving after 10:00 PM, a time of lights out for many families during weekdays, and the corresponding figure for the weekend was 6.7% (Table 2).

Table 3 shows the use of MPs in relation to the prevalence of various selected health symptoms. Children who used MPs experienced a significantly increased prevalence of headaches/migraine and skin itches with an AOR of 1.42 (95% CI = 1.12–1.81) and 1.84 (95% CI = 1.47–2.29), respectively. By contrast, MP use was associated with a significantly reduced AOR of insomnia (AOR = 0.55, 95% CI = 0.37–0.82).

Table 4 shows MP use in relation to children's general health. The MP users were more likely to be considered as having a health status worse than it was 1 year ago

Table 2 Mobile phone use pattern in study children (n = 1292).

Pattern	n	%
Leading reasons for mobile phone use[a]		
Safety consideration	919	71.1
Easy to contact	888	68.7
Peer pressure	357	27.6
Frequency of mobile phone use for calling or receiving		
Daily	582	45.0
3–6 d/wk	396	30.7
1–2 d/wk	244	18.9
<1 d/wk	70	5.4
Daily average min spent for mobile phone use		
≤20	718	55.6
21–40	449	34.8
41–60	68	5.3
≥60	57	4.4
Time period within which mobile phone most frequently used for calling or receiving		
Weekdays		
Morning (7:00–11:59 AM)	28	2.2
Afternoon (12:00–4:59 PM)	285	22.0
Evening before 10:00 PM (5:00–9:59 PM)	539	41.7
After 10:00 PM	126	9.8
Not sure	314	24.3
Weekend		
Morning (7:00–11:59 AM)	47	3.6
Afternoon (12:00–4:59 PM)	431	33.3
Evening before 10:00 PM (5:00–9:59 PM)	317	24.6
After 10:00 PM	86	6.7
Not sure	411	31.9

[a] More than one choice was allowed.

Table 3 Mobile phone use in relation to health symptoms in children.

Health symptoms	Mobile phone users	
	No	Yes
	$n = 750$	$n = 1292$
Excess daytime sleepiness		
Yes	232 (30.9)	492 (38.1)
AOR (95% CI)[a]	1.00	1.12 (0.92–1.37)
Headaches and migraine		
Yes	126 (16.8)	298 (23.1)
AOR (95% CI)	1.00	1.42 (1.12–1.81)
Insomnia[b]		
Yes	60 (8.0)	63 (4.9)
AOR (95% CI)	1.00	0.55 (0.37–0.82)
Skin itches		
Yes	150 (20.0)	421 (32.6)
AOR (95% CI)	1.00	1.84 (1.47–2.29)

Data are presented as *n* (%), unless otherwise indicated.
AOR = adjusted odds ratio; CI = confidence interval.
[a] Adjusted for grade, sex, residential area, type of school, guardian's educational level, and density of high-voltage transmission lines.
[b] Takes >30 minutes to get to sleep.

(β = 0.27, 95% CI = 0.17–0.37). By contrast, guardians of those MP users neither had a tendency to worry about their children's health, nor considered their children to be more vulnerable to sickness.

Discussion

This is believed to be the first nationwide survey of MP use among children of Taiwan. Some 63.2% of children aged 11–15 years in Taiwan used MPs regularly and the prevalence of use increased with age. In addition to apparent geographic and socioeconomic variations in prevalence of MP use, we also noted that 45% of children used MPs for calling or receiving every day; nearly 10% of children often used MPs for calling or receiving in the late evening probably after lights out during weekdays (i.e., school days). In addition, MP use was found to be associated with an increased prevalence of headaches/migraine and skin itches.

Table 4 Mobile phone use in relation to general health in children.

Children's health reported by guardians	Mobile phone use	
	No ($n = 750$)	Yes ($n = 1292$)
Worry about children's health		
Mean ± SD	3.56 ± 1.07	3.63 ± 0.90
Mean difference β (95% CI)[a]		0.04 (−0.05–0.13)
Children's health is worse than it was 1 y ago		
Mean ± SD	3.29 ± 1.24	3.68 ± 1.08
Mean difference β (95% CI)		0.27 (0.17–0.37)
More vulnerable to sickness than other children		
Mean ± SD	2.90 ± 1.11	2.96 ± 0.79
Mean difference β (95% CI)		0.03 (−0.05–0.12)

CI = confidence interval; SD = standard deviation.
[a] Adjusted for grade, sex, residential area, guardian's educational level, density of high-voltage transmission lines.

Although there is an increasing trend of MP use in children and adolescents in most parts of the world, there variation in the prevalence of MP use in young people in different countries. In 2005, a German study reported that 6% of children aged 9–10 years used a MP for calling or receiving daily; 35% owned their own MPs.[1] Also in 2007, Mezei et al[22] surveyed 1301 fourth grade school children (aged 10 years) from 24 schools in three Hungarian cities, and found that 76% owned a MP, 24% used MPs daily to make phone calls, and an additional 33% used MPs for phone calls at least several times/week. An earlier Australian study conducted in 2002–2003 reported that among children aged 6–9 years, 5% owned their own MP, and this was 36% among children aged 10–13 years.[1] Compared to the above data, children from Nordic countries tend to have a higher prevalence of MP use. In Finland, use of MPs among children aged 9–10 years increased from 19% in 2000 to 70% in 2002.[1] In addition, Söderqvist et al[2] sent a questionnaire to 2000 children aged 7–14 years in Sweden. With a response rate of 71.2%, this Swedish study reported that overall 79.1% of the respondents had access to MPs, and 26.7% of them talked for ≥2 minutes/day. Although our study was conducted in a later year and covered an age range not identical to those reported in previous studies, findings of our study tended to indicate a lower rate of MP use in Taiwanese children.

Although Taiwanese children had a relatively low prevalence of MP use, they had a utilization pattern similar to that of children from other nations. Some 45% of MP users in Taiwan (or 28.5% of all children of the study ages) used MPs daily, and an additional 30.7% MP users (or 19.4% of all children) used MPs for >2 days/week. In Hungary, 24% of fourth grade school children (aged 10 years) used a MP every day, and 33% used MPs for talking at least several times/week.[22] Similar figures were also reported in Swedish children aged 7–14 years old; 26.7% of them talked almost every day for ≥2 minutes.[2] The time spent for using MPs for talking by Taiwanese children was also generally comparable with the time spent by children from other nations.[1,2] Some 55.6% of Taiwanese children spent <20 minutes/day for talking on MPs, 34.8% spent 21–40 minutes/day, and 4.4% talked on MPs for >1 hour every day. In the UK, 90% of children aged <16 years owned a MP in 2001, and 1 in 10 spent >45 minutes/day using it.[1] In addition, >95% of Swedish children with comparable ages (i.e., 11–14years) used MPs for <30 minutes/day in 2007, and only 0.6% spent 1 hour or more using MPs for talking every day.[2]

It is worth mentioning that our data showed that nearly 10% of Taiwanese children used MPs after 10:00 PM. van den Bulck[23] surveyed 1656 secondary school children aged 13–17 years in Flanders, Belgium for the prevalence of MP use after lights out, and found that 48.4% and 27.9%, respectively, of children received and made calls at least 1 day/week after lights out. After 1 year follow-up, the

Belgian study noted that use of the phone right after lights out increased the odds of being very tired during day time by 2.2-fold (95% CI = 1.4—3.4); between 00:00 AM and 03:00 AM 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). Although the prevalence of using MPs in the late evening in Taiwanese children was not as high as that reported in the Belgian study, the potential adverse effects associated with using MPs after lights out among Taiwanese children deserve further attentions.

We noted that the use of MPs by children was significantly and positively associated with headaches/migraines and skin itches by an elevated risk of 42% and 84%, respectively. A wide range of subjective symptoms has been attributed to exposure to various sources of RF-EMF both at home and at work. Some individuals reported that they suffered a variety of complaints, including headaches and migraines, fatigue, skin itches, and sensations of warmth.[24] Our study is consistent with findings in some previous studies. For example, Oftedal et al[25] sent a questionnaire to 12,000 Swedes and 5000 Norwegians and found that longer calls and a higher number of calls were associated with a higher prevalence of warmth behind, around, or on the ear and with headaches and fatigue. However, in provocation studies, a causal relation between RF exposure and the above complaints symptoms has not been convincingly demonstrated, suggesting that psychological factors, such as the conscious expectation of effect, may play a role in the relationship between MP use and health symptoms.[24] In addition, some studies also argued that a higher prevalence of health symptoms observed in MP users could be due to an increasing number of people with these symptoms considering themselves "electromagnetically hypersensitive".[26,27] An earlier Taiwanese population-based study estimated that 13.3% (95% CI = 11.2—15.3%) of Taiwanese adults had self-reported EMF sensitivity. The study also found that people with a very poor self-reported health status, those who were unable to work, and those who had psychiatric morbidity were associated with a higher risk of having self-reported EMF sensitivity.[28] Nonetheless, comparison of our study with previous ones might not be appropriate, because the majority of previous studies were conducted to investigate health symptoms in adults, who may have a different biological response to RF-EMF. Interpretations in the studies of adults may have been further limited, because a number of work-related confounding factors such as psychosocial workload and occupation might affect the prevalence of symptoms.[29]

Our study found a positive relationship between MP use and risk of skin itches. A review by Rajpara and Feldman[30] noted that recent reports of facial allergic contact dermatitis to cell phone metals have begun to emerge. This is particularly enhanced by the combination of increased cell phone ownership and unlimited usage plans, which led to a situation in which metal cell phone parts may come into contact with the cell phone user's ear and face for prolonged periods of time. A previous study also presented a case of allergic contact dermatitis to cell phone metal.[31] In our telephone interview, we did not request information on the body parts that presented skin itches. Nor did we ask about how close MPs were to the face while children used them, which does not make it possible for our data to substantiate or refute the previous observation.

There are some weaknesses in this study. First, this survey had a response rate of only 25%, which is considered low. A number of factors contributed to this including unavailability of the guardians, concerns over study legitimacy, fear of deception, lack of adequate incentive for participation, time constraints, and communication difficulty with foreign born mothers who comprised nearly 10% of all Taiwanese mothers.[32] Although there is no obvious reason to believe that an unsuccessful interview is related to both the MP use and selected health symptoms, the potential selection bias might have influenced our study results, at least to some extent. Second, we were unable to validate the information on MP use and children's health symptoms obtained from the guardians who might have a recall bias, therefore, exposure and outcome misclassifications might occur in our study. Exposure misclassification might also result from inadequate coverage of all possible indoor and outdoor sources of RF, such as cordless telephone and MP base stations. No information on whether the children used hand-free devices in calling or receiving also limits the exposure measures. It is, however, difficult to tell to what extent such exposure and outcome misclassifications may affect our results. Third, due to time constraints, we were unable to collect from the telephone interview the information on all risk factors, including lifestyle, physical activities, and stress at schools, for the selected health symptoms, which might have biased the study results. Lastly, the nature of the cross-sectional study design might have entailed a certain degree of causal reverse bias. We did note a higher prevalence of certain health in children with MP use. It is also likely that some parents allowed their children to own/use an MP due to the fact that their children are relatively unhealthy and need an MP to keep in close contact with their parents.

Utilization of modern technologies including wireless communication devices for monitoring and managing diseases has increased in recent years.[33] Even though it is lower than the prevalence rate reported from many other developed nations, the prevalence of MP use is still considered high in Taiwanese children aged 11—15 years. Some 10% of children often used MPs for calling or receiving in the late evening or after lights out, which may have led to increased levels of tiredness in children. Although the cross-sectional design precludes the causal inference, our study tends to support findings from some previous studies linking higher MP use and prevalence of certain health complaints/symptoms, including headaches/migraine, fatigue, and skin itches.[24,30] We suggest that continuing to monitor children's health in relation to MP use is essential, not only because the prevalence of MP use is increasing in children, but also because children might be more sensitive than adults to potential adverse effects from exposure to RF-EMF.

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