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An international prospective cohort study of mobile phone users and health (COSMOS): Factors affecting validity of self-reported mobile phone use

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ABSTRACT

This study investigates validity of self-reported mobile phone use in a subset of 75 993 adults from the COSMOS cohort study. Agreement between self-reported and operator-derived mobile call frequency and duration for a 3-month period was assessed using Cohen's weighted Kappa (κ). Sensitivity and specificity of both self-reported high (≥10 calls/day or ≥4 h/week) and low (≤6 calls/week or < 30 min/week) mobile phone use were calculated, as compared to operator data. For users of one mobile phone, agreement was fair for call frequency (κ = 0.35, 95% CI: 0.35, 0.36) and moderate for call duration (κ = 0.50, 95% CI: 0.49, 0.50). Self-reported low call frequency and duration demonstrated high sensitivity (87% and 76% respectively), but for high call frequency and duration sensitivity was lower (38% and 56% respectively), reflecting a tendency for greater underestimation than overestimation. Validity of self-reported mobile phone use was lower in women, younger age groups and those reporting symptoms during/shortly after using a mobile phone. This study highlights the ongoing value of using self-report data to measure mobile phone use. Furthermore, compared to continuous scale estimates used by previous studies, categorical response options used in COSMOS appear to improve validity considerably, most likely by preventing unrealistically high estimates from being reported.

1. Introduction

The possible adverse health effects of radiofrequency exposure from mobile phones are of considerable public and scientific interest. Overall, the balance of evidence does not suggest an excess risk, with studies on mobile phone use and cancer, primarily brain tumours, mostly reporting risk estimates close to unity (AGNIR, 2012; Ahlbom et al., 2009; Pettersson et al., 2014; Schoemaker et al., 2005; Swerdlow et al., 2011; Lahkola et al., 2006; Frei et al., 2011; Interphone Study Group, 2010), though some have reported increased risk of brain tumours among the heaviest mobile phone users when considering long-term (> 10 years) use (Interphone Study Group, 2010; Coureau et al., 2014; Hardell et al., 2013; Hardell and Carlberg, 2015; The INTERPHONE Study Group, 2011). However, the majority of these

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cancer studies are limited by their reliance on subjective, self-reported measures of telephone use in the past (Schoemaker et al., 2005; Interphone Study Group, 2010; Coureau et al., 2014; Hardell et al., 2013; Hardell and Carlberg, 2015; The INTERPHONE Study Group, 2011; Takebayashi et al., 2006; Hardell et al., 2011; Mortazavi et al., 2007; Soderqvist et al., 2008) which are prone to substantial recall error (Parslow et al., 2003; Vrijheid et al., 2006; Vrijheid et al., 2009a; Berg et al., 2005; Samkange-Zeeb et al., 2004; Pettersson et al., 2015), and are case-control studies (Interphone Study Group, 2010; Hardell et al., 2013; Hardell and Carlberg, 2015; The INTERPHONE Study Group, 2011; Hardell et al., 2011) which are also prone to recall and selection bias (Mann, 2003; Schulz and Grimes, 2002). Evidence for potential effects of mobile phone use on other health outcomes (e.g. headaches, migraines, fatigue, cognition, sleep disturbance, dizziness, hearing loss, etc) is largely based on cross-sectional studies, with inconsistent results (AGNIR, 2012; Roosli and Hug, 2011; Frei et al., 2012; Seitz et al., 2005; Baliatsas et al., 2012; Baliatsas et al., 2015).

Non-differential random error in continuous exposure measures is more likely, but not guaranteed, to bias risk estimates towards the null (Armstrong, 1998), whereas the impact of non-differential misclassification of categorical measures (Wacholder et al., 1995; Brenner and Loomis, 1994), and systematic and differential error is less predictable, and can attenuate, strengthen, or reverse a true association, or produce spurious associations (Armstrong, 1998; Drews and Greeland, 1990; Armstrong, 1990; White, 2003; Jurek et al., 2005). Non-differential random error or misclassification also reduces statistical power to detect a true association (Armstrong, 1998).

Previous validation studies have generally reported fair-to-moderate agreement between self-reported mobile phone use and mobile network operator data (Parslow et al., 2003; Vrijheid et al., 2006; Berg et al., 2005; Samkange-Zeeb et al., 2004; Pettersson et al., 2015; Schuz and Johansen, 2007; Vrijheid et al., 2009b; Funch et al., 1996; Heinavaara et al., 2011; Inyang et al., 2009), and have consistently demonstrated substantial overestimation of call duration by self-reported measures (Vrijheid et al., 2006; Samkange-Zeeb et al., 2004; Vrijheid et al., 2009b; Heinavaara et al., 2011; Inyang et al., 2009; Tokola et al., 2008; Aydin et al., 2011), particularly among the heaviest users (Vrijheid et al., 2009b). Conversely, call frequency tends to be slightly underestimated by self-reported measures (Samkange-Zeeb et al., 2004; Vrijheid et al., 2009b; Inyang et al., 2009), although some studies report overestimation for both frequency and duration (Parslow et al., 2003; Heinavaara et al., 2011). However, these findings are often based on small numbers [e.g. n < 100 (Parslow et al., 2003; Samkange-Zeeb et al., 2004; Inyang et al., 2009; Tokola et al., 2008)], and some are drawn from case-control studies of mobile phone use and risk of cancer (Samkange-Zeeb et al., 2004; Pettersson et al., 2015; Vrijheid et al., 2009b; Aydin et al., 2011), thus limiting generalizability to the general population. Moreover, it is unknown if validity differs between subgroups of the population e.g. between males and females, different age groups, users of more than one mobile phone, those experiencing symptoms when using a mobile phone, or those concerned about mobile phones/base stations and health. For such groups, both level of mobile phone use and accuracy of self-reporting may be associated, potentially resulting in differential error according to usage.

This study investigates the validity of self-reported mobile phone use, by comparing cross-sectional baseline data on self-reported and operator-derived mobile phone use (frequency and duration of calls), in a large sub-population of 75 993 adults participating in the COSMOS (COhort Study of MObile phone uSe and health) project. It also investigates, for the first time, validity among general population subgroups, e.g. those who experience symptoms during mobile phone use or have concerns related to mobile phones.

2. Participants and methods

2.1. Sampling and participants

The study design for the international prospective cohort study COSMOS has been described in detail elsewhere (Schuz et al., 2011; Toledano et al., 2015a). The target population for COSMOS was adult mobile phone users, aged 18–69 years, in 5 European countries: Denmark, Finland, the Netherlands, Sweden and the UK, and recently a 6th cohort has been initiated in France.

This analysis focuses on participants recruited into the study in Finland, Sweden and the UK between 2007 and 2010. Participants were identified by stratified random sampling (based on call time and age; in Finland and the UK also on sex) from subscriber lists of the major network operators in each country. Eligible for inclusion were those who gave permission for COSMOS to access their operator data and who answered the baseline questionnaire: comprising 13 070 participants in Finland, 50 736 participants in Sweden and 62 938 participants in the UK. We further limited the analysis to those who reported one or two mobile phone numbers (used in the last three months) which could each be matched to a single network operator (i.e. participants who switched operators within this time were excluded), and for which complete operator data were successfully obtained for the three months preceding the completion of the baseline questionnaire for these mobile phone numbers (N.B. not all mobile phone operators had been contacted at the time of compilation of data for these analyses). This left 75 993 participants (6 229, 30 874, and 38 890 from Finland, Sweden and the UK, respectively) in this analysis.

2.2. Consent and ethical approval

COSMOS was approved by the local research ethics committees in each country. Participants gave written or electronic informed consent.

2.3. Questionnaire data

The COSMOS baseline questionnaire was administered as a web-based survey (Finland and UK) and/or on paper (Finland and Sweden). It included questions on past and recent use of mobile phones, symptoms during mobile phone use, risk perception related to mobile phone use, and demographic information (Schuz et al., 2011; Toledano et al., 2015a).

2.4. Self-reported mobile phone use

Participants were asked to report frequency and duration of mobile phone voice calls for the preceding three months via the following two questions:

"Over the last three months, how often did you talk on a mobile phone?" with the response options: < 1 call per week (Finland and Sweden only; the UK web-based questionnaire filtered out these respondents in a previous question), 1–6 calls per week, 1–9 calls per day, ≥10 calls per day.

"Over the last three months, on average, how much time per week did you spend talking on a mobile phone?" with the response options: < 5 min, 5–29 min, 30–59 min, 1–3 h, 4–6 h, > 6 h.

Questionnaire response category cut-point choices were informed by distributions observed in operator data in the COSMOS pilot study, and also in the Interphone study (Interphone Study Group, 2010; Schuz et al., 2011), in order to give categories that would be distinct based on those distributions, and would also appear logical to participants. In the UK questionnaire, the highest categories were expanded to reflect high and rapidly increasing mobile phone use in the general population (i.e. "≥10 calls per day" was expanded to "10–29 calls/day" and "≥30 calls/day", and " > 6 h/week" was expanded to "7–9 h/week" and "≥10 h/week"). For this analysis, these categories were collapsed to be