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Cohort Profile

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Cohort Profile: UK COSMOS—a UK cohort for study of environment and health

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Why was the cohort set up?

The United Kingdom COhort Study of MObile phone uSe and health (UK COSMOS) is a prospective cohort study established to investigate the possible health effects associated with long-term use of mobile phones and other wireless technologies, to inform public health policy in the UK and beyond. UK COSMOS is part of the international COSMOS cohort study consortium (the UK, Sweden, The Netherlands, Finland, Denmark and France) on mobile phones and health, which has over 300 000 study participants across the six partner countries.[1] Details of consortium partners are given at [www.ukcosmos.org]. A large prospective cohort study of mobile phone users with long-term follow-up has been recommended as a high priority by the World Health Organization.[2,3] This reflects both scientific uncertainty and public concern regarding possible health effects of mobile phone use. Radiofrequency electromagnetic fields have recently been classified as possibly carcinogenic to humans (Group 2B) on the basis of limited evidence concerning risk of brain cancers.[4] Results from the Interphone study, the largest case-control study on brain cancer to date, suggested possible increased risks of glioma at the highest levels of mobile phone use, but interpretation was unclear and the possible health effects of long-term heavy use of mobile phones remain uncertain.[5] The COSMOS study was designed to investigate this question while addressing limitations of previous studies. Its cohort study design, with prospective exposure assessment, is less prone to potential selection and recall biases associated with case-control studies such as Interphone. Unlike the case-control approach, it addresses a wide range of disease outcomes of importance for public health in one investigation, including neurodegenerative disease, stroke and depression which have rarely been studied; previous studies have focused on few outcomes, mainly tumours of the brain and head.

Large long-term cohort studies have huge potential to increase understanding of environmental exposures and disease and thus improve the health of current and future generations, but require sustained investment from funders and continued involvement by participants. To maximize the value of this investment and the benefit to public health, UK COSMOS is not only collecting data to address the question of mobile phones and health, but also has obtained extensive data on wider environmental exposures, lifestyle and demographics, so as to address a wide range of environment and health questions.

With over 100 000 participants, UK COSMOS is the UK's fourth largest cohort study[6] and the largest cohort in the international COSMOS consortium. The UK COSMOS study protocol and subsequent amendments

were approved by the North West Haydock Research Ethics Committee (ref. 08/H1010/90). Participants gave electronic written informed consent before taking part in the study.

Who is in the cohort?

The UK COSMOS cohort recruited 105 028 men and women aged 18 years or over at baseline, from across the UK (Figure 1). Participants were recruited between 2009 and 2012 from two primary sampling frames: 65% from mobile phone subscriber lists (stratified random sampling by call time, age and sex, with oversampling for low and high call time groups, in order to maximize exposure contrasts and ensure sufficient participants in each age band), and 35% from the UK edited electoral register. The former was chosen to be broadly representative of the adult mobile phone user population but, given the widespread use of mobile phones, both will probably have achieved this. There were no exclusion criteria except being aged under 18. People who said they did not use a mobile phone at all were as welcome as those who did, as a range of exposure is required. The vast majority (99%) of study invitations were by letter (with one reminder letter to non-responders) and 1% were SMS (text message) invitations. Of ~3.1 million people invited to take part in the UK, ~105 000 participated at baseline, giving a response rate of 3.4% (Table 1).

Of the ~105 000 participants, 92% are of White ethnicity, compared with 86% White ethnicity in England and Wales[7] and 52% are women. The cohort spans the socioeconomic spectrum, although the highest socio economic class, 'managerial and professional occupations', is over-represented (66%); 53% were married or in a civil partnership (data not shown). Participants are relatively well educated, with 39% educated to degree level. UK COSMOS participants appear to be healthier than the UK adult general population; 13% are current smokers compared with 20% smoking prevalence in Great Britain in 2012,[8] and prevalence of obesity is 19% for men and 18% for women in UK COSMOS compared with 23.6% for men and 25.9% for women in England in 2013.[9] Women tended to lower levels of heavy physical activity in both leisure and work time compared with men, but distributions for sedentary activity were similar by sex (Table 2).

In terms of mobile phone use, to date over 50% have regularly used a mobile phone for at least 15 years, 12% make 10 or more mobile phone calls per day (compared with 19% of the UK population)[10] and 18% spend 4 h or more per week on mobile phone calls (Table 2). Men tend towards earlier first use of a mobile phone, higher frequency of mobile phone calls, higher mobile data use (not shown) and lower text message use (not shown) at baseline compared with women, whereas women tend towards longer duration talking on cordless phones (not shown) compared with men (Table 2).

Almost everyone (97%) recruited gave broad consent for record linkage and follow-up (Table 1). We analysed key characteristics according to whether participants gave consent or not, and extent of baseline questionnaire completion (Table S1, available as Supplementary Data at *IJE* online). Those withholding consent were slightly older, included slightly higher proportions of Asian (4.9%) and Black ethnicities (3.2%) compared with those who consented (3.1% and 2.0%, respectively) and were less likely to be educated to degree level (29.9% vs 39.1% of consenters); and a lower proportion rated their general health as good or better (86.8%) compared with those who consented (91.8%) (Table S1).

In all 86% of participants fully completed the baseline questionnaire, i.e. reached the end of the web-based questionnaire. There were differences in smoking and education between completers and non-completers (Table S1).

Non-responders cannot be described because for confidentiality reasons we did not have access to the lists of mobile phone subscribers who were invited. These were processed by a third party, as part of our data provision agreement with mobile phone network operators. In addition, the edited electoral register provides only name and address data, so we have no additional demographic data with which to profile non-responders from this sampling frame.

How often have they been followed up?

Direct follow-up with participants

Participants completed a baseline questionnaire at recruitment. To maintain participant interest and minimize attrition between baseline and follow-up questionnaires, we contact participants annually via e-mail to ask for a confirmation/update of contact details via a web-based participant portal, and we provide an annual newsletter. In such a large study, ongoing engagement with participants via postal routes is prohibitively expensive.[11] By collecting e-mail addresses and mobile phone numbers at baseline, we have multiple contact routes to follow up individuals who have moved and not updated address details. Participants will undertake a follow-up web-based questionnaire in 2016. For this, we intend to first contact participants via e-mail, with non-responders subsequently being contacted by letter.

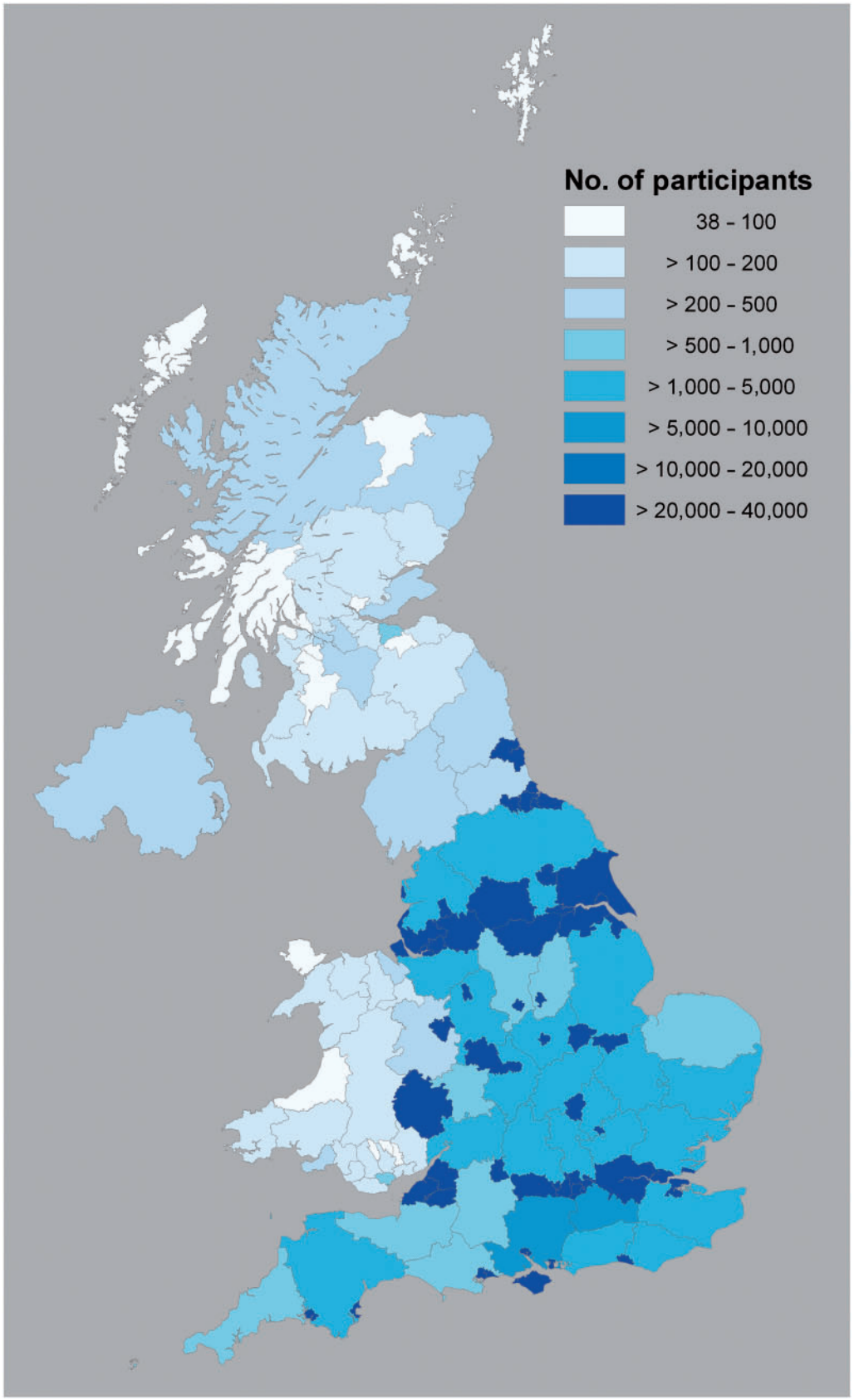

Figure 1. Number of participants by UK county.

Table 1. Participation at initial recruitment and follow-up in UK COSMOS

	Total *N*	Response rate (% of invitations)	% of participants recruited, consenting or logging in[a]	*N* (% of consenting participants)	
				Recruited 2010 from mobile subscriber lists	Recruited 2012 from UK edited electoral register
No. of invitations (*N*)[b]	3 099 704				
Adverse reaction[c]	17	0.0005			
No. of participants (*N*)					
With broad consent for record linkage and follow-up[d]	101 540	3.3	96.7		
Questionnaire only[e]	2266		2.2		
Registration only	1222		1.2		
Total	105 028	3.4			
Questionnaire completion (*N*)					
Not started	5268		5.0		
Started but not completed	9350		8.9		
Completed	90 074		85.8		
Withdrawals (no further use)[f]	281		0.3		
Annual traffic data matching[g]					
2010	60 410		91.0[a]	60 410 (91%[h])	-
2011	61 288		92.0[a]	61 288 (91%)	-
2012	80 913		80.0[a]	57 710 (87%)	23 178 (66%[i])
2013	80 394		79.0[a]	56 841 (84%)	23 532 (67%)
Annual follow-up					
Login to update portal	32 522		31.0		
Change of name/contact details	11 035		34.0[a]		

[a]Denominator for percentages is total participants recruited ($N = 105\ 028$), except for 'Annual traffic data matching' where the denominator is participants who gave consent ($N = 101\ 540$), and for 'Change of name/contact details' where the denominator is participants who have ever logged in to the update portal ($N = 32\ 522$).

[b]Number of invitations actually received, opened and read may be lower, e.g. if invitation is returned to sender.

[c]Adverse reaction is classified as receiving an irate response from an individual sent a study invitation or reminder invitation via post, SMS or e-mail.

[d]Broad consent allowing access to and long-term storage of information about participant mobile phone use from mobile network operators, and participant medical and other health-related records.

[e]Participants agreed to complete questionnaire, but did not give consent for access to information about mobile phone use from their mobile network operators or their medical and other health-related records.

[f]The numbers given here are for withdrawal option 3, where individuals requested no further use of their data. Participants selecting one of the two other categories of withdrawal (1, no further contact; 2, no further access) are still counted as cohort participants.

[g]Matching defined as at least one mobile phone number belonging to participant being matched to network operator data.

[h]Denominator for percentage is $N = 66\ 723$ consenting participants recruited in 2010, who were sent for matching.

[i]Denominator is $N = 35\ 105$, i.e. those consenting participants recruited in 2012 who were sent for matching.

Response to follow-up

Overall, 31% have responded to the annual request to check and update personal and mobile phone details by ever logging into the UK COSMOS participant update portal (2011–15) (Table 1). Of these, 34% have changed one or more name or contact details (e.g. address, mobile phone number, e-mail address) (Table 1). Those responding tend to be older and more likely to be educated to degree level (48.1% vs 34.1% of non-responders). In contrast, non-responders include a slightly higher proportion of current smokers (14.2% vs 9.1% of responders) and non-White ethnicities. One caveat is that response may be related to a change such as moving address, which in turn is related to, for example, age and socioeconomic factors.[12,13]

Passive follow-up via record linkage

Linkage to health records for long-term health follow-up is in process for mortality records, cancer registrations, hospital episode data via the Health and Social Care Information Centre (HSCIC) for England and Wales,

Table 2. Baseline characteristics

	Overall		Men		Women	
	($N = 104\,692$[a])		($N = 49\,557$[a], 47.3%)		($N = 54\,823$[a], 52.4%)	
	N	%[b]	*N*	%[b]	*N*	%[b]
Age (years)						
18–30	23 386	22.4	10 008	20.3	13 341	24.4
31–59	59 885	57.4	27 459	55.6	32 246	59.1
60+	20 970	20.1	11 890	24.1	9017	16.5
Missing	451	—	200	—	219	—
Ethnicity						
White	83 163	92.2	39 096	91.3	44 036	93.1
Mixed	1153	1.3	497	1.2	656	1.4
Asian	2847	3.2	1697	4.0	1146	2.4
Black	1828	2.0	973	2.3	854	1.8
Chinese	507	0.6	219	0.5	288	0.6
Any other	696	0.8	358	0.8	336	0.7
Missing	14 498	—	6717	—	7507	—
Socioeconomic classification [c]						
Managerial/professional occupations	57 761	65.7	27241	65.2	30 491	66.2
Intermediate occupations	9325	10.6	1558	3.7	7767	16.9
Small employers/own account workers	8232	9.4	5416	13.0	2814	6.1
Lower supervisory/technical occupations	5619	6.4	4192	10.0	1424	3.1
Semi-routine/routine occupations	6947	7.9	3378	8.1	3567	7.7
Missing/unclassified[d]	16 808	—	7772	—	8760	—
Education						
College/university degree	35 185	39.0	16 336	38.1	18 827	39.7
Secondary school	25 792	28.6	11 194	26.1	14 588	30.8
NVQ/HND/HNC or equivalent	20 430	22.6	10 146	23.6	10 282	21.7
Other professional qualifications	1308	1.4	570	1.3	737	1.6
None of the above	7613	8.4	4665	10.9	2945	6.2
Missing	14 364	—	6646	—	7444	—
Employment						
Employed	61 725	68.5	29 816	69.7	31 887	67.5
Unemployed	28 354	31.5	12 968	30.3	15 379	32.5
Missing	14 613	—	6773	—	7557	—
Smoking						
Never smoker	43 958	48.1	19 368	44.6	24 568	51.3
Ever smoker	36 024	39.4	18 315	42.2	17 683	36.9
Current smoker	11 391	12.5	5731	13.2	5652	11.8
Missing	13 319	—	6143	—	6920	—
General health						
Excellent	21 063	22.4	10 273	23.0	10 771	21.9
Very good	41 229	43.9	19 244	43.1	21 942	44.6
Good	23882	25.4	11 386	25.5	12 474	25.3
Fair	6399	6.8	3010	6.7	3375	6.9
Poor	1375	1.5	687	1.5	685	1.4
Missing	5462	—	4957	—	5576	—
Mobile phone use in past 3 months (frequency)						
Less than once per week	6958	7.1	3082	6.7	3870	7.6
1–6 calls per week	32 378	33.2	13 412	29.0	18 920	37.1
1–9 calls per day	46 195	47.4	22 011	47.6	24 100	47.2
10 calls or more per day	11 874	12.2	7704	16.7	4146	8.1
Missing	7287	—	3348	—	3787	—

(continued)

Table 2. Continued

	Overall		Men		Women	
	($N = 104\,692$[a])		($N = 49\,557$[a], 47.3%)		($N = 54\,823$[a], 52.4%)	
	N	%[b]	*N*	%[b]	*N*	%[b]
Mobile phone use in past 3 months (duration)						
Less than 5 min per week	11 221	11.5	5077	11.0	6131	12.0
5-29 min per week	24 657	25.4	11 387	24.7	13 233	26.0
30-59 min per week	19 848	20.4	9479	20.6	10 343	20.3
1–3 h per week	24 386	25.1	11 681	25.3	12 666	24.9
4–6 h per week	9725	10.0	4656	10.1	5055	9.9
More than 6 h per week	7381	7.6	3822	8.3	3541	6.9
Missing	7474	—	3455	—	3854	—
First started using a mobile phone once per week in:						
Never used a mobile phone that often	4111	4.1	1671	3.5	2438	4.7
1980–84	1474	1.5	1132	2.4	336	0.6
1985–89	4748	4.8	3582	7.6	1152	2.2
1990–94	13 386	13.5	8085	17.2	5267	10.1
1995–99	35 521	35.8	16 434	34.9	19 013	36.5
2000–04	29 865	30.1	12 041	25.6	17 773	34.1
2005–09	8924	9.0	3554	7.5	5361	10.3
2010–12	1312	1.3	600	1.3	712	1.4
Missing	5351	—	2458	—	2778	—
Obesity/BMI						
Obese (BMI > 30 kg/m^2)	15 878	18.5	7781	19.2	8091	18.0
BMI (Mean and SD)[e]	85 680	26.2 (5.1)	40 597	26.7 (4.7)	45 049	25.7 (5.5)
Missing	19 709	—	9305	—	10 125	—
Heavy activity in leisure time during the last year						
< 1 h per week	41 170	45.5	18 332	42.6	22 812	48.1
1–3 h per week	25 132	27.8	11 442	26.6	13 684	28.9
4–6 h per week	16 060	17.8	8596	20.0	7456	15.7
1–4 h per day	7372	8.1	4138	9.6	3233	6.8
5–9 h per day	552	0.6	377	0.9	174	0.4
10+ h per day	168	0.2	113	0.3	55	0.1
Missing	14 238	—	6559	—	7409	—
Sedentary activity in leisure time during the last year						
< 1 h per week	974	1.1	470	1.1	504	1.1
1–3 h per week	6018	6.7	2408	5.6	3607	7.6
4–6 h per week	13 211	14.6	5852	13.6	7349	15.5
1–4 h per day	48 289	53.5	22 920	53.4	25 350	53.5
5–9 h per day	16 789	18.6	8632	20.1	8152	17.2
10+ h per day	5043	5.6	2629	6.1	2410	5.1
Missing	14 368	—	6646	—	7451	—

[a]104,692 excludes 281 withdrawals (where individuals requested no further use of their data), and 55 records excluded for quality control reasons. Stratified by male and female, 312 further exclusions made due to missing information on sex.

[b]% calculated excluding missing from the denominator.

[c]Following the National Statistics Socioeconomic Classification (NS-SEC).

[d]Unclassified are those who have never been employed, or who were long-term unemployed at baseline.

[e]BMI, body mass index; SD, standard deviation.

hospital episode data for Wales via NHS Wales Informatics Service (NWIS) and, for birth and stillbirth registrations, the Office of National Statistics (ONS) for England and Wales. NHS National Services Scotland will provide all the above outcomes for the Scottish participants. Linkage to participants' mobile traffic data (objective data on mobile phone use, texting and data downloads) via their mobile network operator has been undertaken annually. Linkage rates are high, but not constant over the years (Table 1), indicating some attrition due to changes in, for example, participants' mobile phone number, operator and address details. As expected, linkage

rates to mobile phone operators were higher for those recruited from mobile subscriber lists (91% at baseline) vs the edited electoral register (66% at baseline).

What has been measured?

Table 3 describes the main data collected to date, and planned for the future. A follow-up questionnaire will be conducted in 2016 to obtain repeated measures, e.g. to assess change in use of mobile phones, residential address and uptake of other rapidly evolving wireless technologies such as induction cooking hobs, body scanners in airports [intermediate and extremely low frequency electromagnetic frequency (EMF) exposures] as well as changes in health, symptoms, perceptions of health risk, new medical diagnoses, prescription medication and social interaction via technologies.

In all, 98% of participant addresses have been geocoded to allow linkage to area-level socioeconomic[14] and environmental exposure estimates.[15] Road traffic noise (L_{day}, L_{eve}, L_{night}, $L_{aeq,16\,hr}$, L_{den}) estimates were modelled for each address using a version of the Common Noise aSSessment methOdS (CNOSSOS)-EU noise model.[16,17] CNOSSOS are recommended by the European Noise Directive 2002/49/EC. Annual average air pollution concentrations (NO_2, NO_X, $PM_{2.5}$, $PM_{2.5}$absorbance, PM_{10} and PM_{COARSE}) were modelled for each address using a Land Use Regression (LUR) model developed as part of the European Study of Cohorts for Air Pollution (ESCAPE) study.[18,19] We have also assigned exposure estimates of extremely low frequency (ELF)-EMF from high-voltage overhead powerlines,[20] and radiofrequency (RF)-EMF from radio and TV broadcast transmitters. In the future, we plan to link to other exposures such as air and rail traffic noise, and green space (see Table 3).

What has it found? Key findings from the baseline study

Lessons learned from UK COSMOS

We recently shared our experiences[11] in establishing the UK COSMOS cohort, on how we addressed the modern-day challenges involved in setting up large-scale prospective cohort studies by taking advantage of web-based and mobile phone technologies. Compared with traditional paper-based methods, we found that web-based consent and data collection offered significant cost and time savings and a streamlined experience for participants and researchers. We found that some parts of the process were better suited to the adoption of these technologies than others; for example, for initial invitation to participate in research we would still recommend using a letter over text messaging/e-mail, but for consent and data collection we would fully recommend web-based methods in large-scale observational studies. We also found that reminders were beneficial for increasing participation and encouraging participants to complete web-based questionnaires.

Mobile phone use and obesity

Mobile technology allows us to undertake activities such as making phone calls, using the internet and emailing while 'on the move', whereas previously these were sedentary activities. However, more time may now be devoted to using a mobile phone, thus displacing other activities, including more physical ones. Thus, mobile phone use could either increase or decrease sedentary behaviour, which is associated with weight gain.[21] Obesity and adiposity are associated with health outcomes such as stroke[22,23] and cancers,[24] which are of interest in relation to RF exposure, and therefore there is potential for confounding. We investigated relationships between mobile phone use and obesity [body mass index (BMI) ≥ 30 kg/m^2] to inform our future RF exposure-health analyses.

We conducted multiple logistic regression to examine if mobile phone use at baseline [mobile phone call frequency (calls/day) and duration of mobile phone calls (time/week) in the past 3 months], or years of mobile phone use are associated with obesity, based on self-reported weight and height. Methodological details are given in Supplementary material (available as Supplementary Data at *IJE* online).

Results for adjusted models are presented in Figures 2 and 3, and Table S2 (available as Supplementary Data at *IJE* online). We found significant dose-response relationships between frequency of mobile phone calls, duration of mobile phone calls and years of mobile phone use, with obesity, which remained after stratification by age sub-groups (18–30, 31–59 and 60+). In terms of time spent on mobile phone calls, there was a clear dose-response relationship across usage categories; odds of obesity for 6 h or more mobile phone use per week was 1.44 [95 % confidence interval (CI): 1.33, 1.56] times higher than in the reference category of 5–29 min per week. When models were further adjusted for years of use, significant dose-response patterns remained, but there was some reduction in effect size. When exploring the risk associated with years of use, each additional year of mobile phone use was associated with a small but significant elevated risk of obesity [odds ratio: 1.03 (95% CI: 1.03, 1.04)]. However, when further adjusting for call frequency and duration, there was little change in the odds ratio for years of mobile phone use, suggesting it is the most influential mobile phone variable in relation to obesity. This does not simply reflect an effect of age upon obesity, as there was limited

Table 3. Measurements in UK COSMOS to date, and planned for future

Measurement	Baseline 2009-11	Baseline 2012	Annually from baseline	Follow-up 2016
Self-reported questionnaire (web-based)				
Mobile phone use history (first use, calls, hands-free)	✓	✓		✓
First use	✓	✓		✓
Frequency and duration of voice calls	✓	✓		✓
Use of hands-free devices	✓	✓		
Mobile phone use in past 3 months (calls, messaging, internet, hands-free)	✓	✓		✓
Frequency and duration of voice calls	✓	✓		✓
Use of hands-free devices	✓	✓		✓
Mobile internet use	✓	✓		✓
Text messaging frequency	✓	✓		✓
Instant messaging frequency				✓
Use of cordless phones	✓	✓		✓
Use of cordless baby monitors	✓	✓		✓
Use of computers/wireless internet access	✓	✓		✓
Health and well-being	✓	✓		✓
General well-being (SF-12v2)	✓	✓		✓
Headaches (HIT-6)	✓	✓		✓
Hearing and tinnitus	✓	✓		✓
Sleeping habits and problems (MOS Sleep Scale)	✓	✓		✓
Chronotype	✓	✓		✓
Recollection/memory	✓	✓		✓
Symptoms while using a mobile phone	✓	✓		✓
Stress (Sheldon Cohen scale)				✓
Medical history (doctor diagnosis and age at diagnosis)	✓	✓		✓
Medications	✓	✓		✓
Light therapy		✓		
Accidents (concussion, electrical shocks)				✓
Parkinson's disease screening		✓		✓
Family history of disease				✓
Lifestyle (alcohol, smoking frequency, diet, caffeine, physical activity)	✓	✓		✓
Concerns re environment and health	✓	✓		✓
Impact of mobile technologies (positive/negative impact, sleep)				✓
Basic information, e.g. sex, height, weight, eye/hair colour, handedness	✓	✓		✓
Demographics, e.g. ethnicity, education, SES, marital status	✓	✓		✓
Employment	✓	✓		✓
Work-life balance/control				✓
Shift work				✓
Night work		✓		
Reproductive history	✓[a]	✓[a]		✓
Menstruation	✓[a]	✓[a]		✓
Pregnancies	✓[a]	✓[a]		✓
Hormone use	✓[a]	✓[a]		✓
Fertility/time to pregnancy		✓		✓
Birth outcomes				✓
Residential history				✓
Green space				✓
Noise exposure, annoyance, sensitivity		✓		✓
Domestic/indoor environment (e.g. cooking, heating, glazing)				✓
Light at night exposure				✓

(continued)

Table 3. Continued

Measurement	Baseline 2009-11	Baseline 2012	Annually from baseline	Follow-up 2016
Other EMF exposures				✓
Intermediate frequency (IF) exposures				✓
Airport body scanners				✓
MRI exposures		✓		✓
Social environment				✓
Family and community interactions				✓
Virtual interactions				✓
Mobile traffic data from operators			✓	
Frequency and duration of voice calls			✓	
Frequency of text messaging			✓	
Frequency and volume of data use			✓	
Routine health data (long-term follow-up)				
Mortality			P	
Cancer registrations			P	
Hospital Episode Statistics			P	
Birth/stillbirth registrations			P	
Prescriptions			P	
Physical environment (assigned to residence)				
Residential address-level geocoding	✓	✓		
Carstairs index of deprivation (2011)	✓	✓		
Road traffic noise exposure estimates	✓	✓		
Rail and air traffic noise exposure estimates (subset)	P	P		
Air pollution exposure estimates	✓	✓		
Environmental EMF exposure				
Mobile phone base stations (RF)	P	P		
Radio and TV broadcast transmitters (RF)	✓	✓		
High-voltage overhead powerlines (ELF)	✓	✓		
Green space	P	P		

P, planned or in progress; SF-12v2, 12-item Short Form Health Survey; HIT-6, Headache Impact Test; MOS, Medical Outcomes Study; SES, socioeconomic status; RF, radiofrequency; EMF, electromagnetic frequency; ELF, extremely low frequency; MRI, magnetic resonance imaging.

[a]Women only questions.

correlation between years of mobile phone use and age (Spearman's rho 0.28). In the adjusted model for years of mobile phone use and obesity (Table S2), the odds ratio for age was 1.01 (95% CI: 1.01, 1.01), and the associations were robust to mutual adjustment.

The literature on mobile phone use, sedentary behaviours / physical activity and obesity/BMI is limited to a few studies in adolescents. One reported a positive association between monthly mobile phone bill and BMI (0.18, 95% CI: 0.06-0.30), but not with risk of being overweight,[25] but the other found no association between mobile phone use and BMI.[26] Moreover, a study of mobile phone use and cardio-respiratory fitness observed an inverse negative association, suggesting that high frequency users were more likely than low frequency users to report displacement of physical activity in order to use a mobile phone for sedentary behaviours.[27]

In our study population, the majority were adults when commencing their mobile phone use. Our finding that increasing years of mobile phone use are associated with higher prevalence of obesity warrants further study. This is particularly the case as mobile phone use now routinely commences in childhood and is likely to result in much longer lifetime use than in previous generations, and because there is considerable public health concern regarding rising levels of obesity in childhood and adulthood in the UK and across the developed world.[28–30]

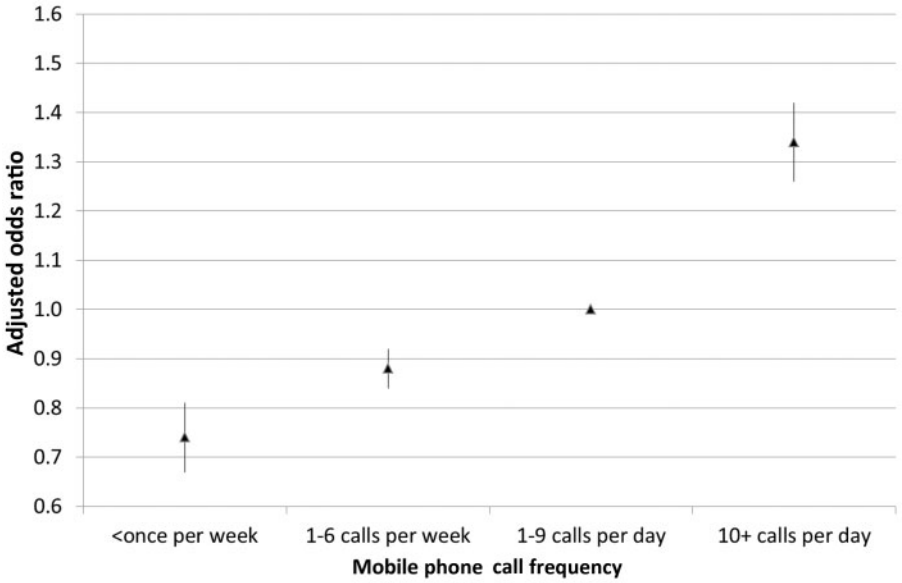

Figure 2. Odds of obesity (BMI $\geq$ 30 kg/m^2) associated with mobile phone call frequency at baseline for UK COSMOS. The reference group is 1–9 calls per day.

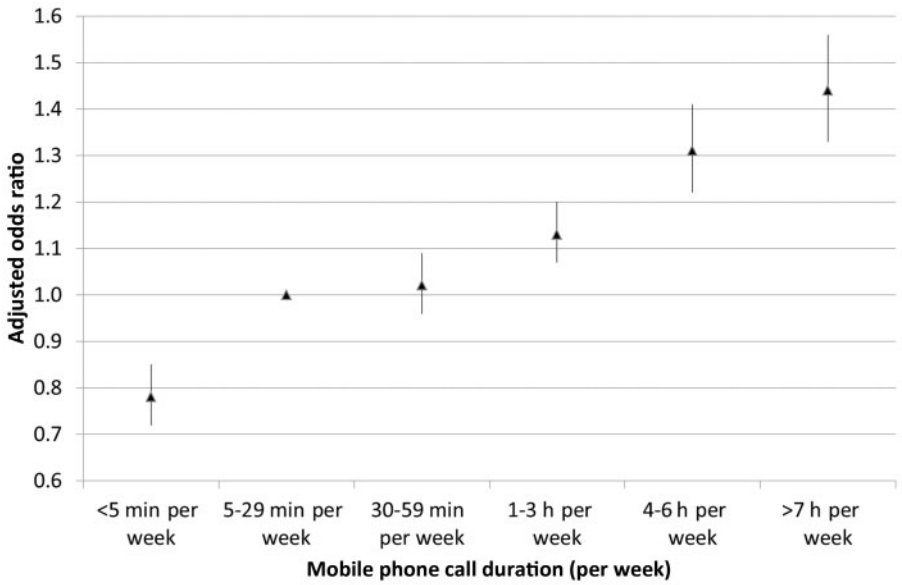

Figure 3. Odds of obesity (BMI $\geq$ 30 kg/m^2) associated with weekly duration of mobile calls at baseline for UK COSMOS. The reference group is 5–29 min per week.

What are the main strengths and weaknesses?

Given the size of UK COSMOS, it will allow the investigation of environmental effects upon health, even if effects are small. In addition, availability of refined exposure information for multiple environmental exposures will allow environment-environment interactions to be investigated.

We have ensured that key questions regarding environmental exposures included in UK COSMOS are comparable to those in both UK Biobank[31] and the newly forming LIFE study[32] to allow potential pooling and a large, rich, environmental data resource for the UK. With consent for linkage to mobile network operator traffic data and health data sources, and active ongoing contact with the cohort, we can follow changes in environmental exposures and health events for over 100 000 and, with pooling across the international consortium, ~300 000 people across Europe, over the long term.

With high linkage rates to mobile network operator traffic data, we have a combination of subjective and objective exposure information, ensuring that UK COSMOS can address many of the limitations of previous studies which have investigated mobile phone use and health.

However, the UK COSMOS study population is not representative of the UK population as a whole, tending to be of higher socioeconomic status. The low participation rate may reflect research apathy/fatigue with participation only appealing to a particular demographic who understand the benefit of research. In addition, recruiting from mobile phone subscriber and electoral register sampling frames may have excluded people such as temporary residents or migrants who may be less likely to have a mobile phone subscription and who may not be eligible for the UK electoral register.

Our baseline questionnaire was long, which may have contributed to the 14% non-completion rate resulting in missing data, particularly for later questions. For baseline non-completers we aim to collect key missing data items via the follow-up questionnaire in 2016, and are considering how to incentivize and support this group.

UK COSMOS recruitment did not involve a face-to-face interview/examination, so physical measures, e.g. height and weight for BMI, are self-reported, which could lead to misclassification.

Where can I find out more? Can I get hold of the data?

Further details about the study are available at [www.ukcosmos.org]. Enquiries re potential collaboration and data access should be sent to the UK COSMOS Investigators Paul Elliott [p.elliott@imperial.ac.uk] and Mireille Toledano [m.toledano@imperial.ac.uk]. These will be considered by the UK COSMOS Data Access Committee, and may require additional ethical approval. Data access would be subject to honorary researcher status and data will only be available for analysis on site, as it is stored on a secure air-gapped private network in accordance with the consent and ethical requirements of the study. We particularly welcome potential collaboration with environmental exposure scientists/modellers to generate further environmental exposure data for UK COSMOS cohort participants.

Supplementary Data

Supplementary data are available at *IJE* online.

UK COSMOS profile in a nutshell

- UK COSMOS is a prospective cohort study to investigate the relationship between mobile phones, other wireless technologies, electromagnetic field exposures and health.
- The cohort comprises 105 028 adult men and women aged 18 and over from across the UK, recruited between 2009 and 2012 from mobile phone subscriber lists and the UK edited electoral register.
- Data collection includes information on: self-reported use of mobile phones and other wireless devices; objective network operator traffic data for up to three mobile phones per participant; other indoor and outdoor environmental measures, e.g. air pollution and road traffic noise; demographic factors, medical and reproductive history, lifestyle, community interactions and support, validated scales for well-being and health symptoms, perceptions of environmental health risk; linkage to routine cancer/mortality/hospital data to determine health events; and residential linkage to administrative records, census data and a broad range of area-level environmental exposures.
- Follow-up includes: annual update of participant contact details; annual linkage to mobile network operator traffic data; and a comprehensive follow-up questionnaire planned for 2016. In all, 0.3% of baseline participants have withdrawn from the study.
- Proposals for potential collaboration and UK COSMOS data access are welcome; please contact the UK COSMOS Investigators Mireille Toledano [m.toledano@imperial.ac.uk] and Paul Elliott [p.elliott@imperial.ac.uk].

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