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Michelle C Turner[1-4], Esther Gracia-Lavedan[1-3], Franco Momoli[5-7], Chelsea E Langer[1-3], Gemma Castaño-Vinyals[1-3,8], Michael Kundi[9], Milena Maule[10], Franco Merletti[10], Siegal Sadetzki[11,12], Roel Vermeulen[13], Alex Albert[1-3], Juan Alguacil[3,14], Nuria Aragones[3,15], Francesc Badia[1-3], Revital Bruchim[11], Gema Carretero[1-3], Noriko Kojimahara[16], Brigitte Lacour[17,18], Maria Morales-Suarez-Varela[3,19], Katja Radon[20], Thomas Remen[17], Tobias Weinmann[20], Naohito Yamaguchi[16], lisabeth Cardis[1-3]

[1] Barcelona Institute for Global Health (ISGlobal), Barcelona, Spain

[2] Universitat Pompeu Fabra (UPF), Barcelona, Spain

[3] CIBER Epidemiología y Salud Pública (CIBERES), Madrid, Spain

[4] McLaughlin Centre for Population Health Risk Assessment, University of Ottawa, Ottawa, Canada

[5] Ottawa Hospital Research Institute, Ottawa, Canada

[6] Children's Hospital of Eastern Ontario Research Institute, Ottawa, Canada

[7] School of Epidemiology and Public Health, University of Ottawa, Ottawa, Canada

[8] IMIM (Hospital del Mar Medical Research Institute), Barcelona, Spain

[9] Institute of Environmental Health, Medical University of Vienna, Vienna, Austria

[10] Unit of Cancer Epidemiology, Department of Medical Sciences, University of Turin, Turin, Italy

[11] Cancer & Radiation Epidemiology Unit, Gertner Institute, Chaim Sheba Medical Center, Ramat Gan, Israel

[12] Sackler Faculty of Medicine, Tel-Aviv University, Tel-Aviv, Israel

[13]Division of Environmental Epidemiology, Institute for Risk Assessment Sciences, Utrecht University, Utrecht, The Netherlands

[14]Research Center on Natural Resources, Health and Environment (NATURHE), Huelva University, Huelva, Spain

[15]Epidemiology Section, Public Health Division, Department of Health of Madrid, Madrid, Spain

[16]Department of Public Health, Tokyo Women's Medical University, Tokyo, Japan

[17]French National Registry of Childhood Solid Tumors, CHU, Nancy, France

[18]Inserm U1153, Epidemiology and Biostatistics Sorbonne Paris Cité Centre (CRESS), Epidemiology of Childhood and Adolescent Cancers eam (PIC A), Paris, France

[19]Área de Medicina Preventiva y Salud Pública, Universitat de Valencia, Valencia, Spain

[20]Institute and Outpatient Clinic for Occupational, Social and Environmental Medicine, University Hospital of Munich (LMU), Munich, Germany

Corresponding author: Michelle C. Turner, Barcelona Institute for Global Health (ISGlobal), Doctor Aiguader, 88, Barcelona, Spain, 08003. Tel. +34 932 147 397

Email: michelle.turner@isglobal.org

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ABSTRACT

Background: MOBI-Kids is a 14-country case–control study designed to investigate the potential effects of electromagnetic field exposure from mobile telecommunications devices on brain tumor risk in children and young adults conducted from 2010-2016. This work describes differences in cellular telephone use and personal characteristics among interviewed participants and refusers responding to a brief non-respondent questionnaire. It also assesses the potential impact of non-participation selection bias on study findings.

Methods: We compared non-respondent questionnaires completed by 77 case and 498 control refusers with responses from 683 interviewed cases and 1,501 controls (suspected appendicitis patients) in six countries (France, Germany, Israel, Italy, Japan, and Spain). We derived selection bias factors and estimated inverse probability of selection weights for use in analysis of MOBI-Kids data.

Results: The prevalence of ever regular use was somewhat higher among interviewed participants than non-respondent questionnaire respondents aged 10-14 years (68% vs 62% controls, 63% vs 48% cases); in those 20-24 years, the prevalence was ≥ 97%. Interviewed controls and cases in the 15-19- and 20-24-year age groups were more likely to have a time since start of use of 5+ years. Selection bias factors generally indicated a small underestimation in cellular telephone odds ratios (ORs) ranging from 0.96-0.97 for ever regular use and 0.92-0.94 for time since start of use (5+ years), but varied in alternative hypothetical scenarios considered.

Conclusions: Although limited by small numbers of non-respondent questionnaire respondents, findings generally indicated a small underestimation in cellular telephone ORs due to selective non-participation.

KEYWORDS: children; adolescents; brain tumors; cellular telephone use; epidemiologic methods; selection bias; case-control study

INTRODUCTION

As participation in epidemiologic studies wanes, there is increasing concern about the potential influence of non-participation selection bias impacting study findings.[1-4] There have been increasing calls for the collection and evaluation of validation data in epidemiologic studies and quantitative approaches to bias analysis in both peer-review and regulatory settings,[5,6] including examination of potential selection bias in case–control studies of weak associations.[7] In the INTERPHONE study, a 13-country case–control study, which examined the association between cellular telephone use and risk of tumors of the head and neck in adults,[8,9] participation was low, particularly among controls, and there was a higher prevalence of ever regular cellular telephone use, and an earlier start date of use, among interviewed participants compared with non-participants responding to a brief non-respondent questionnaire.[10,11] It was estimated that selective non-participation could lead to an underestimation in ever cellular telephone use odds ratios (ORs) of approximately 10%, further emphasizing the importance of bias prevention and control in such studies.[12]

This paper seeks to examine the potential impact of non-participation selection bias in the MOBI-Kids study. MOBI-Kids is a 14-country case–control study designed to investigate the potential effects of exposure to radiofrequency and extremely low frequency electromagnetic fields from mobile telecommunications devices on brain tumor risk in children and adolescents.[13] This work describes differences in cellular telephone use and personal characteristics among interviewed MOBI-Kids study participants and refusers responding to a brief non-respondent questionnaire. It also assesses the potential impact of non-participation selection bias on study findings by deriving selection bias factors under different hypothetical scenarios reflecting cellular telephone use in other non-participants without a non-respondent questionnaire. Inverse probability of selection weights were estimated based on relevant predictors of study participation for use in analysis of cellular telephone associations in MOBI-Kids.

METHODS

Study Design

Details of the MOBI-Kids study are described elsewhere.[13] Briefly, MOBI-Kids is a prospective case–control study conducted in 14 countries (Australia, Austria, Canada, France, Germany, Greece, India, Israel, Italy, Japan, Korea, New Zealand, Spain, and the Netherlands) from May 2010 through March 2016. ligible cases were recruited from neurosurgery, radiology, and oncology units from tertiary centers, were aged between 10 and 24 years residing in the study regions, and were diagnosed with a first primary eligible brain tumor (benign or malignant brain tumor except those located at the base of the skull). We verified completeness of case ascertainment through cancer registry and/or hospital discharge records where available. We excluded case participants with language difficulties (i.e. not speaking the local language) or a known genetic syndrome related to brain tumors (i.e. neurofibromatosis). We recruited case participants rapidly following diagnosis with a maximum of 12 months between the case interview and the reference date (first image with suspicion of a space occupying lesion). If an identified case was too ill to participate or had died, a proxy respondent (usually the parent) was sought.

Two hospital-based controls were recruited for each case among patients undergoing an appendectomy for suspected diagnosis of appendicitis (in an attempt to improve participation rates compared with population controls) in general and pediatric surgery departments from both smaller and tertiary hospitals with catchment areas reflecting those of the neurosurgery departments. Controls were matched by age (within 1 year of age for cases < 17 years and within 2 years of age for cases ≥ 17 years to allow for closer matching among younger participants where patterns in cellular telephone use change more rapidly with age), sex, date of surgery/interview date (within 3 months), and region of residence. These criteria were relaxed somewhat where there were difficulties in control recruitment. We did not seek a proxy for controls as the number who died or were too ill was small.

Hospital staff recruited participants, generally presenting MOBI-Kids as a study of environmental risk factors including communication technologies in an attempt to minimize possible selection bias by cellular telephone use. thics approval was obtained from all appropriate national or local research ethics boards and written informed consent was obtained prior to the study interview.

A total of 899 (72%) out of 1,257 eligible cases and 1,910 (54%) out of 3,539 eligible controls agreed to participate and completed the study interview (able 1). The main reasons for non-participation among both cases and controls were refusal (14% and 27% respectively) and inability to trace (12% and 18% respectively). There were also a small number of participants that did not participate due to medical refusal (n = 10), had died or were too ill and there was no proxy (n = 15), or another reason (n = 63) (i.e. unknown reason, data loss).

Data ollection

Trained interviewers generally interviewed participants in person. The main study questionnaire captured detailed data on demographics, history of communication technology use, medical history, and other factors. We only considered participants reporting ever having made or received on average at least one call per week for at least three months to be ever regular users; they completed the detailed cellular telephone history questionnaire, which included questions regarding when they started using their phone (year and month, or if they could not recall a range, season, or age was provided), whether they still use the phone (i.e. current regular user), and if they had stopped, a stop year and month (or a range, season, or age). Participants were also asked to provide the average length of time spent making and receiving calls in the last three months during which they were using their current phone (or last phone if a former user) among other factors. Parents or guardians helped to complete the questionnaire for younger participants.

Non-Respondent Questionnaire

Interview refusers, including proxies, were asked to complete a brief non-respondent questionnaire, where the ethics committee allowed, to examine whether they differed from interviewed participants according to cellular telephone use or other personal characteristics. These questionnaires were generally completed with a trained interviewer either in person or by phone directly following participant refusal, though in some cases they were self-completed at home and returned by mail (eAppendix 1; http://links.lww.com/ED /B420). The non-respondent questionnaire captured: whether they were ever a regular user (ever having made or received on average at least one call per week for at least three months) (yes/no), start year of use (or range), if they were still using a phone regularly (yes/no), and the average length of time spent making and receiving calls in the last three months during which they were using their phone (for both current and former users) as well as sex, age, and maternal education level (high school or less, medium level technical/professional school, university/post-graduate, other). For interviewed non-respondent questionnaire respondents, we also captured person interviewed (index subject, parent, other), place of interview (hospital, home, other), and responsiveness of person interviewed (not at all, fairly, or very co-operative, responsive and interested). Three study countries (Austria, Greece, and India) did not collect non-respondent questionnaires. In five countries (Australia, Canada, Korea, New Zealand, and the Netherlands) only a limited number of non-respondent questionnaires were collected (n < 10) and were not examined here. Results are based on the remaining six study countries (France, Germany, Israel, Italy, Japan, and Spain) representing the majority of the interviewed MOBI-Kids study population (76% of cases and 79% of controls).

Statistical Analysis

Cellular Telephone Use

We compared the percentage of ever regular cellular telephone use and time since start of use of 5+ years (as an indicator of longer-term use) between interviewed participants and refusers responding to the non-respondent questionnaire among both cases and controls. Multivariable logistic regression models were used to examine whether associations of interviewed status (interviewed participant vs non-respondent questionnaire) and either ever use or time since start of use (5+ years) varied by case/control status, age group, or country.

Selection Probabilities and Bias Factors

We estimated selection probabilities for cases and controls according to ever regular cellular telephone use and time since start of use (5+ years) in order to derive selection bias factors with which to estimate the magnitude of the potential impact of nonparticipation selection bias on cellular telephone associations in MOBI-Kids according to the methodology used in INTERPHONE.[11] Eligible study participants were classified into four categories: 1) interviewed participants (i.e. completed the full study interview); 2) non-participants who refused to participate but completed the non-respondent questionnaire; 3) non-participants who refused to participate and did not complete the non-respondent questionnaire; and 4) non-participants for other reasons (i.e. unable to trace, medical refusal, etc.) (eAppendix 2 and 3; http://links.lww.com/EDE/B420).

Since data on cellular telephone use was only available for the first two categories of participants, namely 1) interviewed participants and 2) refusers with a non-respondent questionnaire, cellular telephone use was imputed for both 3) refusers without a non-respondent questionnaire and 4) non-participants for other reasons according to the following hypothetical scenarios:

a) using a weighted mean of responses among interviewed participants and refusers with a non-respondent questionnaire;

b) applying non-respondent questionnaire response frequencies to refusers without a non-respondent questionnaire, then for other non-participants, using a weighted mean of responses among interviewed participants and refusers;

c) applying non-respondent questionnaire response frequencies to both refusers without a non-respondent questionnaire and other non-participants;

d) assuming refusers without a non-respondent questionnaire and other non-participants had more extreme differences in use from interviewed participants than non-respondent questionnaire respondents including scenarios of both lower or;

e) greater prevalence of use.

f) Finally, a reference scenario was also considered assuming all refusers and other non-participants had the same pattern of use as interviewed participants.

We derived selection bias factors in terms of selection ORs applying either the same scenario to both cases and controls or different scenarios. For each scenario, we calculated selection ORs as follows: $(S1_a S0_b)/(S0_a S1_b)$, where $S1_a$ represents the selection probability of participating in the full study interview for cases who were ever regular cellular telephone users (or had a time since start of use of 5+years) and $S1_b$ for controls; $S0_a$ for cases who were never regular cellular telephone users (or had a time since start of use of < 5 years); and $S0_b$ for controls.[11,14] Selection bias factors of 1.0 represent no selection bias, whereas those < 1.0 represent the magnitude of the underestimation in the observed OR due to selective non-participation, and those > 1.0 the magnitude of the overestimation.

Inverse Probability of Selection Weights

Inverse probability of selection weights were estimated using data from the six included study countries here for application to all interviewed MOBI-Kids participants in an attempt to account for non-participation selection bias in analysis of cellular telephone associations in the full study population in a multivariable manner. We estimated the weights using mixed effects logistic regression models with random country intercepts. First, age-adjusted associations of interviewed status (vs non-respondent questionnaire) with case or control status, sex, maternal education, ever regular cellular telephone use, current cellular telephone use, time since start of use (years), and average length of calls in the last three months during which they were using their phone (min/week) were examined. An initial multivariable model was then fit including predictors significant at the $p < 0.20$ level. In the final model, predictors significant at the $p < 0.05$ level were retained and interactions between all included variables were examined on the multiplicative scale. The functional form of age (continuous) was assessed using generalized additive models and was not found to deviate from linearity (not shown). We then extended the population considered in the final multivariable model to include refusers without a non-respondent questionnaire and other non-participants in order to derive inverse probability of selection weights based on the full eligible study population (i.e. interviewed status vs all non-participants). We used different hypothetical scenarios to impute missing data on cellular telephone use by age group as only data on case/control status and age were available for refusers without a non-respondent questionnaire and other non-participants here. We also assessed the significance of including a random country effect for each included model variable. We then derived the inverse probability of selection weights from the inverse of the fitted values of the regression models, using the individuals' probability of selection from an intercept only model as the numerator to stabilize the weights, and were then applied to participants in all 14 study countries. Statistical analysis was conducted using Stata version 12.1 and R version 3.3.[15,16]

RESULTS

Among the 127 case refusers in the six included study countries, 61% (n = 77) completed the non-respondent questionnaire (eFigure 1; http://links.lww.com/EDE/B420). Among 788 control refusers, 63% (n = 498) completed the non-respondent questionnaire. Non-respondent questionnaires were completed only by interview refusers and not by other types of non-participants (i.e. unable to trace, medical refusal, etc.). We compared non-respondent questionnaires completed by the 77 case and 498 control refusers with responses from 683 interviewed cases and 1,501 controls (suspected appendicitis patients) in the six countries. The distribution of responses by respondent type is presented in eAppendix 4; http://links.lww.com/EDE/B420. The total number of non-respondent questionnaires ranged from 37 in Japan to 158 in Spain. There were more males among non-respondent questionnaire cases than interviewed cases. Non-respondent questionnaire controls tended to be older than interviewed controls and had a lower maternal level of education.

Cellular Telephone Use

The prevalence of ever regular use was generally similar among interviewed and non-respondent questionnaire controls ranging from 92%-98% in the 15-19 and 20-24 year age groups (Table 2). In the youngest 10-14 year age group, the prevalence of ever regular use was somewhat higher among interviewed (68%) vs non-respondent questionnaire (62%) controls. The prevalence of ever regular use was also similar among interviewed and non-respondent questionnaire cases ranging from 97%-100% in the 20-24 year age group, whereas it was somewhat higher among interviewed vs non-respondent questionnaire cases in both the 15-19 (95% vs 89%) and 10-14 (63% vs 48%) year age groups.

Interviewed controls were more likely to have a time since start of use of 5+ years than non-respondent questionnaire controls in both the 15-19 (64% vs 47%) and 20-24 (94% vs 88%) year age groups (Table 2). A similar finding was also observed among cases (66% vs 37% 15-19 year age group and 94% vs 82% 20-24 year age group). Fewer cases or controls in the 10-14 year age group had a time since start of use of 5+ years. Associations of interviewed status and either ever use or time since start of use (5+ years) were not found to vary by case/control status, age group, or country ($p > 0.05$). Selection Probabilities and Bias Factors

Scenarios of cellular telephone use among refusers and other non-participants without a non-respondent questionnaire for both cases and controls are presented in eAppendix 2 and 3; http://links.lww.com/EDE/B420. The ratios of selection probabilities according to both ever use and time since start of use (5+ years) were small but somewhat greater among controls than cases for each of the different scenarios examined, due to differences in study participation rates.

Table 3 presents selection ORs estimated for various combinations of scenarios of cellular telephone use among cases and controls. For ever regular use, selection ORs ranged from 0.96-0.97, applying non-respondent questionnaire results to non-respondent questionnaire respondents only (Aa), all refusers (Bb), or all non-participants (Cc) using the same scenario for both cases and controls. Selection ORs ranged from 0.92 (Ca) – 1.00 (Ac) applying different combinations of these scenarios to cases and controls. The largest selection bias factors were observed with assumptions of larger differences in use among non-participants without a non-respondent questionnaire, ranging from 0.73 under a scenario of 10% less use among refusers and other non-participating controls without a non-respondent questionnaire and 10% greater use among cases (De) to 1.34 under the opposite scenario (Ed).

For time since start of use of 5+ years, selection ORs ranged from 0.92-0.94 under scenarios Aa, Bb, or Cc, applying the same scenario to both cases and controls and 0.86 (Ca) - 1.00 (Ac) applying different combinations of these scenarios. The largest selection bias factors, of 0.76 and 1.16, were obtained with assumptions of larger differences in use among refusers and other non-participants without a non-respondent questionnaire (scenarios De and Ed (as well as Rd) respectively). Inverse Probability of Selection Weights

Age-adjusted associations of interviewed status (vs. non-respondent questionnaire) with various individual demographic and cellular telephone use characteristics are presented in Table 4. Variables retained in the final multivariable model included age, case or control status, and, due to collinearity, a combined time since start of use (years) and average weekly length of calls variable (min/week), collapsing the 5-9 and 10+ years time since start of use categories. There was no evidence for interactions between any included model variables ($p > 0.05$), though an interaction term between case/control status and the combined cellular telephone use variable was forced into the model to allow for differential participation by cellular telephone use history. Lastly, a random country effect for case/control status was also included in the final model ($p < 0.05$) (eAppendix 5; http://links.lww.com/EDE/B420).

Upon extending models to include all refusers and other non-participants without a non-respondent questionnaire, ORs were largely similar across the different model scenarios, imputing missing data on cellular telephone use history by age group. The best model fit, according to the Akaike Information Criterion (AIC), was for scenario C, imputing missing cellular telephone use history data according to the distribution among non-respondent questionnaire respondents. Mean stabilized inverse probability of selection weights estimated for interviewed participants in all 14 MOBI-Kids study countries were 1.09 for controls and 0.80 for cases and ranged from 0.60-1.71 in Scenario A to 0.58-2.31 in Scenario C (eAppendix 6; http://links.lww.com/EDE/B420). Inverse probability of selection weights were also estimated in an alternative model including only time since start of use (years) rather than the combined time since start of use (years)/average weekly length of calls (min/week) variable, since data on average length of calls represents use in the previous three months, which may be affected by the developing tumor in cases, with a similar distribution of inverse probability of sampling weights obtained (eAppendix 7 and 8; http://links.lww.com/EDE/B420).

Table 5 presents an example of the weighted distribution of ever use and time since start of use of 5+ years by age group in the six included countries here. There were only small changes in the distribution of cellular telephone use observed.

DISCUSSION

This paper sought to describe differences in cellular telephone use and personal characteristics among interviewed participants and refusers responding to a non-respondent questionnaire as well as the potential impact of non-participation selection bias in MOBI-Kids. The prevalence of ever regular use was generally similar among controls and cases completing either the full study interview or the non-respondent questionnaire in the 15-19 and 20-24 year age groups, whereas in the 10-14 year age group, it was somewhat higher among controls and cases completing the full study interview (68% vs 62% for controls and 63% vs 48% for cases). Interviewed controls and cases, particularly in the 15-19 year age group, were more likely to have a time since start of use of 5+ years (64% vs 47% for controls and 66% vs 37% for cases). Selection bias factors ranged from 0.96-0.97 for ever regular use and 0.92-0.94 for time since start of use of 5+ years applying non-respondent questionnaire results to either non-respondent questionnaire respondents only (Aa), all refusers (Bb), or all non-participants (Cc) for both cases and controls indicating a potential 3%-4% and 6%-8% downward bias in cellular telephone ORs respectively. Although there were somewhat stronger selection ORs with a time since start of 5+ years, possibly suggesting greater differential non-participation among longer-term users, supplemental analysis examining selection bias factors according to increasing time since start of use categories, from 1+ through 10+ years, for these same scenarios (Aa, Bb, and Cc) generally revealed similar findings, though with somewhat stronger bias factors with either 4+ to 5+ years since start of use observed (eAppendix 9; http://links.lww.com/EDE/B420) paralleling greater differences in use between interviewed and non-respondent questionnaire participants (P2/P1 ratio), particularly in the younger 10-14 and 15-19 year age groups. There were fewer users with longer times since start of use, largely in the 20-24 year age group, and somewhat smaller differences in use between interviewed and non-participating subjects resulting in more limited differences in selection probabilities by use category. Findings in INTERPHONE suggested a more recent time of start of use among non-participating cases and controls.[11]

Selection bias factors also varied and were larger when applying different scenarios of use among refusers and other nonparticipants without a non-respondent questionnaire to cases and controls and were sometimes >1.0 including in scenarios assuming bias among nonparticipating cases only but not controls, or in more extreme scenarios of use among nonparticipating cases. However, differences in use among interviewed and non-respondent questionnaire participants were generally similar by case and control status here.

Potential nonparticipation selection bias was examined in other studies of cellular telephone use. A greater prevalence of regular cellular telephone use among participating than non-participating controls was reported in a study of uveal melanoma risk.[17] In the EFALO study of adolescent brain tumors, there were higher participation rates in both cases (83%) and controls (71%), and only minor differences in participation among cellular telephone users and non-users.[18]

Strengths of this study include the collection of data on personal and cellular telephone use characteristics from study refusers with which to examine potential non-participation selection bias and to estimate inverse probability of selection weights for use in analysis of cellular telephone associations in the MOBI-Kids study. Limitations include small numbers of non-respondent questionnaire respondents (n = 77 cases and 498 controls). Although a substantial effort was made to maximize non-respondent questionnaire completion rates, the small number of these questionnaires, particularly among cases, limits our assessment of potential non-participation selection bias here, including in the estimation of inverse probability of selection weights. Although non-respondent questionnaires were completed by a majority of refusers in included countries here (61% and 63% of case and control refusers respectively), they may differ from other refusers and non-participants, including those in the other eight MOBI-Kids study countries, in unpredictable ways.[19] Reasons for non-participation and willingness to complete the non-respondent questionnaires are also likely different for case and control participants, with cases possibly more likely to refuse due to reasons surrounding the seriousness of a brain tumor diagnosis, whereas controls may simply be less interested or distracted. As such, selection ORs were examined in different scenarios of hypothetical use among other non-participants without a non-respondent questionnaire. There was also little evidence for differential non-participation in inverse probability of selection weight modeling with interaction terms between case or control status and cellular telephone use weak and non-significant. There were only small changes in the distribution of personal and cellular telephone use characteristics following application of inverse probability of selection weights to interviewed cases and controls, indicating their likely impact on overall study findings is likely to be modest.

There was limited data collected from non-respondent questionnaire respondents; as such it is possible that there may be other unmeasured factors that may influence study participation not captured here.[20] Data on average length of calls represents use in the previous three months, and may not reflect longer-term use patterns. There was also no data on changes in cellular telephone use over time or on stop year for former users. Included cases here (both interviewed and non-respondent questionnaire responders) were somewhat more likely to be former users (6%) than controls (3%). There was also no data on age or cellular telephone use history of the parent(s).

There are also differences in interview characteristics which may affect the quality and accuracy of responses. Responses may differ as to whether the participant completed the lengthy full study or brief non-respondent questionnaire interview. Interviewed participants were more likely to be interviewed in person either in the hospital (58% interviewed cases, 53% interviewed controls) or at home (33% interviewed cases, 32% interviewed controls) while non-respondent questionnaire respondents were more likely to complete the questionnaire in another location (i.e. telephone interview, self-complete the questionnaire at home) (66% non-respondent questionnaire cases, 76% non-respondent questionnaire controls). Non-respondent questionnaire respondents were also more likely to be considered uninterested or not at all co-operative or responsive (10% of non-respondent questionnaire cases and 17% of non-respondent questionnaire controls) than interviewed participants (2% interviewed cases and controls) by the study interviewer. However, results were similar when excluding such participants from analysis (not shown). There was also no data on brain tumor histology available for non-participating cases, as this data was only captured during the full study data collection process.

We did not consider here other sources of bias, including recall bias,.[18,21,22] Recall and motivation may differ between interviewed participants and non-respondent questionnaire respondents.[23] A related validation study, MOBI-Expo, comparing questionnaire responses to recorded data on use based on software-modified smartphones reported that participants tended to underestimate number of calls but overestimate call duration (min/week).[24] A similar pattern was also observed in INTERPHONE.[22] Another validation study using operator records for number and length of calls for consenting participants was also conducted as part of MOBI-Kids and is currently being analyzed.[13] Further work to account for both recall and selection biases, including in probabilistic multiple-bias modelling, may be useful.[25,26]

Last, this study examines only one possible source of selection bias, namely non-participation selection bias. There may also be some sort of bias due to the largely hospital-based nature of the study, both in cases due non-participating hospitals and limitations in accessing eligible participants and in the use of suspected appendicitis controls possibly limiting the representativeness of included participants.[13] Though we used appendicitis patients in an attempt to improve control participation rates, control participation remained low here with 54% of eligible controls completing the study interview, similar to that of INTERPHONE.[11] Control participation, however, was greater among hospital controls in Germany, the only country that also recruited population controls.[13] Although we assume that appendicitis patients are representative of the general population, and that appendicitis is unrelated to both socioeconomic status as well as use of mobile telecommunications devices, selection bias factors should be interpreted with caution should by chance this be found to differ.

In conclusion, although results were limited by small numbers of non-respondent questionnaire respondents, selection bias factors for both ever regular use and time since start of use of 5+ years generally indicated a small underestimation in cellular telephone ORs. We estimated inverse probability of selection weights in an attempt to account for non-participation selection bias in analysis of MOBI-Kids.

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Table 1. Definition and description of participants and non-participants, MOBI-Kids.

Category	Definition	Controls n (%)	Cases n (%)
Target population	All identified eligible subjects	3,539 (100)	1,257 (100)
Participant	Subject (or proxy) completed the full interview and is included in main MOBI-Kids analysis	1,910 (54)	899 (72)
Non-participant	Subject (or proxy) did not complete the full interview and is not included in the main MOBI-Kids analysis	1,629 (46)	358 (28)
Reason for non-participation			
Refusal	Subject or parent refused participation	952 (27)	173 (14)
Unable to trace	Subject could not be traced, including no answer after numerous attempts to contact	629 (18)	145 (12)
Other	Reason unknown, data lost etc.	47 (1)	16 (1)
Dead or too ill	Subject was dead or too ill to be interviewed and there was no proxy	1 (0)	14 (1)
Medical refusal	Medical doctor did not allow access to the subject	0 (0)	10 (1)

Table 2. Cellular telephone use among interviewed participants and NRQ respondents, MOBI-Kids, France, Germany, Israel, Italy, Japan, and Spain.

	Controls				Cases			
Age Group (years)	Interviewed		NRQ		Interviewed		NRQ	
Ever Regular Use	Total (n)	Phone Users (%)	Total (n)	Phone Users (%)	otal (n)	Phone Users (%)	Total (n)	Phone Users (%)
10-14	519	68	130	62	256	63	21	48
15-19	532	92	156	94	230	95	19	89
20-24	442	98	181	98	197	97	18	100
Total	1,493	86	467	86	683	84	58	78
Time Since Start of Use	Total (n)	5+ Years (%)	Total (n)	5+ Years (%)	Total (n)	5+ Years (%)	Total (n)	5+ Years (%)
10-14	519	11	128	9	256	12	21	10
15-19	532	64	154	47	230	66	19	37
20-24	442	94	178	88	197	94	17	82
Total	1,493	55	460	52	683	54	57	40

Note: The sum does not equal the total due to missing data. Where a range was reported (for year of start of use) the mid-point was used. NRQ indicates non-respondent questionnaire.

Table 3. Selection ORs for cellular telephone use among various usage scenarios for cases and controls, MOBI-Kids.

Control Scenarios		Case Scenarios					
Ever Regular Use vs Never Regular Use		r	a	b	c	d	e
R	Reference	1.00	1.02	1.03	1.06	1.14	0.90
A	NRQ applies to refusers with NRQ, weighted mean of responses among interviewed participants and refusers with a NRQ for other non-participants	0.95	0.97	0.98	1.00	1.08	0.85
B	NRQ applies to all refusers, weighted mean of responses among interviewed participants and refusers with and without a NRQ for other non-participants	0.93	0.95	0.96	0.98	1.05	0.83
C	NRQ applies to all nonparticipants	0.90	0.92	0.93	0.96	1.03	0.81
D	NRQ applies to refusers with NRQ, 10% less use in other nonparticipants	0.81	0.82	0.83	0.85	0.92	0.73
E	NRQ applies to refusers with NRQ, 10% more use in other nonparticipants	1.18	1.20	1.21	1.25	1.34	1.06
Time Since Start of Use 5+ Years vs < 5 Years		r	a	b	c	d	e
R	Reference	1.00	1.04	1.06	1.11	1.16	0.99
A	NRQ applies to refusers with NRQ, weighted mean of responses among interviewed participants and refusers with a NRQ for other non-participants	0.91	0.94	0.96	1.00	1.06	0.90
B	NRQ applies to all refusers, weighted mean of responses among interviewed participants and refusers with and without a NRQ for other non-participants	0.87	0.91	0.92	0.97	1.02	0.86
	NRQ applies to all nonparticipants	0.83	0.86	0.88	0.92	0.97	0.82
D	NRQ applies to refusers with NRQ, 30% less use in other nonparticipants	0.77	0.80	0.82	0.86	0.90	0.76

E	NRQ applies to refusers with NRQ, 10% more use in other nonparticipants	0.99	1.03	1.05	1.10	1.16	0.98

NRQ indicates non-respondent questionnaire. OR indicates odds ratio. Case scenarios are defined using the same definitions as the corresponding control scenario.

Table 4. Age-adjusted associations of interviewed status (vs. NRQ) with individual demographic and cellular telephone use characteristics, MOBI-Kids, France, Germany, Israel, Italy, Japan, and Spain.

Characteristic	n	OR (95% CI)
Status		
Control	1,981	Ref.
Case	754	3.27 (2.51-4.28)
Sex		
Male	1,522	Ref.
Female	1,212	1.12 (0.93-1.36)
Age (Years)	2,735	0.96 (0.93-0.98)
Maternal Education		
High school or less	1,105	Ref.
Medium level tech./prof. school or University/post-graduate	1,330	1.22 (0.99-1.51)
Other/missing	300	0.55 (0.41-0.74)
Ever Regular Cellular Telephone Use		
Never	403	Ref.
Ever	2,298	1.36 (1.00-1.83)
Current Cellular Telephone Use		
No	514	Ref.
Yes	2,179	1.04 (0.79-1.37)
Time Since Start of Use (Years)		
Never Regular Use	403	Ref.
1-4	844	1.11 (0.81-1.51)
5-9	998	2.38 (1.66-3.42)
10+	448	3.18 (1.99-5.08)
verage Length of Calls (Min/Week)		
Never Regular Use	403	Ref.
<60	1,161	1.67 (1.22-2.29)
60+	1,107	1.21 (0.86-1.70)

Note: The sum does not add up to the total due to missing data. Where a range was reported (for both year of start of use and average length of calls) the mid-point was used. ORs (95% CIs) from mixed effects logistic regression models with a random country intercept and adjusting for age. Average length of calls represents average length of time spent making and receiving calls in the last three months during which they were using their phone. NRQ indicates non-respondent questionnaire, OR odds ratio, CI confidence interval

Table 5. Cellular telephone use among interviewed participants following application of IPSWs, MOBI-Kids, France, Germany, Israel, Italy, Japan, and Spain.

	Controls						Cases					
Age Group (years)	Interviewed		IPSWs 1 Scenario C		IPSWs 2 Scenario C		Interviewed		IPSWs 1 Scenario C		IPSWs 2 Scenario C	
Ever Regular Use	Total (n)	Phone Users (%)	Total (n)	Phone Users (%)	Total (n)	Phone Users (%)	otal (n)	Phone Users (%)	otal (n)	Phone Users (%)	Total (n)	Phone Users (%)
10-14	519	68	533	66	533	67	256	63	199	63	198	63
15-19	532	92	571	91	574	91	230	95	183	94	181	94
20-24	442	98	525	97	518	97	197	97	161	97	164	97
Total	1,493	86	1,629	85	1,625	85	683	84	544	83	544	84
Time Since Start of Use	Total (n)	5+ Years (%)	Total (n)	5+ Years (%)	Total (n)	5+ Years (%)	Total (n)	5+ Years (%)	Total (n)	5+ Years (%)	Total (n)	5+ Years (%)
10-14	519	11	533	9	533	9	256	12	199	11	198	11
15-19	532	64	571	58	574	59	230	66	183	61	181	61
20-24	442	94	525	92	518	92	197	94	161	93	164	93
Total	1,493	55	1,629	53	1,625	53	683	54	544	52	544	52

Note: The sum does not equal the total due to missing data. Where a range was reported (for year of start of use) the mid-point was used. IPSWs 1 refer to eAppendix 5 and 6 and IPSWs2 eAppendix 7 and 8. IPSW indicates inverse probability of selection weight.