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Predictors of non-response in a UK-wide cohort study of children's accelerometer-determined physical activity using postal methods

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ABSTRACT

Objectives: To investigate the biological, social, behavioural and environmental factors associated with non-consent, and non-return of reliable accelerometer data ($\geq$2 days lasting $\geq$10 h/day), in a UK-wide postal study of children's activity.

Design: Nationally representative prospective cohort study.

Setting: Children born across the UK, between 2000 and 2002.

Participants: 13 681 7 to 8-year-old singleton children who were invited to wear an accelerometer on their right hip for 7 consecutive days. Consenting families were posted an Actigraph GT1M accelerometer and asked to return it by post.

Primary outcome measures: Study consent and reliable accelerometer data acquisition.

Results: Consent was obtained for 12 872 (94.5%) interviewed singletons, of whom 6497 (50.5%) returned reliable accelerometer data. Consent was less likely for children with a limiting illness or disability, children who did not have people smoking near them, children who had access to a garden, and those who lived in Northern Ireland. From those who consented, reliable accelerometer data were less likely to be acquired from children who: were boys; overweight/obese; of white, mixed or 'other' ethnicity; had an illness or disability limiting daily activity; whose mothers did not have a degree; who lived in rented accommodation; who exercised once a week or less; who had been breastfed; were from disadvantaged wards; had younger mothers or lone mothers; or were from households with just one, or more than three children.

Conclusions: Studies need to encourage consent and reliable data return in the wide range of groups we have identified to improve response and reduce non-response bias. Additional efforts targeted at such children should increase study consent and data acquisition while also reducing non-response bias. Adjustment must be made for missing data that account for missing data as a non-random event.

ARTICLE SUMMARY

Article focus
- This paper investigates the biological, social, behavioural and environmental factors associated with non-consent and non-return of reliable accelerometer data ($\geq$2 days lasting $\geq$10 h/day) in a UK-wide postal study of children's activity.

Key messages
- Consent was less likely for children with a limiting illness or disability, children who did not have people smoking near them or had access to a garden and children who lived in Northern Ireland.
- From those who consented, reliable data were less likely to be returned by boys, overweight/obese children, those who were not white, mixed or 'other' ethnicity, younger mothers, mothers without a degree, families with only one parent, households with just 1 or more than 3 children, children who lived in rented accommodation, had been breastfed or had a limiting illness or disability and children from disadvantaged wards.
- Children who exercised less than twice a week, according to the parent-proxy report of physical activity, were less likely to return reliable accelerometer data.

Strengths and limitations of this study
- This is the first large-scale accelerometer study using a postal distribution methodology to investigate the predictors of non-response associated with study non-consent and non-receipt of reliable data.
- A wide range of biological, social, behavioural and environmental factors are investigated as potential predictors of non-response. But our findings may not be directly applicable to different ages.

BACKGROUND

The development of accelerometers enables the frequency, intensity and duration of free-living activity to be measured objectively in

large-scale population studies. The majority of previous large scale accelerometer studies have demonstrated the use of the activity monitor to participants and distributed them in the context of a face-to-face meeting within a clinic[1–3] or school setting.[4–17] Although effective, the cost and time constraints of this data collection method can be substantial, particularly in large studies where subjects are geographically dispersed. The use of postal methods to distribute and return accelerometers can achieve higher population coverage than face-to-face administering and return, while also potentially reducing time and financial costs. Despite this, there are no large-scale accelerometer studies in UK children that have used this method.

Although non-response is a problem for nearly all large-scale studies, the use of a postal methodology may increase data loss and potentially introduce bias into study findings. Lack of face-to-face contact with researchers may reduce motivation for participation, or involve uncertainty for participants relating to the accelerometer wear or return protocol. There is also a dependence on external factors such as an efficient postal service and relying on subjects to return their accelerometers.

Few studies have examined predictors of consent in large-scale accelerometer studies in children. In those available, only the effects of gender[17] and ethnicity[5] have been investigated. No large-scale accelerometer studies using postal distribution methods have evaluated predictors of consent, and only one has evaluated differences between children who did and did not return reliable data.[18] Gender, age and ethnic differences between children who did and did not provide reliable accelerometer data are well investigated in studies using face-to-face distribution methods,[3 5 10 13 16 18–22] but the findings are inconsistent, possibly due to differences in study design, accelerometer protocol or study populations. Further research is needed to determine the factors associated with non-response in large-scale studies using a novel postal distribution methodology. This would enable researchers to minimise non-response, and also reduce the effect of bias through modification of analytical methods (eg, weighting analyses to account for non-response). Therefore, the aim of this study was to investigate the biological, social, behavioural and environmental predictors of non-response resulting from study non-consent and non-return of reliable accelerometer data in a UK-wide postal study of children's activity.

METHODS
Study population
The Millennium Cohort Study (MCS) is a UK-wide prospective study of the social, economic and health-related circumstances of British children born in the new century.[23] All families who were claiming Child Benefit (all UK residents qualify for Child Benefit if they have

children under 16 years) when their children were aged 9 months were eligible for sampling. A stratified clustered sampling design was employed to ensure an adequate representation of all four UK countries, disadvantaged areas and areas with high minority ethnic populations in England. The original cohort (MCS1) comprised 18 818 children (18 295 singletons; response rate 72%) whose parents were first interviewed at home when their child was aged 9 months.[24] Three further home interviews have been completed, at ages 3, 5 and 7 years. At age 7, accelerometers were used to measure children's activity. All children were invited to wear an accelerometer and written consent was obtained from the parents/guardians of those agreeing. Parents/guardians who gave consent were given an explanation on how their child should wear the accelerometer and were asked to demonstrate correctly putting a 'dummy' activity monitor on their child. Interviewers also explained how and when they should expect to receive their child's activity monitor, and how and when they should return the monitor.

Accelerometer protocol
Levels and patterns of physical activity (PA) were measured using the Actigraph GT1M uni-axial accelerometer (Actigraph, Pensacola, Florida). The Actigraph has been extensively validated in children against observational techniques,[25] heart rate telemetry,[26] indirect calorimetry[27] and energy expenditure measured by doubly labelled water.[28] A 15 s sampling epoch was selected in order to optimise the ability to capture the sporadic nature of children's activity.[29] Accelerometers were programmed using ActiLife Lifestyle Monitoring System software (V.3.2.11) to start collecting data at 05:00 2 days after posting. Accelerometers (attached to an elasticated belt) were posted together with a parent cover letter, an information leaflet, a timesheet, a letter for the child's class teacher and a prepaid envelope (for returning the accelerometer) to families via UK Royal Mail first class delivery. Families were asked to complete a timesheet to encourage accelerometer wear, recording the time the accelerometer was first put on in the morning and taken off at night, and any periods during the day when the accelerometer was not worn (including time spent swimming). Distribution occurred between May 2008 and August 2009. A free-phone telephone number was provided for families to call if they had any further questions. Families were sent translated versions of the documents if requested at the MCS home interview. Children were asked to start wearing their accelerometer the morning after they received it on their right hip for seven consecutive days during all waking hours, but were asked to remove it during all aquatic activities as these monitors are not waterproof. If children were unable to wear their accelerometer on the week requested, they were asked to return it so that it could be recharged and reprogrammed for a more convenient date.

Parents/guardians were asked to return the accelerometer and completed timesheet as soon as possible after the monitoring period in the prepaid envelope. On return of the accelerometer, families were sent a certificate and a set of graphs summarising their child's weekly activity, together with a letter thanking them for their involvement. Three postal reminder letters were sent at weekly intervals to those not returning their accelerometer within 3 weeks after issue. The third reminder letter included an additional prepaid envelope. Further weekly reminders were issued by text, email or phone call depending on the contact details held. A final reminder letter offered families a £10 incentive gift voucher for the return of their accelerometer.

Accelerometer data processing

Accelerometer data were processed using the package pawacc[30] developed in the R software environment for statistical computing (V.2.15.0).[31] Accelerometer non-wear was defined as any time period of consecutive zero-counts for a minimum of 20 min[5] and counts $\geq 11\,715$ counts/min were excluded as these values were regarded as extreme.[32] Children with a wear time period of ≥ 2 days lasting ≥ 10 h/day were considered to provide reliable data.[33] Full details on data processing are given in Geraci *et al*[34]

Statistical methods

All analyses were conducted in STATA/SE V.11.0 (Stata Corporation, Texas, USA) and weighted using MCS survey and non-response weights to account for attrition between contacts and adjusted to allow for the clustered sample design. All singleton children that took part in the fourth sweep of the MCS (MCS4) interviews were included in the analyses (n=13 681). Twins and triplets were not included in the analyses because data were unintentionally not coded to allow the interview and accelerometer data for twins (n=332) and triplets (n=30) to be accurately linked. Sample sizes and weighted percentages were calculated for the total sample, and stratified for consenting and non-consenting children, and for children who did and did not return reliable accelerometer data, according to the potential predictor variables. Potential predictor variables are reported in table 1, and were chosen based on prior research investigating non-response in previous large-scale accelerometer studies and the MCS4 interviews[35][36] so that we could determine if the sample was biased according to factors typically associated with PA in children.[24–26]

All potential predictor variables were entered into unadjusted logistic regression models. p Values were obtained from adjusted Wald tests. Multicollinearity was investigated to determine which variables were to be included in the adjusted logistic regression models because several of the variables reported similar concepts. This was achieved by examining the bivariate correlations between all potential predictor variables, and calculating the variance inflation factors (VIF). The VIF is an index that measures how much the variance of an estimated regression coefficient is increased because of collinearity.[38] VIF values were calculated using the formula $1/(1-R^2)$ after regressing each potential predictor variable against all other variables (where R is the correlation coefficient between two variables); VIF values greater than 2.5 are often considered a matter of concern.[38] Multicollinearity was evident between 'maternal occupation' (VIF=2.83) and 'whether the mother was in work or not' (VIF=2.54; correlation coefficient=0.78), and between 'government office region' (VIF=2.49) and 'country' (VIF=2.53; correlation coefficient=0.77). In each case, one of the pair of variables was removed from the model, one at a time, and the VIFs recalculated. The removal of 'mother in work or not' and 'government office region' reduced any signs of multicollinearity (ie, all variables had VIF<2.5).

All the remaining variables were entered into two separate adjusted logistic regression models to determine the predictors of data loss resulting from study non-consent and non-return of reliable data. p Values were obtained from adjusted Wald tests to determine differences between the regression coefficients.

RESULTS
Sample

A total of 14 043 children (13 681 singletons) took part in the fourth sweep of the MCS interviews (figure 1). Parents of 13 219 (94.1%) children (12 872 singletons) gave consent for their child to wear an accelerometer Accelerometers were sent to 12 625 (95.5%) consenting children (12 303 singletons); 29 (0.2%) children were not sent an accelerometer because the fieldwork team were unable to send it during the requested time period, and full contact details of the remaining 565 (4.3%) children were unavailable. We obtained reliable data (≥ 2 days lasting ≥ 10 h/day) from 6675 (50.5%) consenting children (6497 singletons). A total of 7004, 6326, 5910, 5153, 4002 and 2244 consenting children had ≥ 1, ≥ 3, ≥ 4, ≥ 5, ≥ 6 and ≥ 7 reliable days of data lasting at least 10 h/day.

CONSENT
Unadjusted analyses

Biological, social, behavioural and environmental factors were all associated with study consent (table 2). Pakistani/Bangladeshi children were almost half as likely to consent compared with white children. Several social factors were associated with non-consent including mothers not working, mothers without a degree (with the exception of those with no qualifications), households with only one child or an income of £10 400 or less, households that spoke another language apart from English, and children who did not have people smoking near them. Children with a limiting illness or disability were half as likely to provide study consent compared with those without a limiting illness or disability.

Table 1 Potential predictor variables used in analyses

Factor	Approximate age of MCS child at data collection	Level for analysis
Biological		
Child's gender	7 years	Male; female
Child's ethnicity*	7 years	White; mixed; Indian; Pakistani/Bangladeshi; black or black British; other
Child's body mass index (BMI) †	7 years	Underweight/ normal weight; overweight/ obese
Social		
Mother's age at birth (years)	9 months	14–19; 20–29; 30–39; ≥40
Maternal current occupation‡	7 years	Managerial & professional; intermediate; small employers & own account workers; lower supervisory & technical; semi- routine & routine; non-employed
Maternal highest academic qualification	7 years	Degree(s)/ post graduate diplomas; higher education/ teaching qualifications/ diplomas; A/ AS/ S-levels; O-levels/ GCSE grades A-C; GCSE grades D-G; other academic qualifications; none of these
Lone parent status	7 years	Non-lone parent; lone parent
Number of children in the household (including the cohort child)	7 years	1; 2–3; ≥4
Main household language	7 years	English only; English and other language; non-English speaking
Whether anyone smokes near the child	7 years	Yes; no
Whether the mother is in work or not	7 years	In work or on leave; not in work or leave
Main housing tenure	7 years	Own outright, own mortgage/loan, part own/mortgage; rent from local authority or housing association; rent privately; other
Type of accommodation	7 years	House or bungalow; flat or maisonette; studio, room, bedsit, other
Household income	7 years	<£10400; £10400–20800; £20800–31200; £31200–52000; >£52000
Behavioural		
Whether the child has any illnesses or disabilities that limits activity	7 years	Yes; no
Number of days a week the child participates in sport or exercise: parent report	7 years	≥3 days/week; 2 days/week; 1 day/week; less often/not at all
Number of hours the child watches TV on weekdays	7 years	Less than an hour/not at all; 1–3 h; 3–5 h; >5 h
Whether the child was ever breastfed	9 months	Yes; no
Environmental		
Access to garden	7 years	Yes; no
Ward type (at time of sampling) §	9 months	Advantaged; disadvantaged; ethnic
Government office region	7 years	North East; North West; Yorkshire and the Humberside; East Midlands; West Midlands; East of England; London; South East; South West; Wales; Scotland; Northern Ireland; Isle of Man/ Channel Islands
UK country	7 years	England; Wales; Scotland; Northern Ireland

*Categorised according to guidelines from the Office for National Statistics.[32]
† Defined using the International Obesity Task Force cut-off for BMI.[31]
‡Classified according to the National Statistics Socio-economic Classification.[33]
§Wards classified as ethnic if at least 30% of residents were from an ethnic minority group (in the 1991 census), disadvantaged if above the upper quartile of the Child Poverty Index[37] and the remaining were advantaged (no ethnic stratum in Wales, Scotland and Northern Ireland[24]).

Children who exercised less than once a week or had never been breastfed were also less likely to provide consent. Consent was also less likely for children from ethnic wards, or those who lived in Yorkshire and Humberside, London or Northern Ireland.

Adjusted analyses

After controlling for other predictor variables, consent remained significantly less likely for children who did not have people smoking near them and children with an illness or disability that limited daily activity (table 2).
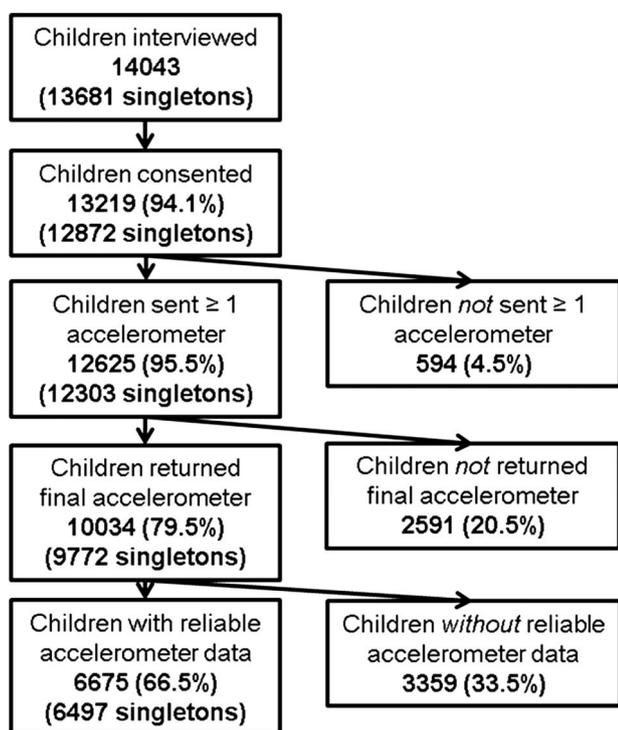
Figure 1 Summary of children in the Millennium Cohort accelerometer study.

Consent was also less likely for children who had access to a garden, and those who lived in Northern Ireland.

RELIABLE DATA ACQUISITION
Unadjusted analyses

All variables in the unadjusted models were associated with reliable data acquisition except residential country (table 3). Within the sample who consented and were sent accelerometers, we were less likely to receive reliable data from boys, overweight/obese children and those who were not white or 'other' ethnicity. The social factors associated with non-return of reliable data included younger mothers (<30 at birth of cohort child), mothers not in managerial, professional, lower supervisory or technical occupations, or not educated to degree level, households with just one, or four or more children, or who spoke English and another language, children who had people smoking near them, or who lived in a flat or maisonette, and families who did not own their own home or had a household income of less than £31 200. Lone parents were half as likely to return reliable accelerometer data compared with two parent families. We were also less likely to acquire reliable accelerometer data from children with a limiting illness or disability, those who exercised 1 day a week or less, or watched TV for 3–5 h on weekdays or who had been breastfed. We were also less likely to acquire reliable data from children without access to a garden, children from disadvantaged or ethnic wards, and those who lived in North East or North West England, Yorkshire and

Humberside, West Midlands, London, Wales, Scotland or Northern Ireland.

Adjusted analyses

After controlling for other predictor variables, reliable accelerometer data acquisition was significantly less likely from boys, overweight/obese children and those who were not white, mixed or 'other' ethnicity (table 3). More social factors remained significantly associated with non-return of reliable data than with consent including younger mothers (<30 at birth of cohort child), mothers without a degree (excluding those with 'other' qualifications), lone parent families, households with just one, or four or more children and children that lived in any type of rented accommodation. We were also less likely to acquire reliable data from children with a limiting illness or disability, children who exercised once a week or less or had been breastfed and children from disadvantaged wards.

DISCUSSION
Summary of findings

In this nationally representative cohort of UK children, a high proportion of families (94.1% of children interviewed; n=13 219) agreed to take part in a study that used postal methods to distribute and return accelerometers in order to measure children's PA. The use of a postal methodology enabled the MCS to acquire a large volume of reliable accelerometer data (n=6675; 51% of consenting children).

A number of different factors were associated with study non-consent and non-return of reliable accelerometer data in a nationally representative cohort of UK children (table 4). More differences were observed for the return of reliable data than in the consent to participate, quite likely to be due to the very high consent rate. In particular, a number of biological and social factors were related to non-return of reliable data that were not associated with non-consent. Social disadvantage was more apparent in children who did not return reliable data than in non-consenting children.

Comparisons with existing research

Few accelerometer-based studies of children's PA have investigated correlates of consent.[5] [17] Van Sluijs et al[17] and Owen et al[5] investigated gender differences between children who consented to wearing an accelerometer in two large-scale studies. In contrast to our study, girls were more likely to consent than boys in the Sport, Physical activity and Eating behaviour: environmental Determinants in Young people (SPEEDY)[17] study, whereas Owen et al[5] found no ethnic differences between consenting and non-consenting children participating in the Child Heart Health Study in England.

Only one large-scale study using postal methods to distribute and return accelerometers has investigated predictors of reliable data acquisition.[18] Janz et al[18] found

Table 2 Weighted percentages and sample sizes for total singletons interviewed (n=13 681), consenting (n=12 872) and non-consenting singletons (n=809), adjusted and unadjusted ORs (95% CI) and p values for predictors of consent

	Weighted % (n)			Unadjusted regressions		Adjusted regression	
	Interviewed	Consenting	Non-consenting	OR (95% CI)	p Value	OR (95% CI)	p Value
All	100.0 (13681)	94.5 (12872)	5.5 (809)				
Biological							
Child's gender							
Male	51.4 (6950)	94.7 (6541)	5.3 (409)	1.07 (0.90 to 1.28)	0.442	1.10 (0.91 to 1.32)	0.318
Female	48.6 (6731)	94.4 (6331)	5.6 (400)	1		1	
Child's ethnicity							
White	85.5 (11373)	95.1 (10745)	4.9 (628)	1		1	
Mixed	3.2 (367)	91.9 (345)	8.1 (22)	0.59 (0.32 to 1.08)		0.57 (0.30 to 1.10)	0.093
Indian	1.9 (339)	91.8 (316)	8.2 (23)	0.58 (0.35 to 0.96)	0.089	0.91 (0.45 to 1.84)	0.793
Pakistani/Bangladeshi	4.7 (869)	92.1 (794)	7.9 (75)	0.61 (0.45 to 0.82)	0.001	1.06 (0.67 to 1.70)	0.779
Black or Black British	3.2 (446)	92.8 (411)	7.2 (35)	0.67 (0.41 to 1.09)	0.103	0.64 (0.36 to 1.14)	0.126
Other	1.4 (186)	92.4 (173)	7.6 (13)	0.63 (0.32 to 1.26)	0.190	1.06 (0.49 to 2.26)	0.884
Child's BMI							
Under/normal weight	79.9 (10582)	94.9 (10011)	5.1 (571)	1	0.313	1	0.802
Overweight/obese	20.1 (2759)	94.4 (2583)	5.6 (176)	0.90 (0.74 to 1.10)		0.97 (0.79 to 1.20)	
Social							
Mother's age at birth (years)							
14–19	8.5 (1005)	93.9 (940)	6.1 (65)	0.87 (0.61 to 1.26)	0.468	1.01 (0.69 to 1.48)	0.962
20–29	45.4 (6103)	94.7 (5752)	5.3 (351)	1.02 (0.87 to 1.19)	0.844	1.14 (0.95 to 1.36)	0.159
30–39	43.4 (6184)	94.6 (5817)	5.4 (367)	1	0.215	1	0.983
≥40	2.7 (389)	93.0 (363)	7.0 (26)	0.75 (0.48, 1.18)		1.01 (0.59 to 1.73)	
Maternal occupation							
Managerial and professional	22.5 (3173)	95.4 (3018)	4.6 (155)	1		1	
Intermediate	12.9 (1746)	95.7 (1666)	4.3 (80)	1.08 (0.73 to 1.58)	0.707	1.21 (0.80 to 1.85)	0.371
Small employers and own account workers	5.8 (751)	95.5 (716)	4.5 (35)	1.03 (0.68 to 1.55)	0.885	1.15 (0.74 to 1.77)	0.533
Lower supervisory and technical	2.7 (345)	95.7 (328)	4.3 (17)	1.08 (0.62 to to 1.88)	0.797	1.26 (0.67 to to 2.38)	0.467
Semiroutine and routine	18.1 (2385)	94.8 (2248)	5.2 (137)	0.88 (0.64 to 1.21)	0.433	1.03 (0.73 to 1.46)	0.847
Non-employed	37.9 (4993)	93.3 (4628)	6.7 (365)	0.68 (0.53 to 0.88)	0.003	0.79 (0.60 to 1.07)	0.119
Maternal academic qualification							
Degree(s)/postgraduate diplomas	18.6 (2756)	95.5 (2623)	4.5 (133)	1		1	
Higher education/teaching qualifications/diplomas	11.4 (1592)	94.9 (1512)	5.1 (80)	0.88 (0.63 to 1.22)	0.441	0.81 (0.56 to 1.17)	0.265
A/AS/S-levels	9.2 (1299)	94.9 (1231)	5.1 (68)	0.88 (0.61 to 1.25)	0.467	0.84 (0.56 to 1.26)	0.390
O-levels/GCSE grades A-C	32.0 (4219)	94.6 (3958)	5.4 (261)	0.83 (0.63 to 1.10)	0.191	0.81 (0.57 to 1.13)	0.217
GCSE grades D-G	11.0 (1396)	94.2 (1308)	5.8 (88)	0.77 (0.52 to 1.13)	0.182	0.72 (0.47 to 1.10)	0.129
Other academic qualifications	2.5 (358)	93.3 (335)	6.7 (23)	0.66 (0.39 to 1.10)	0.109	0.73 (0.43 to 1.24)	0.247
None of these	15.3 (2057)	93.3 (1902)	6.7 (155)	0.66 (0.48 to 0.91)	0.012	0.91 (0.61 to 1.35)	0.632
Lone parent status							
Non-lone parent	77.3 (10785)	94.7 (10157)	5.3 (628)	1		1	
Lone parent	22.7 (2896)	94.0 (2715)	6.0 (181)	0.87 (0.72 to 1.05)	0.151	1.01 (0.78 to 1.29)	0.916

Continued

Table 2 Continued

	Weighted % (n)			Unadjusted regressions		Adjusted regression	
	Interviewed	Consenting	Non-consenting	OR (95% CI)	p Value	OR (95% CI)	p Value
Number of children in the household							
1	13.3 (1771)	92.9 (1649)	7.1 (122)	0.73 (0.59 to 0.90)	0.004	0.82 (0.64 to 1.05)	0.110
2–3	72.9 (9886)	94.8 (9325)	5.3 (561)	1		1	
≥4	13.8 (2024)	95.0 (1898)	5.0 (126)	1.05 (0.82 to 1.35)	0.695	1.30 (0.99 to 1.71)	0.062
Household language							
English only	89.8 (11786)	94.9 (11127)	5.1 (659)	1		1	
English and other	9.6 (1796)	91.3 (1656)	8.7 (140)	0.56 (0.43 to 0.72)	0.000	0.68 (0.46 to 1.00)	0.052
Non-English speaking	0.5 (99)	86.7 (89)	13.3 (10)	0.35 (0.14 to 0.89)	0.027	0.45 (0.16 to 1.31)	0.145
Whether anyone smokes near the child							
No	86.4 (11837)	94.4 (11126)	5.6 (711)	1		1	
Yes	13.6 (1759)	95.8 (1672)	4.2 (87)	1.37 (1.03 to 1.82)	0.031	1.37 (1.02 to 1.84)	0.037
Whether mother is in work or not						NA	NA
In work or leave	61.6 (8511)	95.2 (8077)	4.8 (434)	1	0.000		
Not in work or leave	38.4 (5170)	93.4 (4795)	6.6 (375)	0.71 (0.60 to 0.84)			
Main housing tenure							
Own outright to full or part loan/mortgage	63.1 (8996)	94.6 (8475)	5.4 (521)	1	0.577	1	0.197
Rent from local authority or housing association	24.9 (3092)	94.3 (2900)	5.8 (192)	0.93 (0.72 to 1.20)		1.23 (0.90 to 1.70)	
Rent privately	9.8 (1177)	95.8 (1118)	4.2 (59)	1.30 (0.94 to 1.80)	0.111	1.49 (1.01 to 2.20)	0.045
Other	2.2 (277)	92.3 (258)	7.7 (19)	0.68 (0.38 to 1.21)	0.188	1.07 (0.59 to 1.94)	0.836
Type of accommodation							
House or bungalow	89.9 (12436)	94.6 (11708)	5.4 (728)	1		1	
Flat or maisonette	9.7 (1175)	94.5 (1101)	5.5 (74)	0.99 (0.70 to 1.41)	0.952	1.05 (0.65 to 1.68)	0.853
Studio, room, bedsit, other	0.4 (49)	99.7 (48)	0.3 (1)	17.2 (2.78 to 106.5)	0.002	NA	NA
Household income							
<£10400	13.1 (1733)	92.6 (1603)	7.5 (130)	0.56 (0.39 to 0.80)	0.001	0.73 (0.46 to 1.16)	0.185
£10400–£20800	26.8 (3794)	94.6 (3561)	5.4 (233)	0.78 (0.58 to 1.06)	0.113	1.02 (0.71 to 1.49)	0.896
£20800–£31200	23.1 (3234)	94.4 (3035)	5.6 (199)	0.76 (0.57 to 1.00)	0.052	0.99 (0.72 to 1.37)	0.929
£31200–£52000	24.9 (3359)	95.2 (3183)	4.8 (176)	0.88 (0.64 to 1.22)	0.451	1.00 (0.71 to 1.42)	0.996
>£52000	12.2 (1541)	95.7 (1474)	4.3 (67)	1			
Behavioural							
Disability or illness that limits activity							
No	93. 2 (12783)	94.8 (12066)	5.2 (717)	1		1	
Yes	6.8 (898)	90.8 (806)	9.2 (92)	0.54 (0.41 to 0.71)	0.000	0.65 (0.47 to 0.90)	0.010
Frequency of sport or exercise							
3 or more days/week	19.9 (2705)	95.7 (2575)	4.4 (130)	1		1	
2 days/week	20.8 (2829)	95.7 (2693)	4.3 (136)	1.02 (0.76 to 1.38)	0.899	1.12 (0.82 to 1.52)	0.486
1 day/week	26.1 (3592)	94.7 (3383)	5.4 (209)	0.80 (0.61 to 1.07)	0.132	0.87 (0.65 to 1.19)	0.387
Less often or not at all	33.2 (4485)	93.1 (4161)	6.9 (324)	0.62 (0.46 to 0.82)	0.001	0.77 (0.55 to 1.06)	0.110
Hours per weekday child watches TV							
Less than an hour/not at all	19.3 (2684)	94.8 (2524)	5.2 (160)	1		1	
1–3 h	64.8 (8748)	94.3 (8227)	5.7 (521)	0.91 (0.72 to 1.14)	0.415	0.90 (0.70 to 1.16)	0.425

Continued

Table 2 Continued

	Weighted % (n)			Unadjusted regressions		Adjusted regression	
	Interviewed	Consenting	Non-consenting	OR (95% CI)	p Value	OR (95% CI)	p Value
3–5 hours	11.1 (1462)	95.9 (1388)	4.1 (74)	1.30 (0.92 to 1.83)	0.136	1.37 (0.97 to 1.93)	0.073
>5 h	4.8 (711)	94.9 (669)	5.1 (42)	1.02 (0.66 to 1.56)	0.932	1.14 (0.72 to 1.81)	0.581
Child ever breastfed							
No	33.6 (4394)	93.6 (4075)	6.4 (319)	0.77 (0.64 to 0.93)	0.006	0.88 (0.72 to 1.09)	0.236
Yes	66.5 (9287)	95.0 (8797)	5.0 (490)	1		1	
Environmental							
Access to garden							
No	7.4 (905)	95.6 (857)	4.4 (48)	1.27 (0.90 to 1.81)	0.178	1.70 (1.01 to 2.85)	0.045
Yes	92.6 (12755)	94.5 (12000)	5.5 (755)	1		1	
Ward type							
Advantaged	56.7 (5693)	95.1 (5408)	4.9 (285)	1		1	
Disadvantaged	37.0 (6326)	94.0 (5924)	6.0 (402)	0.80 (0.62 to 1.05)	0.103	0.89 (0.66 to 1.21)	0.466
Ethnic	6.3 (1662)	92.2 (1540)	7.8 (122)	0.60 (0.46 to 0.80)	0.000	0.75 (0.48 to 1.17)	0.211
Government office region							
North East	3.6 (395)	93.4 (368)	6.6 (27)	0.42 (0.16 to 1.06)	0.065	NA	NA
North West	10.8 (1125)	94.8 (1063)	5.2 (62)	0.54 (0.28 to 1.03)	0.062		
Yorkshire and the Humberside	8.9 (1013)	92.5 (938)	7.5 (75)	0.36 (0.18 to 0.73)	0.005		
East Midlands	7.3 (734)	95.3 (705)	4.7 (29)	0.60 (0.27 to 1.37)	0.226		
West Midlands	8.0 (1009)	95.7 (958)	4.3 (51)	0.66 (0.32 to 1.34)	0.245		
East of England	9.3 (971)	96.7 (935)	3.3 (36)	0.86 (0.41 to 1.77)	0.674		
London	11.1 (1403)	93.7 (1315)	6.3 (88)	0.44 (0.23 to 0.85)	0.015		
South East	14.5 (1360)	94.6 (1288)	5.4 (72)	0.52 (0.26 to 1.03)	0.060		
South West	8.2 (766)	97.1 (745)	2.9 (21)	1	0.024		
Wales	5.1 (1951)	94.3 (1844)	5.7 (107)	0.49 (0.26 to 0.91)	0.019		
Scotland	9.3 (1598)	94.0 (1499)	6.0 (99)	0.46 (0.24 to 0.88)	0.000		
Northern Ireland	4.0 (1354)	89.3 (1212)	10.7 (142)	0.25 (0.13 to 0.46)			
Isle of Man/Channel Islands	0.02 (2)	100 (2)	0 (0)	NA	NA		
Country							
England	64.2 (8786)	95.0 (8326)	5.1 (460)	1		1	
Wales	14.2 (1945)	94.2 (1838)	5.8 (107)	0.87 (0.65 to 1.15)	0.313	0.97 (0.71 to 1.33)	0.859
Scotland	11.6 (1599)	94.0 (1500)	6.0 (99)	0.83 (0.60 to 1.17)	0.287	0.73 (0.51 to 1.03)	0.077
Northern Ireland	9.9 (1351)	89.1 (1208)	10.9 (143)	0.43 (0.32 to 0.59)	0.000	0.46 (0.32 to 0.65)	0.000

Frequencies of missing data: ethnicity (101); BMI (340); occupation (288); academic (4); smoking (85); housing tenure (139), accommodation (21); income (20); sport (70); TV (76); garden (21).
BMI, body mass index.

Table 3 Weighted percentages and sample sizes for all singletons sent an accelerometer (n=12303), singletons whom we did (n=6497) and did not (n=5806) acquire reliable accelerometer data, adjusted and unadjusted ORs (95% CI) and p values for predictors of reliable data acquisition

	Weighted % (n)			Unadjusted regression		Adjusted regression	
	Sent	Reliable data acquired	Reliable data not acquired	OR (95% CI)	p Value	OR (95% CI)	p Value
All	100.0 (12303)	52.7 (6497)	47.3 (5806)				
Biological							
Child's gender							
Male	51.2 (6233)	50.8 (3176)	49.2 (3057)	0.86 (0.78 to 0.95)	0.002	0.81 (0.74 to 0.90)	0.000
Female	48.8 (6070)	54.6 (3321)	45.4 (2749)	1		1	
Child's ethnicity							
White	86.2 (10 310)	54.8 (5685)	45.2 (4625)	1		1	0.206
Mixed	3.1 (329)	47.7 (167)	52.3 (162)	0.75 (0.57 to 0.99)	0.045	0.84 (0.63 to 1.10)	0.004
Indian	1.9 (305)	42.7 (139)	57.4 (166)	0.61 (0.44 to 0.85)	0.003	0.50 (0.31 to 1.10)	0.001
Pakistani/Bangladeshi	4.4 (726)	32.2 (243)	67.8 (483)	0.39 (0.31 to 0.49)	0.000	0.50 (0.34 to 0.70)	0.002
Black or Black British	3.1 (386)	36.6 (151)	63.5 (235)	0.47 (0.34 to 0.65)	0.000	0.58 (0.41 to 0.83)	0.838
Other	1.4 (165)	53.1 (80)	36.6 (85)	0.93 (0.66 to 1.29)	0.688	0.95 (0.59 to 1.36)	
Child's BMI							
Under/normal weight	80.1 (9671)	54.5 (5315)	45.5 (4356)	1		1	
Overweight/obese	19.9 (2483)	45.5 (1114)	54.6 (1369)	0.69 (0.63 to 0.77)	0.000	0.73 (0.66 to 0.82)	0.000
Social							
Mothers age at birth (years)							
14–19	8.4 (895)	31.8 (283)	68.2 (612)	0.30 (0.25 to 0.36)	0.000	0.52 (0.42 to 0.64)	0.000
20–29	45.3 (5486)	48.5 (2660)	51.5 (2826)	0.61 (0.56 to 0.68)	0.000	0.78 (0.71 to 0.85)	0.000
30–39	43.7 (5578)	60.6 (3346)	39.4 (2232)	1		1	
>40	2.6 (344)	59.3 (208)	40.7 (136)	0.95 (0.74 to 1.21)	0.654	1.21 (0.92 to 1.60)	0.171
Maternal occupation							
Managerial and professional	22.9 (2907)	62.5 (1806)	37.5 (1101)	1		1	
Intermediate	13.3 (1621)	56.4 (922)	43.6 (699)	0.78 (0.67 to 0.90)	0.001	0.97 (0.83 to 1.14)	0.728
Small employers and own account workers	6.0 (695)	55.9 (387)	44.1 (308)	0.76 (0.64 to 0.91)	0.002	0.89 (0.74. 1.08)	0.236
Lower supervisory and Technical	2.8 (318)	54.3 (177)	45.7 (141)	0.71 (0.54 to 0.94)	0.015	1.13 (0.84 to 1.52)	0.413
Semiroutine and routine	18.1 (2140)	51.2 (1104)	48.8 (1036)	0.63 (0.56 to 0.71)	0.000	1.01 (0.88 to 1.17)	0.838
Non-employed	37.0 (4377)	45.6 (1978)	54.4 (2299)	0.50 (0.45 to 0.56)	0.000	1.03 (0.90 to 1.18)	0.691
Maternal academic qualification							
Degree(s)/postgraduate diplomas	19.0 (2525)	67.1 (1661)	32.9 (864)	1		1	
Higher education/teaching qualifications/diplomas	11.7 (1473)	58.4 (854)	41.6 (619)	0.69 (0.59 to 0.80)	0.000	0.82 (0.69 to 0.96)	0.015
A/AS/S-levels	9.4 (1187)	56.8 (682)	43.2 (505)	0.64 (0.54 to 0.77)	0.000	0.78 (0.65 to 0.93)	0.007
O-levels/GCSE grades A-C	32.1 (3787)	51.4 (1940)	48.6 (1847)	0.52 (0.46 to 0.59)	0.000	0.70 (0.61 to 0.82)	0.000
GCSE grades D-G	10.8 (1242)	46.4 (571)	53.6 (671)	0.42 (0.36 to 0.50)	0.000	0.71 (0.58 to 0.86)	0.000
Other academic qualifications	2.3 (311)	44.7 (132)	55.3 (179)	0.40 (0.29 to 0.54)	0.000	0.76 (0.54 to 1.06)	0.102
None of these	14.8 (1776)	35.7 (657)	64.3 (1119)	0.27 (0.23 to 0.32)	0.000	0.56 (0.47 to 0.67)	0.000

Continued

Table 3 Continued

	Weighted % (n)			Unadjusted regression		Adjusted regression	
	Sent	Reliable data acquired	Reliable data not acquired	OR (95% CI)	p Value	OR (95% CI)	p Value
Lone parent status							
Non-lone parent	77.8 (9749)	56.4 (5498)	43.6 (4251)	1		1	
Lone parent	22.2 (2554)	39.5 (999)	60.5 (1555)	0.50 (0.45 to 0.56)	0.000	0.75 (0.65 to 0.86)	0.000
Number of children in the household							
1	12.8 (1558)	46.4 (726)	53.7 (832)	0.70 (0.61 to 0.79)	0.000	0.83 (0.71 to 0.96)	0.012
2–3	73.2 (8926)	55.4 (4957)	44.6 (3969)	1		1	
≥4	14.0 (1819)	44.1 (814)	55.9 (1005)	0.64 (0.55 to 0.73)	0.000	0.82 (0.71 to 0.95)	0.009
Household language							
English only	90.5 (10 688)	53.9 (5795)	46.1 (4893)	1		1	
English and other	9.0 (1536)	40.6 (666)	59.4 (870)	0.58 (0.50 to 0.68)	0.000	0.94 (0.74 to 1.19)	0.616
Non-English speaking	0.5 (79)	42.8 (36)	57.2 (43)	0.64 (0.37 to 1.10)	0.106	1.15 (0.60 to 2.21)	0.681
Whether anyone smokes near the child							
No	86.1 (10 640)	54.5 (5787)	45.5 (4853)	1	0.000	1	
Yes	13.9 (1617)	42.1 (701)	57.9 (916)	0.61 (0.56 to 0.74)		0.90 (0.78 to 1.05)	0.194
Whether mother is in work or not							
In work or leave	62.4 (7768)	57.0 (4443)	43.1 (3325)	1		NA	NA
Not in work or leave	37.6 (4535)	45.6 (2054)	54.4 (2481)	0.63 (0.59 to 0.72)	0.000		
Main housing tenure							
Own outright, full or part mortgage/loan	63.7 (8174)	60.2 (4873)	39.8 (3301)	1		1	
Rent for local authority or housing association	24.3 (2733)	38.5 (1047)	61.5 (1686)	0.41 (0.40 to 0.46)	0.000	0.79 (0.68 to 0.92)	0.002
Rent privately	9.8 (1075)	42.5 (447)	57.5 (628)	0.49 (0.42 to 0.57)	0.000	0.78 (0.66 to 0.92)	0.003
Other	2.1 (238)	41.6 (97)	58.4 (141)	0.47 (0.36 to 0.62)	0.000	0.87 (0.63 to 1.19)	0.382
Type of accommodation							
House or bungalow	90.1 (11 210)	54.3 (6054)	45.7 (5156)	1		1	
Flat or maisonette	9.5 (1033)	38.3 (416)	61.7 (617)	0.52 (0.45 to 0.61)	0.000	0.87 (0.72 to 1.05)	0.141
Studio, room, bedsit, other	0.4 (46)	47.4 (24)	52.6 (22)	0.76 (0.38 to 1.52)	0.433	0.81 (0.40 to 1.67)	0.572
Household income							
<£10 400	12.5 (1503)	36.7 (552)	63.3 (951)	0.33 (0.28 to 0.39)	0.000	1.20 (0.95 to 1.50)	0.121
£10 400–£20 800	26.6 (3381)	43.4 (1485)	56.6 (1896)	0.43 (0.37. 0.50)	0.000	1.17 (0.97 to 1.42)	0.105
£20 800–£31 200	23.1 (2915)	56.4 (1651)	43.6 (1264)	0.73 (0.63 to 0.84)	0.000	1.28 (1.08 to 1.52)	0.004
£31 200–£52 000	25.2 (3065)	61.5 (1895)	38.5 (1170)	0.90 (0.79 to 1.03)	0.115	1.17 (1.01 to 1.35)	0.035
>£52 000	12.5 (1428)	64.0 (913)	36.0 (515)	1		1	
Behavioural							
Disability or illness that limits activity							
No	93.7 (11 555)	53.6 (6192)	46.4 (5363)	1		1	
Yes	6.3 (748)	39.5 (305)	60.5 (443)	0.57 (0.48 to 0.67)	0.000	0.68 (0.56 to 0.82)	0.000
Frequency of sport or exercise							
3 or more days/week	20.3 (2483)	62.6 (1544)	37.4 (939)	1		1	
2 days/week	21.3 (2602)	61.4 (1576)	38.6 (1026)	0.95 (0.82 to 1.09)	0.457	1.03 (0.89 to 1.18)	0.701

Continued

Table 3 Continued

	Weighted % (n)			Unadjusted regression		Adjusted regression	
	Sent	Reliable data acquired	Reliable data not acquired	OR (95% CI)	p Value	OR (95% CI)	p Value
1 day/week	26.0 (3227)	51.5 (1662)	48.5 (1565)	0.63 (0.56 to 0.72)	0.000	0.80 (0.70 to 0.91)	0.001
Less often or not at all	32.4 (3955)	41.9 (1708)	58.1 (2247)	0.43 (0.38 to 0.49)	0.000	0.73 (0.64 to 0.83)	0.000
Hours per weekday that child spends watching TV							
Less than an hour/not at all	19.2 (2411)	54.8 (1337)	45.2 (1074)	1		1	
1–3 h	64.8 (7891)	53.3 (4205)	46.7 (3686)	0.94 (0.84 to 1.06)	0.316	1.09 (0.96 to 1.24)	0.170
3–5 h	11.3 (1330)	47.3 (640)	52.7 (690)	0.74 (0.62 to 0.88)	0.001	1.07 (0.89 to 1.28)	0.490
>5 h	4.8 (632)	49.5 (308)	50.5 (324)	0.81 (0.64 to 1.02)	0.078	1.19 (0.93 to 1.52)	0.168
Child ever breastfed							
Yes	66.9 (8425)	43.5 (1691)	56.5 (2187)	0.58 (0.52 to 0.64)	0.000	0.81 (0.74 to 0.91)	0.000
No	33.1 (3878)	57.2 (4806)	42.8 (3619)	1		1	
Environmental							
Access to garden							
No	7.4 (803)	37.7 (315)	62.3 (488)	0.52 (0.42 to 0.63)	0.000	1.00 (0.75 to 1.22)	0.982
Yes	92.6 (11 486)	53.9 (6179)	46.1 (5307)	1		1	
Ward type							
Advantaged	57.7 (5237)	58.8 (3193)	41.2 (2044)	1		1	
Disadvantaged	36.4 (5622)	45.1 (2705)	54.9 (2917)	0.58 (0.52 to 0.65)	0.000	0.84 (0.75 to 0.95)	0.006
Ethnic	6.0 (1444)	39.8 (599)	60.3 (845)	0.46 (0.40 to 0.54)	0.000	1.05 (0.83 to 1.33)	0.668
Regions in England							
North East	3.5 (339)	50.6 (173)	49.4 (166)	0.55 (0.37 to 0.82)	0.004	NA	NA
North West	10.9 (1025)	48.7 (466)	51.3 (559)	0.48 (0.36 to 0.66)	0.000		
Yorkshire and the Humberside	8.6 (892)	54.0 (438)	46.0 (454)	0.60 (0.43 to 0.84)	0.003		
East midlands	7.4 (682)	61.3 (400)	38.7 (282)	0.84 (0.60 to 1.19)	0.338		
West Midlands	8.2 (913)	53.5 (451)	46.5 (462)	0.60 (0.43 to 0.83)	0.002		
East of England	9.6 (901)	62.3 (534)	37.7 (367)	0.87 (0.66. 1.16)	0.346		
London	10.8 (1230)	48.7 (577)	51.3 (653)	0.52 (0.38 to 0.70)	0.000		
South East	14.6 (1233)	58.9 (713)	41.1 (520)	0.78 (0.59 to 1.02)	0.068		
South West	8.3 (709)	64.4 (448)	35.6 (261)	1			
Wales	5.0 (1755)	56.0 (899)	44.0 (856)	0.65 (0.50 to 0.85)	0.002		
Scotland	9.1 (1421)	54.8 (761)	45.2 (660)	0.64 (0.48 to 0.86)	0.003		
Northern Ireland	4.0 (1201)	54.9 (636)	45.1 (565)	0.68 (0.52 to 0.91)	0.010		
Isle of Man/Channel Islands	0.02 (2)	61.4 (1)	38.6 (1)	0.96 (0.06 to 15.02)	0.978		
Country							
England	64.7 (7936)	53.0 (4204)	47.1 (3732)	1		1	
Wales	14.1 (1748)	51.2 (898)	48.8 (850)	0.93 (0.81 to 1.07)	0.304	0.96 (0.84 to 1.09)	0.521
Scotland	11.5 (1422)	51.5 (761)	48.5 (661)	0.94 (0.79 to 1.12)	0.520	0.94 (0.78 to 1.14)	0.520
Northern Ireland	9.8 (1197)	52.6 (634)	47.4 (563)	0.99 (0.83 to 1.17)	0.869	0.99 (0.81 to 1.21)	0.895

Frequencies of missing data: ethnicity (82); BMI (149); occupation (245); academic (2); smoking (46); housing tenure (83), accommodation (14); income (11); sport (36); TV (39); garden (14).
BMI, body mass index.

Predictors of non-response in a UK-wide children's accelerometer study

Table 4 Predictors of study non-consent and non-receipt of reliable accelerometer data in the Millennium Cohort accelerometer Study

Study non-consent	Non-return of reliable accelerometer data
	Biological
	▶ Boys
	▶ Non-white, mixed or 'other' ethnicity children
	▶ Overweight or obese children
	Social
	▶ Younger mothers (<30 at birth of cohort child)
	▶ Mothers without a degree
	▶ Lone parents
	▶ Households with 1 or ≥4 children
	▶ Children who lived in rented accommodation
Behavioural	*Behavioural*
▶ Children with a limiting illness or disability	▶ Children with a limiting illness or disability
▶ Children who did not have people smoking near them	▶ Children who exercised once a week or less
	▶ Children who had been breastfed
Environmental	*Environmental*
▶ Children who had access to a garden	▶ Children from disadvantaged wards
▶ Children who lived in Northern Ireland	

no differences between boys and girls according to the number of days of reliable data they provided. Other large-scale studies using face-to-face distribution methods have investigated potential predictors of reliable data acquisition using a range of factors, but the findings are inconsistent. In four studies, younger children were more likely to provide reliable accelerometer data than older children,[3] [20–22] whereas another three found no age differences.[10] [16] [19] In agreement with our study, boys were less likely to provide reliable data than girls in the Avon Longitudinal Study of Parents and Children (ALSPAC)[20] and the UK Children's Health and Activity Monitoring Program.[13] In contrast, the National Health and Nutrition Examination Survey[3] and the SPEEDY study[17] reported that girls were less likely to return reliable data than boys: no gender differences in reliable data acquisition were reported in several other studies.[10] [19] [21] In contrast to our study, no ethnic differences according to reliable data acquisition were reported by previous studies.[5] [13] [19] [21] The majority of previous studies report that weight status was not related to reliable data acquisition.[10] [13] [16] [39] However, in agreement with our study, overweight children were less likely to return reliable data than non-overweight children in the ALSPAC,[20] whereas overweight children were more likely to provide reliable data than non-overweight children in Project EAST[19]

Few studies have investigated behavioural predictors of reliable data acquisition.[10] [16] [21] No previous studies have reliably investigated whether PA predicts non-response. However, the Physical Exercise and Appetite in Children Study reported that they were more likely to acquire reliable data from physically active children than those who were less active.[10] In contrast, Sirard et al[21] reported that PA levels did not predict whether children returned reliable accelerometer data. Both studies compared the PA levels of children who did and did not return reliable

data; however, PA is not reliably estimated in children without reliable data. Only studies with an alternative measure of activity can accurately estimate PA differences in non-response. Few studies have investigated social and environmental factors as potential predictors of reliable data acquisition, although studies have looked at socioeconomic status,[10] child deprivation,[13] local and area independent mobility,[16] child[19] and parental[17] education and free school meal status.[22]

Strengths and limitations

The MCS4 is the first large-scale longitudinal cohort study to objectively measure PA in a socially and ethnically diverse population of children from all four UK countries. This is also the first large-scale accelerometer study using a postal distribution methodology to investigate the predictors of non-response associated with study non-consent and non-return of reliable data. The MCS provided a range of biological, social, behavioural and environmental information on children, their families and their environment, which enabled us to simultaneously examine a broad range of potential predictors. As this is a contemporary cohort, the findings of this study are applicable to the lives of young children now. Furthermore, we have used a robust accelerometer wear time threshold to define children with reliable data.[33]

However, our findings may not be applicable to different ages. PA levels vary according to age, and children's PA is very different from adult's PA in many respects;[3] it is therefore unlikely that without further research the findings of this study can be applied to adult populations. Age has also been shown to be related to the return of reliable accelerometer data in several studies.[3] [20–22] In addition, although the UK country of residence did not predict non-response in our study, our findings may differ in other studies involving samples of children living in non-UK countries.

Many of the predictor variables in this study were based on parent-report measures, and therefore recall bias may have influenced the information collected. For example, maternal reports of smoking near the child at the age 7 sweep may have been underreported, although any underestimate in this is likely to lead to an underestimate of the effect.[40] However, the information collected within the MCS using parent-report methods has been shown to be valid and reliable.[41][42] Non-consent for children who did not have people smoking near them may reflect highly protective parents. A small number of the MCS children had missing data for the predictor variables. Since the MCS has a large sample size, imputing data for these missing variables would only increase the sample size by a small proportion. Several factors that were not investigated within this study may also influence non-response, for example, who the cohort children were interviewed by, whether they were sent, or tried to return an accelerometer during a postal strike, or which reminder methods were sent to the family to encourage return of the accelerometer.

Recommendations for study practice and further research

This study has reported the biological, social, behavioural and environmental factors associated with non-response in a PA study using postal methods to distribute and return accelerometers. Researchers should be aware of these factors and recognise potential bias occurring as a result of this methodology so that future studies can implement strategies to reduce the threat of data loss. For example, we found that the language spoken by the cohort families at MCS4 did not influence consent. This may be because non-English speaking families were offered translated versions of all study documents, and a translator was made available at the study interview. However, consent was less likely from children living in Northern Ireland; this may be because a different field-work agency conducted the home interviews in Northern Ireland than in England, Wales and Scotland. Considerable efforts are required by researchers and parents to encourage boys, non-white and overweight/obese children to wear and return their accelerometer as requested so that we can acquire reliable data from these populations. Lone parents and families with a large number of children may not have returned their child's accelerometer because they forgot, or did not have the time to do so. Therefore, it is crucial that studies issue timely reminders throughout fieldwork, and in particular, to these populations. Caution should also be taken if sampling children with an illness or disability that limits daily activity as non-response was very high among these children and may therefore bias study findings.

Further research should be aimed at investigating whether the predictors of non-response identified in this study also predict non-response in other large-scale accelerometer studies across different age groups and countries, and in studies using different accelerometer distribution and return methods. If studies are unable to increase response in the populations identified in our study, then researchers need to be aware of their influence on the validity of findings, and control for these factors in associated analyses. An important finding was that children who were reported to exercise once a week or less were less likely to return reliable data. As a result, study findings may be biased as inferences about the PA levels of the population that are based on the observed sample may not be the same as those based on the target sample. However, the PA predictor variable was based on the parent-proxy report of their child's usual weekly frequency of sport or any other PA. The limitations associated with parent-proxy reports of children's PA have been well defined.[43] Although it is beyond the scope of the study, several statistical methods to deal with missing data have been developed and their performance in reducing estimation bias depends on the quality of the models that underpin them.[44] Current work is being undertaken to develop response propensity weighting adjustments in the MCS4 accelerometer study.

CONCLUSION

Researchers should be aware of factors associated with non-response in a large-scale accelerometer study that uses postal distribution and return methods so that future studies can implement strategies to reduce the threat of data loss. Accelerometer studies in children who use our postal methodology need to encourage data return from boys, overweight/obese and non-white children, mothers who are young or who have few qualifications, families with only one parent or a large number of children, children who exercise less than twice a week and children living in various forms of disadvantaged circumstances. If studies are unable to increase response in these sections of the population, then researchers should weight analyses to account for non-response.

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