



Symptoms and the use of wireless communication devices: A prospective cohort study in Swiss adolescents



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ABSTRACT

Background: We investigated whether radiofrequency electromagnetic fields (RF-EMF) from mobile phones and other wireless devices or by the wireless device use itself due to non-radiation related factors in that context are associated with an increase in health symptom reports of adolescents in Central Switzerland.

Methods: In a prospective cohort study, 439 study participants (participation rate: 36.8%) aged 12–17 years, completed questionnaires about their mobile and cordless phone use, their self-reported symptoms and possible confounding factors at baseline (2012/2013) and one year later (2013/2014). Operator recorded mobile phone data was obtained for a subgroup of 234 adolescents. RF-EMF dose measures considering various factors affecting RF-EMF exposure were computed for the brain and the whole body.

Data were analysed using a mixed-logistic cross-sectional model and a cohort approach, where we investigated whether cumulative dose over one year was related to a new onset of a symptom between baseline and follow-up. All analyses were adjusted for relevant confounders.

Results: Participation rate in the follow-up was 97% (425 participants). In both analyses, cross-sectional and cohort, various symptoms tended to be mostly associated with usage measures that are only marginally related to RF-EMF exposure such as the number of text messages sent per day (e.g. tiredness: OR:1.81; 95%CI:1.20–2.74 for cross-sectional analyses and OR:1.87; 95%CI:1.04–3.38 for cohort analyses). Outcomes were generally less strongly or not associated with mobile phone call duration and RF-EMF dose measures.

Conclusions: Stronger associations between symptoms of ill health and wireless communication device use than for RF-EMF dose measures were observed. Such a result pattern does not support a causal association between RF-EMF exposure and health symptoms of adolescents but rather suggests that other aspects of extensive media use are related to symptoms.

1. Introduction

Use of wireless communication devices by adolescents has substantially increased in the last few years (Waller et al., 2016). This development has raised public concerns regarding adverse health effects especially in young people since the lifetime exposure of adolescents will be longer than that of present-day adults. It has been suggested that children and adolescents may be more susceptible to RF-EMF exposure due to their still developing nervous system (Kheifets et al., 2005).

Several studies have focused on mobile phone use and health symptoms in children and adolescents relying on self-reported number or duration of mobile phone calls and texts as an exposure proxy for RF-EMF. In a nationwide Taiwanese cross-sectional study, Chiu et al. (2014) found that mobile phone use was associated with a significantly

increased odds ratio (OR) for headache and migraine (OR: 1.42, 95% CI: 1.12–1.81) and skin itches (OR: 1.84, 95%CI: 1.47–2.29). In a large Swedish cross-sectional study of 2000 adolescents, self-reported use of mobile phones was related to self-reported health complaints such as tiredness, stress, headache, anxiety, concentration difficulties and sleep disturbances (Soderqvist et al., 2008). Redmayne et al. (2013) found significant cross-sectional associations between adolescents' well-being and their wireless phone use, with most consistent associations for headache. In a cross-sectional Korean study, feeling of discomfort and dry skin were associated with the number of outgoing calls per day and dry skin, fatigue and dizziness were associated with average duration per call (Byun et al., 2013). Ikeda and Nakamura (2014) found associations between mobile phone use and depressed mood or fatigue, respectively in 2785 Japanese high school students. In a representative Finnish sample of 7300 adolescents, high-mobile phone users showed

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more symptoms of depression and sleep disturbances than low-mobile phone users (Koivusilta et al., 2007). Roser et al. (2016a) found that physical well-being was significantly decreased in the 10% of adolescents belonging to the highest category in the shortened 10-item version of the Mobile Phone Problem Use Scale (Foerster et al., 2015).

Most of the existing evidence concerning the exposure of RF-EMF on adverse health effects however comes from cross-sectional studies, where changes over time cannot be assessed and where reverse causality, as well as confounding by lifestyle related factors related to mobile phone use and well-being are of concern. Another limitation in all of these studies was the self-reported mobile phone use, which has been shown to be inaccurate. Adolescents tend to substantially overestimate their amount of mobile phone use (Aydin et al., 2011; Inyang et al., 2009).

Thus, to address RF-EMF long term effects of mobile phone use, the application of a cumulative RF-EMF dose measure, which does not depend on usage only, is necessary, whereas for more transient effects recent exposure is relevant. One major factor determining RF-EMF exposure and not strongly correlated to the duration of mobile phone use is the type of network used. Calls on the UMTS network (3rd generation Universal Mobile Telecommunications System) cause on average 100–500 times less exposure than calls on the GSM network (2nd generation Global System for Mobile Communications) (Gati et al., 2009). In Switzerland both types of network are used and with the help of objectively recorded mobile phone use data provided by mobile phone operators and personal RF-EMF measurements, an integrative RF-EMF dose measure suitable for epidemiological research was calculated (Roser et al., 2015).

By applying this RF-EMF dose measure to the prospective HERMES (Health Effects Related to Mobile phone use in adolescentS) cohort study, we thus aimed to investigate whether self-reported symptoms are associated with RF-EMF from mobile phones and other wireless devices or by the wireless device use itself due to non-radiation related factors in that context.

2. Material and methods

2.1. Study procedure

For the present study, 126 schools (7th, 8th and 9th grade) from rural and urban areas in Central Switzerland were contacted by an initial phone call with the head of the school. In a subsequent visit in the classes of 24 schools that agreed to participate, 1193 adolescents were informed about the study. Participation was voluntary and had to be preceded by informed consent of the adolescents and a parent. The baseline investigation then took place in school during school time between June 2012 and February 2013. The adolescents filled in a questionnaire with questions on non-specific symptoms of ill health, use of wireless communication devices, socio demographics, and other relevant covariables. This information was complemented by a parental questionnaire with additional items such as wireless technology at home and questions on child development. Parents were asked to fill out the questionnaire and send it back directly. This procedure was repeated one year later by the same study managers with the same study participants.

A subgroup of 95 study participants participated voluntarily in personal measurements. The participants were selected so that they represent a broad range of the HERMES cohort according to basic criteria such as age, gender, school level and urbanization of home and school place. The adolescents carried a portable measurement device, a so-called exposimeter, and kept a time-activity diary application installed on a smartphone in flight-mode for about three consecutive days. This sample has been used to estimate the exposure from cordless phone base stations, WLAN access points and other people's mobile phones, which has been used for the development of the RF-EMF dose measures. The study was conducted in accordance with the Declaration

of Helsinki, and the protocol was approved by the Ethics Committee of Lucerne, Switzerland on May 9th, 2012 (Ref. Nr. EK: 12025). Written informed consent was obtained from the adolescents and their parents for the participation in the study and for providing the mobile phone operator data.

2.2. Symptoms

In the written questionnaire, headache was assessed using the six-item Headache Impact Test (HIT-6) providing a summary score of all six items ranging from 36 to 78 (Kosinski et al., 2003). According to Kosinski et al. (2003), a summary score of 49 or less is considered as “headache has no impact on your life,” 50–55 is considered as “headache has some impact on your life,” 56–59 as “headache has substantial impact on your life” and 60 or more as “headache has a very severe impact on your life.” A binary variable was created by using 56 as the cut-off value. Tiredness, lack of energy, lack of concentration and rapid exhaustibility (referred to as exhaustibility) were assessed using a four-point Likert scale with categories “never,” “rare,” “moderate” and “severe.” Binary variables were created by combining answer categories “never” with “rare” and “moderate” with “severe”. Physical well-being was assessed using the dimension “Physical Well-being” from the KidSCREEN-52 questionnaire. This dimension includes five questions exploring the level of adolescents’ physical activity, energy and fitness (The KIDSCREEN Group Europe, 2006; Hadjem et al., 2010; Ravens-Sieberer et al., 2005). A binary variable was created by using the mean minus half a standard deviation as the cut-off, which is suggested as the guiding principle according to the official KidSCREEN questionnaire handbook. For coherent data presentation, the KidSCREEN Well-being scale was inverted and is expressed as ill-being scale.

In most health questions, we referred to the time period 4 weeks prior to the date of examination.

2.3. Exposure data

In the written adolescent questionnaire, all study participants were asked about call duration with their own or any other mobile phone (referred to as duration mobile phone calls), call duration with cordless (fixed line) phone and duration of data traffic on the mobile phone, e.g. for surfing and streaming. The duration of gaming on computers and TV and number of all kind of text messages (SMS, WhatsApp etc.) are not, or only marginally relevant for RF-EMF exposure and were thus asked about to be used as negative exposure control variables in the analyses.

Informed consent to obtain objectively recorded mobile phone use data from the mobile phone operators was given by 234 out of 439 study participants and their parents. This included duration of each call and on which network (GSM or UMTS) it started, number of SMS (text messages) sent per day and volume of data traffic (MB/day). Data were obtained for up to 18 months, from 6 months before baseline until the follow-up investigation.

2.4. RF-EMF dose measures

To be able to calculate a RF-EMF dose to the brain and the whole body of the participating adolescents, an integrative RF-EMF exposure surrogate including various factors affecting near-field and far-field RF-EMF exposure was developed, which is described in detail in Roser et al. (2015). The near-field component combines the exposure from the use of wireless devices (mobile phones, cordless phones, computer/laptop/tablet connected to wireless internet (WLAN)). For mobile phone calls, we also considered the proportion in each network type (network type proportion). Among participants for whom we obtained operator data, network type proportion was calculated directly from objective information. For the other participants, the network type proportion was predicted by mixed linear regression models with

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