Environmental Research 161 (2018) 1–8

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Total recall in the SCAMP cohort: Validation of self-reported mobile phone use in the smartphone era

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ARTICLE INFO

Keywords:
Mobile phones
Adolescents
Exposure measurement error
SCAMP

ABSTRACT

Mobile phone use, predominantly smartphones, is almost ubiquitous amongst both adults and children. However adults and children have different usage patterns. A major challenge with research on mobile phone use is the reliability of self-reported phone activity for accurate exposure assessment. We investigated the agreement between self-reported mobile phone use data and objective mobile operator traffic data in a subset of adolescents aged 11–12 years participating in the Study of Cognition, Adolescents and Mobile Phones (SCAMP) cohort. We examined self-reported mobile phone use, including call frequency, cumulative call time duration and text messages sent among adolescents from SCAMP and matched these data with records provided by mobile network operators (n = 350). The extent of agreement between self-reported mobile phone use and mobile operator traffic data use was evaluated using Cohen's weighted Kappa (κ) statistics. Sensitivity and specificity of self-reported low (< 1 call/day, ≤ 5 min of call/day or ≤ 5 text messages sent/day) and high (≥ 11 calls/day, > 30 min of call/day or ≥ 11 text messages sent /day) use were estimated.

Agreement between self-reported mobile phone use and mobile operator traffic data was highest for the duration spent talking on mobile phones per day on weekdays (38.9%) and weekends (29.4%) compared to frequency of calls and number of text messages sent. Adolescents overestimated their mobile phone use during weekends compared to weekdays. Analysis of agreement showed little difference overall between the sexes and socio-economic groups. Weighted kappa between self-reported and mobile operator traffic data for call frequency during weekdays was κ = 0.12, 95% CI 0.06–0.18. Of the three modes of mobile phone use measured in the questionnaire, call frequency was the most sensitive for low mobile phone users on weekdays and weekends (77.1, 95% CI: 69.3—83.7 and 72.0, 95% CI: 65.0–78.4, respectively). Specificity was moderate to high for high users with the highest for call frequency during weekdays (98.4, 95% CI: 96.4–99.5).

Despite differential agreement between adolescents' self-reported mobile phone use and mobile operator traffic data, our findings demonstrate that self-reported usage adequately distinguishes between high and low use. The greater use of mobile smartphones over Wi-Fi networks by adolescents, as opposed to mobile phone networks, means operator data are not the gold standard for exposure assessment in this age group. This has important implications for epidemiologic research on the health effects of mobile phone use in adolescents.

1. Introduction

Mobile phone use is almost ubiquitous among adults and children, with over 90% ownership in adults and upwards of 75% in 12 to 15-year-olds in the UK (Ofcom, 2015). While these rates are comparable to those recorded a decade ago, children, particularly adolescents, now

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http://dx.doi.org/10.1016/j.envres.2017.10.034
Received 1 December 2016; Received in revised form 20 October 2017; Accepted 22 October 2017

carry smartphones with myriad functions facilitating different and higher function usage: accessing the internet and sending text/instant messages on mobile phones are surpassing traditional telephony activities (Fowler and Noyes, 2015). There are potential health concerns with this increased use; whilst there is limited evidence available for adolescents, it is believed that, due to the continuous maturation of their nervous system and likely greater lifetime exposure, they may be especially susceptible to potential harmful effects from mobile phones (IEGMP, 2000). The International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields (RF-EMF) as "possibly carcinogenic to humans" (IARC, 2011). However, the dose of RF-EMF that a regular mobile phone user is exposed to is difficult to measure as it is dependent on the frequency band, the power output of the mobile phone, and the duration and frequency of use. Depending on these parameters, a recent Swiss study in adolescents estimated an average whole body dose of 28 mJ/kg and an average brain dose of 190 mJ/kg from own mobile phone calls (Roser et al., 2017)

A major challenge with research on mobile phone use is the reliability of self-reported telephone activity to measure exposures, also known as recall error. Though imperfect, self-reported mobile phone use data are valuable, since objective data are often not available (Vergnaud et al., 2016). Validation studies of adults have revealed wide variation in the concordance between reported usage and objective network data (Samkange-Zeeb et al., 2004; Abeele et al., 2013). Similar studies in children and adolescents have found systematic errors, including self-reported call frequency being under and overestimated, and call duration consistently overestimated (Inyang et al., 2009; Aydin et al., 2011a; Kiyohara et al., 2015). Depending on the predominant direction of error, exposure misclassification could reduce, exaggerate, or invert a true association of mobile phone use with a given outcome (Vrijheid et al., 2009).

The purpose of this paper is to examine self-reported mobile phone usage data in relation to objective mobile operator traffic data in a subset of the SCAMP cohort (operator subset). This study represents one of the first to validate the accuracy of self-reported mobile phone use in adolescents, considering weekday and weekend use separately, and investigating the role of socio-demographic characteristics in relation to recall accuracy.

2. Materials and methods

SCAMP is a prospective school-based cohort study aimed to investigate cognitive and behavioural outcomes associated with use of mobile phones and other wireless technologies that emit RF-EMF. The SCAMP cohort directly addresses the WHO 2010 research agenda for radiofrequency fields that ranked prospective cohorts of children and adolescents as 'highest priority research need' (van Deventer et al., 2011). The cohort includes Year 7 pupils 11–12-years-old) across London, UK, from 39 secondary schools. Baseline data collection commenced November 2014 and was completed in July 2016. Data were collected from all adolescents in Year 7 (first year of secondary school) at each school in the cohort, unless parents or adolescents chose to opt out.

2.1. Self-reported mobile phone use

The method of data collection in SCAMP was a computer-based assessment that adolescents completed at school. The assessment includes a questionnaire that enquired about their use of mobile phones (e.g., number of calls, Short Message Service (SMS) text and instant messages sent) and other devices (e.g. time spent on laptop computers, video game consoles), and incorporated a battery of cognitive tests, in addition to wellbeing and behaviour scales. Questions on device use provided categorical responses for weekday and weekend use. For example, to measure the frequency of phone calls, adolescents who reported using or having used a mobile phone were asked separately for weekdays and weekend days, "How often do you make or receive calls with your mobile phone?", and were given the following eight options, "Never", "A few times per month", "A few times per week", "Approximately once per day", "2–5 times per day", "6–10 times per day", "11–20 times per day", and "21 or more times per day". Similar response categories were provided for text and instant messages, and seven categories were presented for the daily amount of time spent talking on the phone, ranging from 0 min to 3+ hours daily.

2.2. Socio-demographic data

Demographic information, including age, sex, ethnicity (combined into "White", "Black", "Asian", "Mixed" and "Other"), and parent occupation as an indicator for socioeconomic status (SES), was captured in the SCAMP assessment. We used the Office for National Statistics classification of parental occupation into five SES levels,[1] with each child allocated the highest SES of either parent (Rose and Pevalin, 2010). To ensure sufficient numbers in each SES category and to be able to compare with earlier research (Aydin et al., 2011b), SES levels two and three, and four and five were collapsed into two SES classes,[2] thereby creating high, medium, low SES categories.

2.3. Objective mobile operator traffic data on mobile phone use

Parents of children in the SCAMP cohort may provide consent to access health and education records, as well as objective mobile traffic data from network operators. Personal details of adolescents for whom we had parental consent were sent to the network operators for data linkage. Network operators matched the personal information to mobile operator traffic data by either using (1) the adolescent's mobile phone number plus either of the adolescent or the account holder's surname, date of birth or postcode; or (2) by using the adolescent's surname, date of birth and postcode should the phone number provided by the parent be incorrect. In this study, mobile operator traffic data were presumed to be the "gold standard" for mobile phone use in line with other validation studies (e.g., Shum et al., 2011; Heinävaara et al., 2011; Abeele et al., 2013). Of the four major network operators in the UK (Ofcom, 2016), three were contacted to obtain records of mobile phone use for those adolescents whose parents had given consent.

Of 1060 parents of SCAMP adolescents who gave consent to access mobile operator traffic records, 838 provided a valid UK number for the adolescent. The remaining 222 did not use mobile phones, provided no phone number or provided an invalid UK phone number. Network operators successfully matched data for 355 adolescents (42.4%). One of the matched data were excluded from the analysis because it was a duplicate. Further, we excluded four matched numbers because self-reported mobile data were missing; therefore, data analysis was based on n = 350 as shown in Fig. 1.

Mobile network operators provided traffic data for voice calls (call date, duration, start/end times of the data period), text messages (text date, incoming/outgoing, start/end times of the data period), and mobile data use (data use in kb, date, start/end time of the data period). The three time periods for which data were provided were February-July 2016 (operator #1), June-August 2015 (operator #2), and July-August 2015 (operator #3). These windows all correspond to a 3 month period (June-July 2015, February-April 2016, and May-July 2016) and during which baseline data collection was ongoing. However, as mobile network operators in the UK retain data for three to six months only, in some cases, the mobile operator traffic data period did not overlap with the time period during which the adolescents in the sub-study self-

[1] 1 "Higher managerial, administrative and professional occupations"; 2 "Intermediate occupations"; 3 "Small employers and own account workers"; 4 "Lower supervisory and technical occupations"; and 5 "Semi-routine routine occupations".

[2] 1 "Higher managerial, administrative and professional occupations"; 2 "Intermediate occupations"; and 3 "Routine and manual occupations".