

## The HomeSPACE-II instrument

1 Validity and reliability of the HomeSPACE-II instrument to assess the influence  
2 of the home physical environment on children's physical activity and sedentary  
3 behaviour

#### 4 **Abstract**

5 The home physical environment has an important influence on children's physical activity  
6 levels and time spent in sedentary behaviours. The aim of this study was to validate the  
7 HomeSPACE-II instrument for use in two-storey homes, to measure physical environmental  
8 factors that influence children's physical activity and sedentary behaviours within the home.  
9 Parents (n=31) with at least one child aged 9-13 years, completed the instrument  
10 independently alongside a criterion-trained researcher, then one week later alone, to assess  
11 validity and reliability, respectively. Parents were mostly female (87.1%) and university  
12 educated (61.3%) with a mean age of  $41.68 \pm 4$  years, while houses were mostly semi-  
13 detached or terraced (61.3%) with two parents (87.1%). Intra-class correlation coefficients,  
14 Pearson correlation coefficients and Kappa statistics revealed that most items, outside of  
15 accessibility and size measures, had strong reliability and validity (94% having ICC > 0.60  
16 and 97% having  $r > 0.80$ ). Excluding physical activity equipment, accessibility items with  
17 lower reliability and validity had low between-subject variation. The HomeSPACE-II  
18 instrument covers a wide range of parameters within the home and demonstrated strong  
19 validity and reliability, suggesting it is a useful tool for measuring physical factors that  
20 influence children's physical activity and sedentary behaviour within the home.

21 **Keywords:** Measurement, youth, screen time, house, families

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## 24 **Introduction**

25 The importance of physical activity (PA) for disease prevention and health promotion in  
26 children is well established (Poitras et al. 2016). Conversely, time spent sedentary,  
27 particularly using screens, has been associated with poor health outcomes (Carson et al.  
28 2016). Despite this, few children meet the current PA and sedentary behaviour  
29 recommendations (Department of Health Physical Activity 2011). The social ecological  
30 model is used to contextualise the determinants of children's sedentary behaviour and PA  
31 (Veitch et al. 2013; Wilk et al. 2018). This model emphasises the influence of the  
32 environment and posits that behaviours are most likely influenced by the setting in which  
33 they occur (Bronfenbrenner 1977; Sallis et al. 2006). Outside of school, children spend  
34 significant time within their home and neighbourhood environments. The influence of the  
35 neighbourhood environment on children's PA levels and sedentary behaviour has been well  
36 studied, where proximity to parks and recreation areas have been positively associated with  
37 PA (Tappe et al. 2013), and neighbourhood safety has been negatively associated with  
38 sedentary behaviour (Côté-Lussier, Mathieu, and Barnett 2015). However, children have less  
39 independent mobility (Karsten 2005) and therefore opportunities for active free play (J.  
40 Veitch, Salmon, and Ball 2008) in their neighbourhoods compared with previous generations.  
41 Given that children spend considerable time at home (Karsten 2005), an improved  
42 understanding of its influence on PA and sedentary behaviour is imperative for developing  
43 effective interventions.

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45 To date, research into the influence of the home environment on children's PA and  
46 sedentary behaviour has focused on the social environment, with the physical environment  
47 receiving little attention (Maitland et al. 2013; Kaushal and Rhodes 2014). Nonetheless, there  
48 is a consistent positive relationship between the quantity of media equipment within the home

49 (Rosenberg et al. 2010; Sirard et al. 2010), its presence within a child’s bedroom (Atkin,  
50 Corder, and van Sluijs 2013; Tandon et al. 2012), and screen-based sedentary behaviours.  
51 There is limited evidence for an association between PA equipment and PA levels (Maitland  
52 et al. 2013). Moreover, some studies have reported an inverse relationship between media  
53 equipment and PA (Wong et al. 2010; Ridgers et al. 2010), and between PA equipment and  
54 sedentary behaviour (Rosenberg et al. 2010; Sirard et al. 2010), but evidence is inconclusive  
55 (Maitland et al. 2013). Similarly, whilst PA at home is most likely to occur outdoors (Biddle  
56 et al. 2009), the relationship between garden space and PA remains equivocal (Page et al.  
57 2010; Trang et al. 2009). Even though the evidence base is growing, there remains a paucity  
58 of research investigating the home physical environment, outside of PA and media  
59 equipment.

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61 In addition, most home environment measurement tools only assess the availability of  
62 equipment, without considering its accessibility, thus limiting investigation. Accessibility is  
63 associated with “ease of use and cueing of behaviour” (Sirard et al. 2008)<sup>p.2</sup>, therefore, a  
64 readily available item posing little barrier to use may act as an important prompt to engage in  
65 a behaviour. Studies investigating accessibility have reported a positive relationship between  
66 the accessibility of PA equipment and accelerometer-derived PA in children (Sirard et al.  
67 2010; Hales et al. 2013; Gattshall et al. 2008), as well as the accessibility of media equipment  
68 and screen-time in girls (Sirard et al. 2010). Hales et al. (2013) also found that only the  
69 accessibility, and not availability, of portable play equipment was positively associated with  
70 children’s outdoor play (Hales et al. 2013). Taken together, these findings demonstrate the  
71 potential utility of accessibility in influencing behaviour, and accordingly the need to include  
72 a measure of accessibility in a measurement tool.

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74       Reviews (Maitland et al. 2013; Kaushal and Rhodes 2014) recommended that more  
75       objective measurement tools are needed to improve our understanding of how the home  
76       physical environment influences children’s PA and sedentary behaviour. Sirard et al. (2008)  
77       developed a valid and reliable PA and media equipment inventory (PAMI), a room-level  
78       home audit which records the availability and accessibility of PA and media equipment in  
79       homes. Similarly, Pinard et al. (2014) created a parent-report instrument to measure PA and  
80       media equipment in low income family homes, however in-home observation was not used to  
81       assess criterion validity. Lastly, the HomeSTEAD instrument (Hales et al. 2013) underwent  
82       rigorous validity and reliability and it provides a more comprehensive assessment, including  
83       a large range of PA and media items as well as garden characteristics, although it did not  
84       include room-level location for most items. Whilst these provide valid and reliable  
85       assessments of media and PA equipment at home, instruments which explore other physical  
86       environmental factors in detail are lacking.

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88       The HomeSPACE-I instrument (Maitland et al. 2018) advanced previous instruments by  
89       measuring previously unexplored characteristics of the physical home environment such as  
90       musical instruments, room/area size and furniture, as well as providing room-level data,  
91       assessing garden size and outdoor features. Thus, the HomeSPACE-I instrument allows a  
92       more detailed assessment of the physical home environment than previous instruments  
93       (Sirard et al. 2008; Hales et al. 2013). The HomeSPACE-I instrument was designed and  
94       validated for use in Western Australia (WA) where homes are typically one-storey, thereby  
95       potentially limiting its appropriateness for use in countries with predominantly two-storey  
96       homes. Specifically, one-storey homes are often open plan and have less separation between  
97       the bedroom and living areas, and therefore likely to impact family interaction as well as  
98       parents’ ability to monitor children’s electronic media usage. One-storey homes can offer

99 families more freedom to design the layout to suit their preferences and priorities, which may  
100 or may not be aligned to promotion of healthy behaviours. In contrast, two-storey homes  
101 have a smaller footprint, which generally allows more outdoor space when on a similar sized  
102 plot. Such inherent layout and design differences highlight the necessity for the HomeSPACE  
103 instrument to be validated for use in two-storey homes.

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105 The HomeSPACE-II instrument was developed for use in two-story homes with the added  
106 measure of accessibility, to measure parameters of the home physical environment that  
107 influence children's PA and sedentary behaviours. The construct validity of the measure has  
108 been established previously, with significant associations between several home physical  
109 environmental factors assessed by the instrument and children's objectively measured home-  
110 based sitting and PA in the expected directions being found (Sheldrick et al. 2019).

111 Specifically, home-based sitting time was negatively associated with musical instrument  
112 accessibility and availability, perceived house size, and an open plan living area, and  
113 positively associated with media equipment availability and accessibility. Total physical  
114 activity (TPA) levels at home were also positively associated with the number of floors in the  
115 home and an open plan living area. The present study aimed to test the criterion validity and  
116 reliability of the HomeSPACE-II instrument.

## 117 **Method**

### 118 ***Participants***

119 A convenience sample and parents of children participating in the Swan-Linx school  
120 health, fitness and wellbeing project (Sheldrick et al. 2018) were provided with information  
121 about the study. Thirty-one families, 22 via Swan-Linx and nine from the convenience  
122 sample, living in the two largest conurbations in South Wales (Cardiff and Swansea) agreed  
123 to participate. Families had at least one child aged 9 to 13 years and a parent or guardian

124 prepared to complete the audit on two separate occasions. Family passes for a local water  
125 park were offered as an incentive for participating in the study. The institutional ethics  
126 committee approved the study.

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### 128 *HomeSPACE-II instrument*

129 The HomeSPACE-II instrument measures the physical environment of the home space in  
130 relation to children's PA and sedentary behaviour, and was based on the audit section of its  
131 Australian counterpart (Maitland et al. 2018). However, the instrument was adapted to  
132 include equipment most relevant to home-based activity in the UK, and to assess the  
133 accessibility as well as the availability of each item and where appropriate questions were  
134 adapted to the UK context. A draft instrument was reviewed by researchers with over 10  
135 years of experience in the field of children's PA and sedentary behaviour (GS and CM). The  
136 instrument and full study procedure were then pilot tested with a convenience sample of two  
137 families. At the end of the home visits, parents provided verbal feedback on the audit and  
138 home visit data collection protocol. Based on their feedback the audit was refined to improve  
139 instruction clarity, the magazines item was moved to the questions section, and items  
140 commonly found in UK households such as a football net, frisbee, skipping rope, hula hoop,  
141 table football and swing ball were added, and a spa was removed.

142 The final instrument incorporated 39 equipment items, and allowed the presence, amount  
143 and accessibility of each item, as well as room size (perceived), to be recorded for up to 14  
144 rooms indoors and eight areas outdoors (see instrument provided as a supplementary file).  
145 Accessibility was rated on a scale of A-D, using developed and validated scores (Sirard et al.  
146 2008). The response options were; A: put away and difficult to get to; B: put away and easy  
147 to get to; C: in plain view and difficult to get to; D: in plain view and easy to get to. The

148 accessibility options were designed to also account for the condition of an item. For example,  
149 a punctured football in plain view should be given a C rating, while a tennis racquet in usable  
150 condition and in plain view should be given a D rating. Instructions and examples were  
151 provided on the first page of the instrument. There were ten items assessing the presence of  
152 outdoor features in the front garden, back garden and verge. Items related to home features  
153 (home type, home size, number of storeys, stairs, fencing and adjacency to public open  
154 space) were also included. In addition, there were questions for home equipment (books,  
155 magazines, DVDs, TV channels, electronic games, active electronic games, smartphones,  
156 internet service, dogs and other pets) that could not be assessed by the room-level audit.

### 157 ***Procedures***

158 Participant home visits were conducted during February to May 2016. Parents were  
159 provided the study information prior to the visit. Under ethical guidelines, written informed  
160 consent was received upon arrival and all family members provided verbal permission for the  
161 home visit. One parent/guardian was required to walk around their home and complete the  
162 instrument, while a criterion-trained researcher simultaneously, but independently, completed  
163 the instrument. Parents were asked not to communicate with the researcher during the audit.  
164 If items were hidden, such as underneath furniture, parents were asked to make them visible.  
165 At the end of the visit, parents were given a second copy of the instrument, which they were  
166 asked to complete one week later and return via a pre-paid envelope. All the data collected  
167 was kept private and confidential.

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### 169 ***Data Reduction***

170 Individual items, features and the number of items within each accessibility group were  
171 collated into category summary scores (Table 1). Density measures were calculated by  
172 dividing the category summary scores by the total number of indoor rooms, outdoor areas or  
173 total rooms/locations in the house. Summary scores that accounted for the accessibility and  
174 availability of the media equipment, PA equipment, musical instrument and seated furniture  
175 items were also created by multiplying each item by their accessibility scores (A=1; B=2;  
176 C=3; D=4). The higher the score, the greater the overall “presence” of the type of item in the  
177 home. Further, an overall home environment score was calculated to assess whether a home  
178 was more conducive to physical activity or sedentary behaviour. The score was calculated as  
179 the ratio of PA equipment summary score to media equipment summary score (activity:  
180 media ratio score). A higher score would reflect a home more likely to facilitate PA and  
181 discourage sedentariness.

## 182 *Demographics*

183 Parents reported their age, place of birth, sex, educational status, as well as the postcode,  
184 sex and age of primary child, family situation, homeowner status and the main language  
185 spoken at home. Additionally, postcodes (i.e., zip codes) were used to generate Welsh Index  
186 of Multiple Deprivation (WIMD) scores, using the National Statistics Postcode Directory  
187 database, as an indication of socioeconomic status (SES). The WIMD scores, consider eight  
188 domains of deprivation; employment; health; income; housing; community safety; access to  
189 services; education and the environment (Noble et al. 2006). Small areas in Wales are ranked  
190 from 1-1909, with 1 being the most deprived and 1909 being the least deprived. Tertiles of  
191 SES were formed: Low (WIMD score = 1-636), medium (WIMD score=636-1272) and high  
192 (WIMD score=1272-1909).

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## 194 *Statistical Analysis*

195 For continuous variables, criterion validity was assessed by examining agreement  
196 between the “gold standard” trained researcher and the participant using Pearson correlation  
197 coefficients and 95% limits of agreement. Mean differences between the researcher and the  
198 participant were evaluated using two-tailed paired t-tests. Test-retest reliability between  
199 participants at time-points was evaluated using intraclass correlation coefficients (ICC; 95%  
200 confidence intervals displayed). ICCs were rated using cut-off points of: < 0.40 (poor); 0.40  
201 to 0.59 (fair); 0.60 to 0.74 (good); and 0.75 to 1.00 (excellent) (Cicchetti 1994).

202 For the categorical variables, validity and test-retest reliability were assessed by Cohen’s  
203 Kappa coefficients (CKC; 95% confidence intervals displayed). Kappa coefficients were  
204 interpreted as follows: < 0.00 (poor); 0.00 - 0.20 (slight); 0.21- 0.40 (fair); 0.41- 0.60  
205 (moderate); 0.61- 0.80 (substantial); and 0.81-1.00 (almost perfect) (Landis and Koch 1977).  
206 Statistical analyses, were conducted using IBM SPSS statistics 22 (IBM SPSS Statistics Inc.,  
207 Chicago, IL, USA), where significance was set at  $\leq 0.05$ .

## 208 **Results**

209 Demographic characteristics of the participating families are provided in Table 1. All  
210 parents (n=31) completed the HomeSPACE-II instrument at both time-points, where 87.1%  
211 were female, 61.3% held a university degree and 45.2% lived in the highest SES locations.  
212 Houses were mostly semi-detached or terraced (61.3%) with two parents (87.1%), and there  
213 were most often four occupants per home (48.4%), including two children (51.6%). Most  
214 participants reported they had either a medium or large-sized house (45.2% and 41.9%  
215 respectively), and a medium or large-sized garden (42% for both).

## 216 *Validity*

217 The results of the availability validation analysis are shown in Table 2. Pearson  
218 correlation coefficients between the researcher and parent were  $> 0.80$  for all the room/area  
219 summary variables, and  $\geq 0.84$  for the availability and density of PA equipment, musical  
220 instruments, media equipment and seated furniture. Three of four outdoor features  
221 correlations were  $> 0.90$ , only the “back garden” summary item fell below 0.70 ( $r = 0.65$ ).  
222 There were significant mean differences for five PA equipment categories, including sports  
223 equipment ( $p = 0.05$ ), PA equipment indoors ( $p = 0.01$ ) and in total ( $p = 0.03$ ), and the  
224 density of PA equipment indoors ( $p = 0.02$ ) and in total ( $p = 0.03$ ). Significant mean  
225 differences were also noted for three seated furniture categories; seated furniture indoors ( $p =$   
226  $0.03$ ) and in total ( $p = 0.03$ ), and the density of seated furniture indoors ( $p = 0.05$ ).

227 Table 3 contains the results for the accessibility variables. Correlation coefficients  
228 between the researcher and participant were  $\geq 0.35$  across all four accessibility ratings for PA  
229 equipment (total, indoor and outdoor), media equipment and musical instruments. Correlation  
230 coefficients for three accessibility ratings for seated furniture (total, indoor and outdoor) fell  
231 below 0.18. Correlation coefficients for the number of items recorded as “in plain view and  
232 easy to get to” were most favourable, where six of eight were  $\geq 0.80$  (Table 3). Average  
233 accessibility ratings for three of eight item categories achieved correlation coefficients  $\leq$   
234  $0.35$ . Mean differences were noted between the researcher and participant for four  
235 accessibility ratings, with the researcher recording a greater number of PA equipment items  
236 indoors as “in plain view and easy to get to” ( $p = 0.02$ ) and both outdoors and in total as “put  
237 away and easy to get to” (both  $p = 0.01$ ), as well as more media equipment items as “in plain  
238 view and easy to get to” ( $p = 0.02$ ). Further, there were significant differences in average  
239 accessibility ratings for two item categories, with the researcher observing fewer PA  
240 equipment in total as harder to access ( $p = 0.04$ ) and more PA equipment outdoors as harder  
241 to access ( $p = < 0.01$ ).

242 Correlation coefficients were high for the calculated accessibility and availability  
243 summary scores ( $r > 0.75$  [number of items \* accessibility rating]) [Table 2] and for the PA:  
244 Media ratio score (the ratio of PA equipment summary score to the media equipment  
245 summary score [ $r = 0.70$ ]; Table 3). However, the media equipment accessibility and  
246 availability summary score was significantly greater for the researcher ( $p = 0.02$ ).

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248 Validation results for the categorical variables are provided in Table 4. All variables  
249 assessing adjacent space showed almost perfect agreement ( $K > 0.80$ ) and those assessing  
250 home design showed either substantial or almost perfect agreement ( $K \geq 0.69$ ). Validity for  
251 seven out of 14 size measures showed either substantial or almost perfect agreement ( $K \geq$   
252  $0.63$ ), and the remaining seven demonstrated fair or moderate agreement ( $K = 0.24 - 0.58$ ).

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### 254 ***Reliability***

255 For test-retest reliability, ICCs for 28 of the availability variables were excellent ( $ICC \geq$   
256  $0.76$ ), with the other 6 being either fair or good ( $ICC = 0.52 - 0.73$ ; Table 2). For the majority  
257 of the categorical variables, Cohen's Kappa was either substantial or almost perfect ( $K >$   
258  $0.61$ ; Table 4). Most other kappa coefficients were moderate ( $K = 0.41 - 0.60$ ), however one  
259 item, hall size, was fair ( $K = 0.28$ ).

260 As shown in Table 3, most of the ICCs for the accessibility categories were either  
261 excellent or good ( $ICC > 0.60$ ). Across the accessibility summary categories, the highest  
262 ICCs were found for the number of items rated as "put away and difficult to get to" and "in  
263 plain view and easy to get to", where six of seven and five of eight, respectively, were  
264 excellent ( $ICC \geq 0.75$ ). Conversely, the lowest ICCs were found for the number of items  
265 rated as "in plain view and difficult to get to", with five of eight being poor ( $ICC = -0.03 -$

266 0.32). In terms of average accessibility ratings, all but one of the item categories achieved fair  
267 to excellent ICCs  $\geq 0.42$ ; the ICC for musical instruments was poor (ICC = 0.15). Reliability  
268 was excellent between the parent at Time 1 and Time 2 for all four accessibility and  
269 availability summary scores (ICC  $\geq 0.84$ ; Table 2), and for the PA: Media Ratio score (ICC =  
270 0.79; Table 3).

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291 **Table 1-Descriptive statistics of the study sample**  
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		Both validity and reliability and Sample <i>n</i> =31 %	Families from Swansea <i>n</i> =22 %	Families from Cardiff <i>n</i> =9 %
<b>Family Characteristics</b>				
Parent age, mean (SD)		41.67 (4.04)	41.68 (4.20)	41.67 (5.46)
Parent sex	Female	87.1%	90.9%	77.8%
	Male	12.9%	9.1%	22.2%
Parent country of birth	Wales	74.2%	72.7%	77.8%
	England	16.1%	13.6%	22.2%
	Other	9.7%	13.6%	-
Primary child age, mean (SD)		10.15 (0.98)	10.16 (0.78)	10.11 (1.45)
Primary child sex	Girl	48.4%	36.4%	77.8%
	Boy	51.6%	63.6%	22.2%
Main language spoken at home	English	83.9%	77.3%	100%
	Welsh	12.9%	18.2%	-
	Other	3.2%	4.5%	-
Number of children at home	1	12.9%	13.6%	11.1%
	2	51.6%	50%	55.6%
	3	25.8%	22.7%	33.3%
	≥ 4	9.7%	13.6%	-
Number of people at home	≤ 3	12.9%	18.2%	0
	4	48.4%	45.4%	55.6%
	≥ 5	38.7%	36.4%	44.4%
Parental education	≤ Secondary school	12.9%	18.1%	-
	Trade or Diploma	25.8%	18.1%	44.4%
	University degree	61.3%	63.6%	55.6%
SES (based on WIMD scores)	High	45.2%	45.5%	44.4%
	Medium	38.7%	31.8%	55.6%
	Low	16.1%	22.7%	-
Family situation	Single parent	9.7%	13.6%	-
	Two parents	87.1%	86.4%	88.9%
	Other	3.2%	-	11.1%
Home ownership	Rent	12.9%	18.2%	-
	Owner	87.1%	81.8%	100%
<b>Home characteristics</b>				
House type	Detached house	38.7%	40.9%	33.3%
	Semi-detached or terrace house	61.3%	59.1%	66.7%
House size	Small	12.9%	9.1%	22.2%
	Medium	45.2%	45.5%	44.4%
	Large	41.9%	45.5%	33.3%
Garden Size	No	-	-	-
	Small	16%	13.6%	22.2%
	Medium	42%	45.5%	33.3%
	Large	42%	40.9%	44.4%

293 **Table 2. Validity and reliability for home equipment and features—continuous variables.**  
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Home equipment and features	Time 1 (n=31)	Researcher (n=31)	Time 2 (n=31)	Validity Time 1 vs Researcher			Reliability Time 1 vs Time 2
				Pearson's correlation	t-test of means	Limits of agreement (95%)	Intraclass Correlation Coefficient (1,1)
				<i>r</i>	P-value		ICC (95% CI)
<b>ROOMS/ AREAS</b>							
Living rooms	4.32 (1.09)	4.29 (1.05)	4.35 (1.31)	0.96	0.57	(0.58, 0.65)	0.86 (0.73, 0.93)
Bedrooms	3.52 (0.76)	3.52 (0.76)	3.45 (0.66)	1	Constant	-	0.88 (0.76, 0.94)
<b>Total-Indoors</b>	7.84 (1.57)	7.81 (1.51)	7.81 (1.67)	0.98	0.57	(-0.58, 0.65)	0.89 (0.79, 0.95)
<b>Total-Outdoors</b>	3.26 (1.05)	3.35 (0.93)	3.45 (1.01)	0.83	0.37	(-1.27, 1.07)	0.53 (0.23, 0.74)
<b>Total-Home</b>	11.10 (2.28)	11.16 (2.16)	11.26 (2.37)	0.96	0.60	(-1.40, 1.27)	0.87 (0.75, 0.94)
<b>OUTDOOR FEATURES</b>							
Back garden	5.74 (1.16)	5.71 (1.05)	5.66 (1.40)	0.65	0.85	(-1.83, 1.89)	0.61 (0.32, 0.78)
Front garden	4.16 (2.11)	4.45 (2.06)	4.52 (1.92)	0.93	0.06	(-1.91, 1.33)	0.84 (0.69, 0.92)
Verge	1.23 (2.28)	1.19 (2.16)	1.38 (2.20)	0.97	0.77	(-1.15, 1.22)	0.95 (0.89, 0.98)
<b>Total-Outdoors</b>	11.13 (3.75)	11.35 (3.63)	11.55 (3.73)	0.91	0.45	(-3.41, 2.96)	0.87 (0.74, 0.94)
<b>PA EQUIPMENT</b>							
Sports	13.65 (9.52)	15.87 (10.83)	16.03 (11.25)	0.84	0.05*	(-10.75, 7.91)	0.78 (0.59, 0.89)
Transportation	8.81 (5.01)	9.06 (4.63)	8.48 (5.66)	0.94	0.42	(-3.69, 3.69)	0.81 (0.64, 0.90)
Fitness	1.65 (2.01)	1.90 (2.48)	1.94 (2.54)	0.94	0.13	(-2.08, 1.56)	0.86 (0.74, 0.93)
Outdoor play	2.77 (2.09)	2.90 (2.12)	2.90 (2.39)	0.90	0.46	(-2.01, 1.75)	0.86 (0.73, 0.93)
Indoor play	0.35 (0.54)	0.42 (0.75)	0.32 (0.59)	0.90	0.33	(-0.77, 0.64)	0.76 (0.56, 0.87)
Total-Indoors	6.03 (4.70)	7.19 (5.66)	6.71 (6.22)	0.91	0.01*	(-6.02, 3.70)	0.79 (0.61, 0.89)
Total-Outdoors	21.19 (12.69)	22.97 (13.31)	22.97 (14.94)	0.87	0.16	(-15.12, 11.57)	0.85 (0.71, 0.92)
<b>Total-Home</b>	27.23 (13.43)	30.16 (14.93)	29.68 (17.26)	0.88	0.03*	(-17.21, 11.34)	0.83 (0.67, 0.91)
Density-Indoors	0.83 (0.72)	0.98 (0.83)	0.88 (0.85)	0.92	0.02*	(-0.81, 0.52)	0.76 (0.55, 0.88)
Density-Outdoors	6.74 (4.06)	7.13 (4.41)	6.59 (3.81)	0.84	0.39	(-5.28, 4.49)	0.70 (0.46, 0.84)
<b>Density-Home</b>	2.50 (1.29)	2.79 (1.52)	2.62 (1.60)	0.89	0.03*	(-1.68, 1.10)	0.81 (0.65, 0.90)
<b>Summary score</b> <sup>1</sup>	80.26 (45.22)	83 (45.38)	91.16 (61.20)	0.77	0.63	(-62.96, 57.48)	0.84 (0.69, 0.92)
<b>MEDIA EQUIPMENT</b>							
Fixed	8.52 (3.65)	8.58 (3.54)	8.00 (4.29)	0.97	0.69	(-1.81, 1.81)	0.89 (0.78, 0.94)
Portable	5.03 (2.40)	5.46 (2.50)	5.10 (2.79)	0.88	0.07	(-2.83, 2.00)	0.81 (0.63, 0.90)
Bedrooms	3.94 (2.85)	4.00 (2.93)	3.81 (3.04)	0.99	0.49	(-1.07, 0.94)	0.90 (0.82, 0.95)
<b>Total-Home</b>	13.55 (4.88)	14.03 (4.71)	13.10 (5.92)	0.95	0.11	(-3.68, 2.71)	0.91 (0.83, 0.96)
<b>Density-Home</b>	1.22 (0.36)	1.26 (0.37)	1.16 (0.50)	0.90	0.17	(-0.28, -0.37)	0.82 (0.67, 0.91)
<b>Summary score</b> <sup>1</sup>	48.42 (17.40)	51.26 (16.51)	48 (22.32)	0.93	0.02*	(-15.10, 9.42)	0.93 (0.86, 0.97)
<b>MUSICAL EQUIPMENT</b>							
<b>Total-Home</b>	2.68 (2.31)	2.58 (2.37)	2.77 (2.15)	0.97	0.37	(-1.07, 2.14)	0.92 (0.83, 0.96)
<b>Density-Home</b>	0.24 (0.22)	0.23 (0.22)	0.24 (0.20)	0.96	0.38	(-0.11, 0.13)	0.92 (0.84, 0.96)
<b>Summary score</b> <sup>1</sup>	9.42 (8.16)	9.48 (9.00)	9.74 (7.83)	0.95	0.90	(-5.63, 5.50)	0.96 (0.92, 0.98)
<b>SEATED FURNITURE</b>							
Bedroom	2.52 (3.97)	2.58 (3.14)	2.32 (2.83)	0.92	0.78	(-2.54, 2.41)	0.81 (0.64, 0.90)
Total-Indoor	15.39 (8.29)	16.19 (8.74)	15.35 (9.81)	0.97	0.03*	(-4.80, 3.19)	0.91 (0.83, 0.96)
Total Outdoor	3.65 (4.04)	3.90 (4.21)	2.48 (3.99)	0.95	0.28	(-2.84, 2.32)	0.73 (0.49, 0.86)
<b>Total-Home</b>	19.03 (9.06)	20.10 (9.40)	17.84 (9.93)	0.96	0.03*	(-6.30, 4.17)	0.86 (0.74, 0.93)
Density-Indoors	1.90 (0.73)	2.01 (0.76)	1.89 (0.88)	0.93	0.05*	(-0.46, 0.68)	0.78 (0.59, 0.89)
Density-Outdoors	1.23 (1.31)	1.20 (1.18)	0.66 (0.97)	0.81	0.81	(-1.57, 1.57)	0.52 (0.19, 0.74)
<b>Density-Home</b>	1.70 (0.66)	1.78 (0.66)	1.55 (0.67)	0.97	0.46	(-0.38, -0.38)	0.72 (0.47, 0.84)
<b>Summary score</b> <sup>1</sup>	73.83 (35.90)	78.19 (37.23)	68.58 (38.51)	0.94	0.06	(28.63, 19.92)	0.85 (0.71, 0.92)

295 \* Significant difference ( $p < 0.05$ ) between parent at Time 1 and Researcher. <sup>1</sup> Accessibility and availability equipment  
 296 summary score.

297 **Table 3. Validity and reliability for accessibility of home equipment– continuous**  
 298 **variables**  
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Home equipment and features	Time 1 (n=31)	Observer (n=31)	Time 2 (n=31)	Validity		Reliability
				Time 1 vs Researcher		Time 1 vs Time 2
				Pearson's Correlation	t-test of means	Intraclass Correlation Coefficient (1.1)
	Mean (SD)	Mean (SD)	Mean (SD)	r	P-value	ICC (95% CI)
<b>PA EQUIPMENT</b>						
<b>Total-Home accessibility</b>						
A-Put away and difficult to get to	3.26 (6.83)	2.74 (4.38)	2.65 (5.90)	0.51	0.64	0.87 (0.75, 0.94)
B-Put away and easy to get to	8.29 (8.23)	13.90 (10.62)	8.45 (9.73)	0.39	0.01*	0.48 (0.16, 0.71)
C-In plain view and difficult to get	1.65 (4.18)	0.65 (1.98)	1.94 (3.59)	0.43	0.16	0.05 (-0.32, 0.40)
D-In plain view and easy to get to	13.87 (10.94)	12.71 (10.15)	16.45 (14.19)	0.46	0.57	0.74 (0.53, 0.87)
<b>Average accessibility rating (1-4)</b>	3 (0.69)	3.14 (0.71)	2.75 (0.57)	0.55	0.04 *	0.59 (0.31, 0.78)
<b>Total-Indoor accessibility</b>						
A-Put away and difficult to get to	0 (0)	0 (0)	0.03 (0.18)	-	-	-
B-Put away and easy to get to	2.45 (3.50)	2.81 (3.14)	1.97 (3.28)	0.82	0.35	0.85 (0.71, 0.93)
C-In plain view and difficult to get	0.10 (0.30)	0 (0)	0.45 (2.30)	-	0.08	-0.00 (-0.36, 0.35)
D-In plain view and easy to get to	3.39 (3.69)	4.58 (4.79)	4.65 (4.75)	0.84	0.02*	0.75 (0.52, 0.88)
<b>Average accessibility rating (1-4)</b>	3.21 (0.75)	3.17 (0.70)	3.44 (0.61)	0.52	0.76	0.48 (0.15, 0.72)
<b>Total-Outdoor accessibility</b>						
A-Put away and difficult to get to	3.26 (6.83)	2.74 (4.38)	2.61 (5.91)	0.51	0.64	0.87 (0.75, 0.94)
B-Put away and easy to get to	5.84 (8.12)	11.10 (10.46)	6.48 (9.49)	0.39	0.01*	0.43 (0.09, 0.68)
C-In plain view and difficult to get	1.55 (4.20)	0.65 (1.98)	1.48 (2.99)	0.44	0.20	0.08 (-0.29, 0.42)
D-In plain view and easy to get to	10.48 (9.74)	8.13 (8.06)	11.81 (11.84)	0.35	0.22	0.73 (0.51, 0.86)
<b>Average accessibility rating (1-4)</b>	3.03 (0.87)	2.59 (0.67)	2.99 (0.83)	0.61	<0.01*	0.53 (0.21, 0.75)
<b>MUSICAL INSTRUMENTS</b>						
<b>Total -Home accessibility</b>						
A-Put away and difficult to get to	0.03 (0.18)	0.06 (0.25)	0.03 (0.18)	0.70	0.56	1.00
B-Put away and easy to get to	0.48 (0.91)	0.32 (0.74)	0.55 (0.98)	0.54	0.45	0.36 (0.00, 0.63)
C-In plain view and difficult to get	0.03 (0.18)	0 (0)	0.03 (0.18)	-	0.33	-0.03 (-0.40, 0.33)
D-In plain view and easy to get to	2.10 (1.86)	2.19 (2.13)	2.13 (1.86)	0.88	0.85	0.92 (0.85, 0.96)
<b>Average accessibility rating (1-4)</b>	3.56 (0.63)	3.67 (0.52)	3.56 (0.60)	0.29	0.64	0.15 (-0.29, 0.53)
<b>MEDIA EQUIPMENT</b>						
<b>Total-Home accessibility</b>						
A-Put away and difficult to get to	0.45 (1.29)	0.48 (1.32)	0.35 (1.15)	0.92	0.75	0.95 (0.90, 0.97)
B-Put away and easy to get to	1.94 (2.15)	1.74 (1.83)	1.55 (1.88)	0.57	0.58	0.61 (0.33, 0.79)
C-In plain view and difficult to get	0.29 (0.73)	0.06 (0.35)	0.10 (0.30)	0.43	0.07	0.32 (-0.02, 0.59)
D-In plain view and easy to get to	10.81 (4.34)	11.77 (3.96)	11.06 (5.59)	0.87	0.02*	0.83 (0.67, 0.91)
<b>Average accessibility rating (1-4)</b>	3.62 (0.35)	3.67 (0.30)	3.68 (0.36)	0.55	0.34	0.45 (0.13, 0.69)
<b>SEATED FURNITURE</b>						
<b>Total-Home accessibility</b>						
A-Put away and difficult to get to	0.26 (0.95)	0.19 (0.90)	0.26 (0.95)	0.89	0.79	0.97 (0.93, 0.98)
B-Put away and easy to get to	0.23 (0.79)	0.55 (1.62)	0.35 (1.40)	0.10	0.33	0.34 (-0.02, 0.62)
C-In plain view and difficult to get	0.29 (0.96)	0.26 (1.01)	0.26 (0.95)	0.59	0.90	0.88 (0.76, 0.94)
D-In plain view and easy to get to	18.06 (8.56)	19.03 (9.01)	16.71 (9.12)	0.92	0.67	0.83 (0.68, 0.92)
<b>Average accessibility rating (1-4)</b>	3.93 (0.14)	3.91 (0.21)	3.89 (0.22)	0.16	0.64	0.42 (0.07, 0.67)
<b>Total-Indoor accessibility</b>						

The HomeSPACE-II instrument

<b>A</b> -Put away and difficult to get to	0.03 (0.18)	0.03 (0.18)	0.03 (0.18)	-0.03	1.00	-0.03 (-0.40, 0.33)
<b>B</b> -Put away and easy to get to	0.16 (0.72)	0.06 (0.25)	0.13 (0.71)	0.67	0.49	0.97 (0.94, 0.99)
<b>C</b> -In plain view and difficult to get	0.23 (0.94)	0.10 (0.53)	0.19 (0.90)	0.93	0.52	0.91 (0.82, 0.95)
<b>D</b> -In plain view and easy to get to	14.84 (7.88)	16.03 (8.54)	14.74 (9.14)	0.96	0.58	0.92 (0.83, 0.96)
<b>Average accessibility rating (1-4)</b>	3.97 (0.10)	3.98 (0.06)	3.98 (0.07)	0.35	0.34	0.48 (0.16, 0.71)
<b>Total-Outdoor accessibility</b>						
<b>A</b> -Put away and difficult to get to	0.23 (0.94)	0.16 (0.88)	0.23 (0.94)	0.93	0.79	1.00
<b>B</b> -Put away and easy to get to	0.06 (0.35)	0.48 (1.62)	0.23 (1.24)	0.17	0.16	-0.02 (-0.37, 0.34)
<b>C</b> -In plain view and difficult to get	0.06 (0.25)	0.16 (0.88)	0.06 (0.35)	0.70	0.57	0.66 (0.40, 0.82)
<b>D</b> -In plain view and easy to get to	3.23 (3.43)	3.00 (3.41)	1.97 (3.29)	0.80	0.80	0.54 (0.24, 0.75)
<b>Average accessibility rating (1-4)</b>	3.80 (0.63)	3.70 (0.61)	3.63 (0.92)	0.41	0.10	0.80 (0.49, 0.93)
<b>PA: Media ratio score</b>	1.72 (0.91)	1.75 (1.24)	1.94 (1.07)	0.70	0.88	0.79 (0.61, 0.90)

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\*Significant difference ( $p < 0.05$ ) between parent at Time 1 and Researcher



344 **Table 4. Validity and reliability for home equipment and features - categorical variables**

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Home Equipment and Features	Potential Score	Validity and reliability sample (n=311)		
		Time 1 vs Researcher Cohen's Kappa K	Time 1 vs Time 2 Cohen's Kappa K	
<b>HOME DESIGN</b>				347
Type of home	4 options	1.00	0.92	348
Number of storeys	3 options	0.69	0.82	349
Internal stairs	Y/N	constant	1.00	350
External stairs	Y/N	constant	constant	351
Front fence	Y/N/Partial	0.79	0.70	352
<b>HOME SIZE ^</b>				353
Entry/Hall/Foyer	S/M/L	0.54	0.28	354
Open plan living room	S/M/L	0.80	0.69	355
Kitchen	S/M/L	0.38	0.41	356
Lounge room (separate)	S/M/L	0.58	0.76	357
Dining room (separate)	S/M/L	0.92	1.00	358
Games room	S/M/L	0.94	0.82	359
Study	S/M/L	0.87	0.67	360
Bedroom of primary child	S/M/L	0.24	0.64	361
Garage	S/M/L	0.73	0.64	362
Garden shed	S/M/L	0.63	0.60	363
Back garden	S/M/L	0.55	0.52	364
Front garden	S/M/L	0.81	0.56	365
<b>Total house size</b>	S/M/L	0.40	0.88	366
<b>Total garden size</b>	No/S/M/L	0.26	0.83	367
<b>ADJACENT SPACE</b>				370
Next to public open space	Y/N	0.93	0.83	371
Next to laneway	Y/N	0.86	0.57	372
Next to vacant block	Y/N	1.00	1.00	373
Next to pedestrian cut-through	Y/N	0.82	0.51	374
<b>HOME EQUIPMENT</b>				375
Number of books	6 options	N/A	0.60	376
Number of magazines	6 options	N/A	0.49	377
Number of DVDs	6 options	N/A	0.64	378
Number of TV channels	6 options	N/A	0.55	379
Number of electronic games	6 options	N/A	0.49	380
Number of active electronic games	6 options	N/A	0.54	381
Number of smartphones	6 options	N/A	0.89	382
Type of internet	3 options	N/A	1.00	383
<b>PET OWNERSHIP</b>				384
Dog ownership	Y/N	N/A	0.61	385
Other pet ownership	Y/N	N/A	0.75	386

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^Not all participant homes included every room/area.

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## 391 **Discussion**

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394 This study assessed the validity and reliability of the HomeSPACE-II instrument,  
395 designed to measure parameters of the home physical environment that may influence  
396 children's sedentary behaviour and PA at home. Whilst the instrument was primarily based  
397 on HomeSPACE-I (Maitland et al. 2018), there are several differences. Specifically, it was  
398 tested for use in two-storey homes and modified to include equipment most relevant to home-  
399 based activity in the UK and to assess the accessibility, as well as the availability, of each  
400 item. The strong criterion validity and reliability demonstrated in this study for most of the  
401 equipment, size, feature and design items and the already established construct validity of the  
402 instrument (Sheldrick et al. 2019), suggest it can be independently used by parents to detect  
403 important characteristics of the home physical environment that may impact children's PA  
404 and sedentary time.

405 Most of the continuous variables for availability showed good to excellent reliability,  
406 however reliability results for accessibility were mixed. For items rated as "put away and  
407 difficult to get to" and "in plain view and easy to get to", ICCs were mostly to good  
408 excellent. However, ICCs for the number of items rated as "put away and easy to get to" and  
409 "in plain view and difficult to get to" were mostly poor to fair. This may be because, the  
410 terms "put away and difficult to get to" and "in plain view and easy to get to" are less  
411 ambiguous and more congruent than "put away and easy to get to" and "in plain view and  
412 difficult to get to". Moreover, ICCs for the average accessibility ratings were mostly fair.  
413 Between the parent completing the instrument at time one and time two, items may have  
414 moved location and therefore the parent's perception of accessibility may have changed  
415 which may partly explain the lower reliability estimates. Despite this, the overall summary  
416 scores (number of items \* accessibility rating) for all four item categories were strong.

417  
418 Reliability for the categorical variables was generally high, except for home equipment  
419 and size. Indeed, hall size was the only variable to fall below acceptable reliability limits,  
420 possibly because the parent did not record it at the second time-point as they may not have  
421 perceived it as a living area. Moreover, the moderate reliability limits achieved for several of  
422 the home equipment variables assessed by questions rather than the walk-through audit, may  
423 reflect the difficulty in estimating a number of smaller items from memory, particularly when  
424 a large number of that item exists within the home.

425  
426 Validity was strong for most of the continuous variables, outside of accessibility.  
427 Further, validity coefficients for PA equipment, media equipment, seated furniture and  
428 musical instrument measures were higher than in the HomeSPACE-I tool (Maitland et al.  
429 2018). However, the sample size was slightly smaller in this study, which may, at least in  
430 part, explain the more favourable validity coefficients (Goodwin and Leech 2006). In  
431 contrast, validity for the 10 outdoor features across the three areas (front garden, back garden  
432 and verge) was better in HomeSPACE-I. It could be postulated that the WA sample were  
433 more familiar with their outdoor space due to the better climate they experience (Murphy and  
434 Raper 2007), which may partly explain this discrepancy.

435  
436 While validity coefficients in general were strong, several differences between the  
437 researcher and the parent were observed. The researcher achieved a higher media  
438 accessibility and availability summary score which might reflect the greater number of items  
439 recorded as “in plain view and easy to get to” by the researcher. In addition, the researcher  
440 recorded a higher number of seated furniture indoors and in total than the parent, which  
441 concurs with Maitland et al. (2018). This could be due to the researcher taking a more  
442 thorough walk-through approach recording all types of seated furniture, whereas the parent

443 may have not acknowledged some pieces or identified table and chairs together as one piece  
444 of furniture. Further, the researcher recorded more PA equipment items indoors and in total,  
445 which would account for the higher total and indoor PA equipment density. This difference is  
446 likely driven by the greater number of balls recorded by the researcher in total, indoors and  
447 outdoors (result not shown). Perhaps, because the researcher recorded all types of balls  
448 irrespective of their condition, while the parents may have missed those either in poor  
449 condition or smaller balls as they were less visible. To minimize such error, efforts were  
450 made to define what constitutes seated furniture and balls; parents were also instructed to  
451 record everything regardless of condition. Nonetheless, these items may need further  
452 clarification in future versions of the instrument.

453

454       Validity of home size measures was assessed by comparing the parent's estimates against  
455 the researcher's. While a number of studies have sought to validate self-reported garden size  
456 against a researcher with little success (Bryant et al. 2008; Spurrier et al. 2016; Hales et al.  
457 2013), Maitland et al. (2018) are the only other group to validate self-reported size for indoor  
458 rooms, non-garden outdoor areas, overall house size and garden size. In general, validity  
459 estimates for the home size measures were higher than those reported by Maitland et al. (  
460 2018), with most showing moderate agreement. The reason for this difference is not clear,  
461 however the average house in Australia is one of the largest in the world (CommSec 2017),  
462 which may have influenced parental perceptions in the Maitland et al. (2018) study.

463 Although, overall house and garden size achieved only fair agreement, compared to the  
464 moderate agreement achieved in the Maitland et al. (2018) study for the equivalent measures.  
465 Whilst the reason for this is unknown, housing type may have influenced perceptions of  
466 house and garden size. Specifically, all the houses in this study had two storeys and were  
467 mostly semi-detached or terraced (61.3%), converse to the Australian sample where most

468 were single-storey (83%) and detached (90%). Therefore, these discrepancies in parent-  
469 researcher agreement are most likely related to the difference in the nature of homes (e.g.,  
470 layout, type and size). As overall house and garden size may influence children's PA levels  
471 and sedentary time (Maitland et al. 2013; Sheldrick et al. 2019), an objective measurement of  
472 size may be necessary. Conversely, if UK homes continue to reduce in size (Roberts-Hughes  
473 2011), the design and layout of homes may be of greater importance.

474

475 Achieving agreement between the researcher and parent for a largely subjective construct,  
476 such as accessibility, was challenging. In general, acceptable validity was observed; although  
477 results for PA equipment were particularly low, with the researcher observing fewer PA  
478 equipment in total as harder to access and more PA equipment outdoors as harder to access.  
479 Similar discrepancies were observed in previous inventories that assessed the accessibility of  
480 PA equipment within the home (Hales et al. 2013; Sirard et al. 2008), although the  
481 HomeSPACE-II demonstrated higher ICCs for validity for the average accessibility rating of  
482 PA equipment than the HomeSTEAD instrument (Hales et al. 2013). These results suggest  
483 that parents may have different perceptions of accessibility, particularly for PA equipment.  
484 However, while trained researchers may provide an objective assessment of accessibility, it  
485 might be just as, or more, important to consider a parent's perception of accessibility. For  
486 example, if an item seems hard to access to the researcher, but is frequently made available to  
487 the child by the parent, then the parent's perception of accessibility may better indicate how  
488 that item influences activity. Further, the HomeSTEAD study (Hales et al. 2013) found a  
489 stronger relationship between child BMI and parent reported accessibility compared with  
490 researcher reported accessibility. Therefore, it may be more important for future studies to  
491 consider parents' perceptions when investigating the relationship between equipment  
492 accessibility and children's behaviour.

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495       The strengths of this study include its rigorous reliability and validity testing procedure  
496 and the extensive nature of the HomeSPACE-II instrument, which covers a wide range of  
497 parameters within the home, providing a comprehensive assessment of the physical home  
498 space. There were equal representations of boys and girls within the sample, which is  
499 important given studies have found a greater density of PA equipment within boys' houses  
500 (Sirard et al. 2010) and boys are more likely to have electronic media in their bedroom  
501 (Nuutinen, Ray, and Roos 2013). Although measurement tools have been tested in Australia  
502 (Maitland et al. 2018) and the USA (Hales et al. 2013; Pinard et al. 2014; Sirard et al. 2008),  
503 this is the first to be used in a European country. This is important due to several  
504 environmental differences; Australia and America largely experience a better climate than  
505 most parts of Europe (Murphy and Raper 2007), their average house size is significantly  
506 larger than in any European country (CommSec 2017), and Europe is less ethnically and  
507 racially diverse than America (Gören 2013).

508  
509       This study also has several limitations. First the sample was homogenous, as most parents  
510 were female, university educated, and houses were mostly semi-detached or terraced with  
511 two parents. Although, the predominantly female and university educated sample is similar to  
512 that of previous studies (Hales et al. 2013; Maitland et al. 2018; Sirard et al. 2008). We  
513 sought to validate home size measures against a researcher with mixed success, however due  
514 to the subjective nature of these items, future research should seek to validate them against  
515 objective measures (e.g., GIS [Geographic Information System software]). There was low  
516 between subject variation for accessibility ratings in several item categories, which can result  
517 in low ICCs (Lee et al. 2012) and Pearson correlation coefficients (Goodwin and Leech  
518 2006), which may explain why some accessibility variables had low validity coefficients and

519 ICCs, in spite of their means and standard deviations indicating minimal differences between  
520 scores. The sample was comprised of families living in Wales' two largest cities. Whilst  
521 Wales is less affluent than the national average (Office for national statistics 2014), its  
522 physical geography, home environmental characteristics and cultural traits are comparable  
523 with the rest of the UK. Further, data were collected in the spring and winter and therefore  
524 seasonality may have influenced accessibility data, particularly for outdoor PA equipment,  
525 whereby equipment may be stored away in the winter but made accessible in the spring.  
526 Lastly, the large number of statistical tests conducted in this study may have increased the  
527 risk of type I error. Given that some of the results may have therefore occurred by chance, the  
528 authors considered employing a more stringent alpha value, however, such corrections may  
529 have increased the probability of type II error. As the present results are similar to those  
530 reported in other studies (Sirard et al. 2008; Hales et al. 2013; Maitland et al. 2018), an alpha  
531 value of 0.05 was retained.

532  
533 Several modifications should be considered for future iterations of the HomeSPACE  
534 instrument. Given that types of seated furniture, balls, electronic games and active games  
535 varied greatly, the instrument would benefit from further clarification around what defines  
536 these. Secondly, although the importance of considering a parent's perception of accessibility  
537 has been discussed, the accessibility ratings may need further investigation. Specifically,  
538 although the accessibility ratings were designed to take into account condition (Sirard et al.  
539 2008), this may not have been clear enough to the parents. To improve how the accessibility  
540 ratings are defined, future research should seek to utilise qualitative methodologies to  
541 ascertain how parents perceive and interpret accessibility. Thirdly, the number of TV  
542 channels question should be replaced with a question concerning the type of TV service as  
543 even Freeview offers over 70 channels. Moreover, a question on movie streaming services  
544 (e.g., Netflix, Now TV, Amazon Prime, etc...) should be included, due to their growing

545 popularity, essential for a comprehensive assessment of media sources available in the home.  
546 Portable types of electronic media (laptops, tablet computers and handheld devices) do not  
547 have a fixed location and can therefore be used almost anywhere, meaning they may not  
548 always be captured with the instrument. Therefore, future work on how to account for the  
549 portable nature of these devices may be needed. Finally, fitness trackers (e.g., Fitbits, apple  
550 watches, Garmin) should be explored, as they have the potential to facilitate children's PA in  
551 interventions through goal-setting and self-monitoring (Ridgers, McNarry, and Mackintosh  
552 2016). The presence of these in a home may reflect a family promotive of being physically  
553 active. Due to constant changes in media technology, updating these types of instruments  
554 with relevant media equipment will be ongoing.

555

## 556 **Conclusion**

557 The HomeSPACE-II instrument builds upon its Australian counterpart (Maitland et al.  
558 2018) by being tested in two-storey homes and because it includes a wider range of PA  
559 equipment, and a measure of accessibility, rather than just availability. The generally strong  
560 reliability and criterion validity demonstrated here and the construct validity established  
561 previously (Sheldrick et al. 2019), HomeSPACE-II is a useful tool for assessing the home  
562 physical environment in relation to children's PA and sedentary behaviour. Using the  
563 instrument will provide researchers with greater insight into the correlates of important  
564 health-related behaviours in an environment where children spend a significant amount of  
565 time (Briggs et al. 2003; Khajehzadeh and Vale 2017). Such insight may also impact future  
566 home planning and design to create physical home environments more conducive to health  
567 behaviours. Additionally, the HomeSPACE-II instrument may also help parents become  
568 more aware of how their home environment is influencing their child's PA and sedentary  
569 time, thereby indirectly promoting healthy active living in families. The instrument may be



570 appropriate for use in countries which share similar geographical and home environment  
571 characteristics with the UK.

572

573 **Acknowledgments:**

574 The authors wish to thank the parents for their participation in the study. The authors would  
575 also like to acknowledge everyone who helped with data collection.

576 **Funding:**

577 M.S is supported by a Zienkiewicz scholarship awarded by Swansea University.

578 **Conflicts of Interest:**

579 The authors report no conflicts of interest

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<i><b>Audit Categories -Room/Area Level</b></i>	<i><b>Individual Items</b></i>	<i><b>Summary Scores</b></i>			
		<i><b>Sum of</b></i>	<i><b>Density</b></i>	<i><b>Average Accessibility Rating</b></i>	<i><b>Accessibility and Availability Score</b></i>
<b>Physical Activity (PA) Equipment</b>	Number, accessibility and location of 19 types	- Sports Equipment - Transport Equipment - Exercise Equipment - Outdoor Play Equipment - Indoor Play Equipment - PA Equipment Indoors - PA Equipment Outdoors - PA Equipment Home	- PA Equipment Indoors - PA Equipment Outdoors - PA Equipment Home	- PA Equipment Indoors - PA Equipment Outdoors - PA Equipment Home	- PA Equipment
<b>Musical Instruments</b>	Number, accessibility and location of 3 types	- Musical Instruments Home	- Musical Instruments Home	- Musical Instruments Home	- Musical Instruments Home
<b>Media Equipment</b>	Number, accessibility and location of 10 types	- Fixed Media Equipment - Portable Media Equipment - Bedroom Media Equipment - Media Equipment Home	- Media Equipment Home	- Media Equipment Home	- Media Equipment Home
<b>Seated Furniture</b>	Number, accessibility and location of 7 types.	- Seated Furniture Bedroom - Seated Furniture Indoors - Seated Furniture Outdoors - Seated Furniture Home	- Seated Furniture Indoors - Seated Furniture Outdoors - Seated Furniture Home	- Seated Furniture Indoors - Seated Furniture Outdoors - Seated Furniture Home	- Seated Furniture Home
<b>Rooms/Areas in Home</b>	Number and perceived size of up to 14 indoor rooms and 8 outdoor areas Perceived size of overall house and garden	- Livings Rooms - Bedrooms - Indoor Rooms - Outdoor Areas - Total Rooms/Areas			
<b>Outdoor Features</b>	Presence of 10 types of outdoor features in 3 outdoor areas	- Back Garden Features - Front Garden Features - Verge Features - Total Outdoor Features			

<i>Audit Categories – Overall</i>	<i>Individual Items</i>	<i>Item Categories</i>
<b>Home Features</b>	Type of home	Detached house; semi-detached/townhouse/terrace house/villa; flat/unit/apartment; other (4)
	Number of storeys	one; two; more than two (3)
	Presence of: internal stairs; external stairs	yes; no (2)
	Presence of front fence that encloses garden	yes; no; partially (3)
	Location next to 4 types of public space (public open space; back/side laneway; vacant block; pedestrian cut-through)	yes; no (2)
<i>Questionnaire Items</i>	<i>Individual Items</i>	<i>Item Categories</i>
<b>Home Equipment</b>	Number of books	0; 1-50; 51-100;101-150;151-200; >200 (6)
	Number of magazines	0; 1-50; 51-100;101-150;151-200; >200 (6)
	Number of DVDs	0;1-25; 26-50; 51-75; 76-100; >100 (6)
	Number of TV channels	0;1-25; 26-50; 51-75; 76-100; >100 (6)
	Number of electronic games	0; 1-10; 11-20; 21-30; 31-40; >40 (6)
	Number of active video games	0; 1-5; 6-10; 11-15; 16-20; >20 (6)
	Number of smartphones	0; 1-2;3-4;5-6; 7-8; >8 (6)
	Type of internet service	No internet access; dial-up modem; wireless broadband (3)
<b>Pet Ownership</b>	Ownership of dog; other pets	yes; no (2)

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754 **Appendix 1; Description of HomeSPACE-II Instrument Items and Summary Scores**

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ID No \_\_\_\_\_

**HomeSPACE Home Audit**

770 We are interested in learning more about your home and how it might influence children's  
771 physical activity and sitting at home.

772 This checklist will ask you about the size, space and design of your home, and the types of  
773 equipment you have at home. If you have any questions about the checklist or the study  
774 please contact the Lead Researcher:

775 Michael Sheldrick  
776 Email: [708824@swansea.ac.uk](mailto:708824@swansea.ac.uk)  
777 College of Engineering; Swansea University  
778 Bay Campus; Fabian Way; Swansea; SA1 8EN

779  
780 Thank you for helping us with this study!  
781

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**SECTION 1: HOME AUDIT**

**Instructions**

Please walk through each room in your house, garden and garage.

For each room/area please answer the first two questions: “Whose room is this?” and “How big is this room?” by circling the best answer.

Then use the numbered list to indicate which items are in the room by writing the corresponding numbers in the row of boxes (see example below). The numbered list is on the next page and repeated for your convenience on page 8. There are physical activity, media, musical and furniture items on the list. Please write only one item per box.

Also we would like you to use the following list to indicate how accessible each item is, by writing the appropriate letter in the bottom row of boxes

- A) Put away and difficult to get to ..... (e.g., A games console kept on top of a cupboard
- B) Put away and easy to get to ..... (e.g., A tablet Computer behind a cabinet door)
- C) In plain view and difficult to get to ..... (e.g., A Table Tennis table stored in the garage)
- D) In plain view and easy to get to ..... (e.g., A skateboard on the floor in doorway)

When rating an item’s accessibility, you should take into account its condition. For example, a punctured football in plain view should be given a C rating, as it’s in plain view but difficult to get to. While a tennis racquet in usable condition should be given a rating of D, as it’s in plain view and easy to get to.

**Important Notes**

1. Please take the time to walk through your home rather than sitting in one place to complete this checklist. Walking through each room will help your memory.
2. If there is more than one of the same item in a room (e.g. two bikes in the garage), write the code number in the top left of the box and the amount of the item in the bottom right of the box (see example below).
3. If there are not enough boxes for all of the items in the room, use one of the “Other” rows and write in the name of the room.
4. Count all items regardless of condition
5. If the room does not apply to your home, write “NA” in the first box for that room.
6. If there is nothing from the list in the room, write “0” in the “Item #” row.
7. If your home has other rooms not mentioned please use one of the “Other” rows and write in the name of the room.

**Example: medium sized family lounge room with a piano, two couches, a TV and DVD player.**  
**Room: Lounge Room**

children / adults / everyone

small / medium / large

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<b>Item #</b>	20	33 2	2	2					
<b>Access #</b>	D	D	D	B					

<b>Equipment Item Number List</b>	
<p><b>Sports Equipment</b></p> <p>1 Balls (e.g. football, rugby, basketball)</p> <p>2 Bats / racquets (e.g. cricket, softball, tennis)</p> <p>3 Frisbee</p> <p>4 Skipping rope</p> <p>5 Hula hoop</p> <p><b>Transportation Equipment</b></p> <p>6 Bicycle</p> <p>7 Scooter / skateboard / ripstick / skates</p> <p><b>Fitness Equipment</b></p> <p>8 Stationary (aerobic) exercise equipment (e.g. treadmill, exercise bike, punch bag)</p> <p>9 Weights / toning equipment (e.g. weights bench, sit up machine)</p> <p><b>Outdoor Play Equipment</b></p> <p>10 Basketball Ring</p> <p>11 Fixed Play Structure (e.g. swings, slide, climbing, sandpit)</p> <p>12 Cubby/Tree house</p> <p>13 Trampoline</p> <p>14 Pool (in ground or above)</p> <p>15 Football goal net</p> <p>16 Swing ball</p> <p><b>Indoor Play Equipment</b></p> <p>17 Pool/snooker Table</p> <p>18 Table Tennis Table</p> <p>19 Table football</p>	<p><b>Musical Instruments</b></p> <p>20 Piano / Keyboard</p> <p>21 Drums</p> <p>22 Other Instrument (e.g. guitar, trumpet, violin, flute)</p> <p><b>Media Equipment - Fixed</b></p> <p>23 Television</p> <p>24 VCR / DVD / Blu-ray Player</p> <p>25 Pay TV (e.g. Sky)</p> <p>26 TV on Demand (e.g. Apple TV)</p> <p>27 Desktop Computer</p> <p>28 Video game system (attached to TV) (e.g. X-Box, Wii, Playstation)</p> <p><b>Media Equipment - Portable</b></p> <p>29 Handheld Video Game Player (e.g. Nintendo DS, Sony PSP)</p> <p>30 Laptop Computer</p> <p>31 Tablet Computer (e.g., iPad, Samsung galaxy)</p> <p>32 Ipod Touch / Galaxy Player (or similar)</p> <p><b>Furniture</b></p> <p>33 Couch (2+ seater)</p> <p>34 Lounge Chair (single seater)</p> <p>35 Coffee Table</p> <p>36 Dining / Kitchen Chair</p> <p>37 Dining / Kitchen Table</p> <p>38 Office Chair</p> <p>39 Desk</p>

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**ROOMS IN THE HOUSE**

**Room: Entry / Foyer / Hall**

small / medium / large; \_\_\_\_\_  
children / adults / everyone

**Item #**


**Accessibility**


**Room: Bedroom of Child in study**

small / medium / large; \_\_\_\_\_  
children / adults / everyone


**Room: Open Plan Living Area**

small / medium / large; \_\_\_\_\_  
children / adults / everyone

**Item #**


**Accessibility**


**Room: Bedroom 2**

small / medium / large; \_\_\_\_\_  
children / adults / everyone


**Room: Kitchen**

small / medium / large; \_\_\_\_\_  
children / adults / everyone

**Item #**


**Accessibility**


**Room: Bedroom 3**

small / medium / large; \_\_\_\_\_  
children / adults / everyone


**Room: Lounge Room (separate)**

small / medium / large; \_\_\_\_\_  
children / adults / everyone

**Item #**


**Accessibility**


**Room: Bedroom 4**

small / medium / large; \_\_\_\_\_  
children / adults / everyone


**Room: Dining Room (separate)**

small / medium / large; \_\_\_\_\_  
children / adults / everyone

**Item #**


**Accessibility**


**Room: Games/Activities Room**

small / medium / large; \_\_\_\_\_  
children / adults / everyone


**Room: Study/Office**

small / medium / large; \_\_\_\_\_  
children / adults / everyone

**Item #**


**Accessibility**


**Room: Bathrooms**

small / medium / large; \_\_\_\_\_  
children / adults / everyone


**Accessibility rating of items:**

**B=**The item is put away and easy to get to

**A**=The item is put away and difficult to get to    **D**= The item is in plain view and easy to get to  
**C**=The item is in plain view and difficult to get

<p><b>Room: Other</b> _____ (specify)                  small / medium / large; _____                  children / adults / everyone</p>	<p><b>Room: Other</b> _____ (specify)                  small / medium / large; _____                  children / adults / everyone</p>																				
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829 **Accessibility rating of items:**

830 **A**= The item is put away and difficult to get to    **B**= The item is put away and easy to get  
 831 to

832 **C**= The item is in plain view and difficult to get to    **D**= The item is in plain view and easy to  
 833 get to

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<b>Equipment Item Number List</b>
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<p><b>Sports Equipment</b></p> <p>1 Balls (e.g. football, rugby, basketball)</p> <p>2 Bats / racquets (e.g. cricket, softball, tennis)</p> <p>3 Frisbee</p> <p>4 Skipping rope</p> <p>5 Hula hoop</p> <p><b>Transportation Equipment</b></p> <p>6 Bicycle</p> <p>7 Scooter / skateboard / ripstick / skates</p> <p><b>Fitness Equipment</b></p> <p>8 Stationary (aerobic) exercise equipment (e.g. treadmill, exercise bike, punch bag)</p> <p>9 Weights / toning equipment (e.g. weights bench, sit up machine)</p> <p><b>Outdoor Play Equipment</b></p> <p>10 Basketball Ring</p> <p>11 Fixed Play Structure (e.g. swings, slide, climbing, sandpit)</p> <p>12 Cubby/Tree house</p> <p>13 Trampoline</p> <p>14 Pool (in ground or above)</p> <p>15 Football goal net</p> <p>16 Swing ball</p> <p><b>Indoor Play Equipment</b></p> <p>17 Pool/snooker Table</p> <p>18 Table Tennis Table</p> <p>19 Table football</p>	<p><b>Musical Instruments</b></p> <p>20 Piano / Keyboard</p> <p>21 Drums</p> <p>22 Other Instrument (e.g. guitar, trumpet, violin, flute)</p> <p><b>Media Equipment - Fixed</b></p> <p>23 Television</p> <p>24 VCR / DVD / Blu-ray Player</p> <p>25 Pay TV (e.g. Sky)</p> <p>26 TV on Demand (e.g. Apple TV)</p> <p>27 Desktop Computer</p> <p>28 Video game system (attached to TV) (e.g. X-Box, Wii, Playstation)</p> <p><b>Media Equipment - Portable</b></p> <p>29 Handheld Video Game Player (e.g. Nintendo DS, Sony PSP)</p> <p>30 Laptop Computer</p> <p>31 Tablet Computer (e.g., iPad, Samsung galaxy)</p> <p>32 Ipod Touch / Galaxy Player (or similar)</p> <p><b>Furniture</b></p> <p>33 Couch (2+ seater)</p> <p>34 Lounge Chair (single seater)</p> <p>35 Coffee Table</p> <p>36 Dining / Kitchen Chair</p> <p>37 Dining / Kitchen Table</p> <p>38 Office Chair</p> <p>39 Desk</p>
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**OUTSIDE AREA**

**Area: Back Garden \***

small / medium / large; \_\_\_\_\_  
children / adults / everyone

**Item #**


**Accessibility**


**Area: Outdoor Eating Area**

small / medium / large; \_\_\_\_\_  
children / adults / everyone


**Area: Front garden (including Porch) \***

small / medium / large; \_\_\_\_\_  
children / adults / everyone

**Item #**


**Accessibility**


**Area: Garage**

small / medium / large; \_\_\_\_\_  
children / adults / everyone


**Area: Front Verge \***

small / medium / large; \_\_\_\_\_  
children / adults / everyone

**Item #**


**Accessibility**


**Area: Garden Shed**

small / medium / large; \_\_\_\_\_  
children / adults / everyone


**Area: Other \_\_\_\_\_ (specify)**

small / medium / large; \_\_\_\_\_  
children / adults / everyone

**Item #**


**Accessibility**


**Area: Other \_\_\_\_\_ (specify)**

small / medium / large; \_\_\_\_\_  
children / adults / everyone


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**Accessibility rating of items:**

- A=** The item is put away and difficult to get to      **B=** The item is put away and easy to get to
- C=** The item is in plain view and difficult to get to      **D=** The item is in plain view and easy to get to

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878

879

880 **Additional Features of Front garden, Back garden and Verge (if applicable)\***

881 Does the home have any of the following outdoor features? Please circle Yes or No for each  
882 item in the back garden, front garden and verge.

<b>Outdoor Features</b>	<b>Back garden</b>	<b>Front garden</b>	<b>Verge</b>
Tree - able to be climbed	Yes / No	Yes / No	Yes / No
Wall - able to throw/kick a ball against	Yes / No	Yes / No	Yes / No
Garden area	Yes / No	Yes / No	Yes / No
Grassed area	Yes / No	Yes / No	Yes / No
Undercover area	Yes / No	Yes / No	Yes / No
Shaded area	Yes / No	Yes / No	Yes / No
Driveway	Yes / No	Yes / No	Yes / No
Paved area	Yes / No	Yes / No	Yes / No
Footpath	-	-	Yes / No
Windows from the home overlook this area	Yes / No	Yes / No	Yes / No

883

884

885

**SECTION 2: ADDITIONAL QUESTIONS**

886

887

**Instructions**

888

You are now finished Section 1 - The Home Audit.

889

890

Section 2 asks you to complete some additional questions about your home, and your

891

family. This will not take too long to complete.

892

893

Please remember that there are no right or wrong answers. We are just interested in what

894

you think.

895

896

**SECTION 2A: HOME FEATURES**

897

898

1. Which best describes the home? *(Please tick one box only)*

899

Separate House

900

Semi-detached / Townhouse / Terrace House / Villa

901

Flat/Unit/Apartment

902

Other, (please specify) \_\_\_\_\_

903

904

2. How many storeys does the home have? *(Please tick one box only)*

One  Two  More than Two

906

907

3a Does the home have internal stairs? (e.g. between storeys or levels)

908

*(please tick one box only)*

Yes  No

909

3b Does the home have external stairs (e.g. to get to the front or back door)?

910

*(please tick one box only)*

Yes  No

911

4 Is there a front fence/gate that encloses the front garden? *(Please tick one box only)*

Yes  No  Partially

912

913

5. Are any of the following spaces directly beside/behind the home?

914

*(Please tick yes or no for each)*

	Yes	No
Public open space (e.g. park)	<input type="checkbox"/>	<input type="checkbox"/>
Back/side laneway	<input type="checkbox"/>	<input type="checkbox"/>
Vacant block	<input type="checkbox"/>	<input type="checkbox"/>
Pedestrian cut through	<input type="checkbox"/>	<input type="checkbox"/>

915

916

917

918

919

920

6. What would you say your house is? *(Please tick one box only)*

Small	<input type="checkbox"/>
Medium	<input type="checkbox"/>
Large	<input type="checkbox"/>

921

7. What would you say your garden is? *(Please tick one box only)*

Small	<input type="checkbox"/>
Medium	<input type="checkbox"/>
Large	<input type="checkbox"/>
No Garden	<input type="checkbox"/>

922

923

924 **SECTION 2B: EQUIPMENT**

925 Please circle one answer for each of the following questions.

926 1. How many books do you currently have in your home?

0            1-50            51-100            101-150            151-200            >200

927 2. How many magazines do you have in your home?

0            1-50            51-100            101-150            151-200            >200

928 3. How many DVDs do you currently have in your home?

0            1-25            26-50            51-75            76-100            >100

929 4. How many TV channels do you currently have available in your home?

0            1-25            26-50            51-75            76-100            >100

930 5. How many electronic games (including computer games) do you currently have in  
931 your home?

0            1-10            11-20            21-30            31-40            >40

932 6. How many of these electronic games in your home are **active** video games?

0            1-5            6-10            11-15            16-20            >20

933 7. How many smart phones do you currently have in your home?

0            1-2            3-4            5-6            7-8            >8

934 8. What best describes your type of internet service? (please tick one box only)

935 No internet access           

936 Dial up modern           

937 Wireless Broadband           

938 9. Do you own a dog? (*please tick one box only*)

939 Yes           

940 No           

941 10. Do you own any other pets? (please specify)



942 -----

943

944

**SECTION 3: YOU AND YOUR FAMILY**

945

1. What is your age in years?

946

\_\_\_\_\_

947

948

2. What is your gender? *(please tick one box only)*

Male  Female

949

3. In which country were you born?

950

\_\_\_\_\_

951

952

953

4. What is the main language spoken in your home?

954

\_\_\_\_\_

955

5. Which best describes your ethnicity?

956

White

957

Mixed Race

958

Asian or Asian British

959

Black or Black British

960

Chinese

961

Other

962

963

964

6. How many people (including yourself) live in your household?

965

\_\_\_\_\_

966

967

968

7. How many children under 18 years of age live in your household?

969

\_\_\_\_\_

970

971

8. What are the ages and gender of the children living in your household?

972

*(please write the age and circle the gender)*

973

1. \_\_\_\_\_ M / F    2. \_\_\_\_\_ M / F    3. \_\_\_\_\_ M / F

974

975

4. \_\_\_\_\_ M / F    5. \_\_\_\_\_ M / F    6. \_\_\_\_\_ M / F

976

977

978 9. Which best describes your highest level of education completed? *(please tick one)*

979 Some Secondary High School

980 Completed Secondary High School (Year 11)

981 Trade Qualifications / Apprenticeship

982 Diploma / Certificate

983 University Bachelor Degree or Higher

984 10. What is your approximate annual household income before tax? *(please tick one box*  
 985 *only)*

986

987 Under £10,000

988 £10,000 – £20,000

989 £20,000 - £30,000

990 £30,000 - £50,000

991 £50,000 - £70,000

992 £70,000 - £100,000

993 £100,000 and above

994

995 11. Which best describes your family situation? *(please tick one box only)*

996 Single Parent Household

997 Two Parent Household

998 Other

999

1000 12. Do you rent or own your home?  Rent  Own / Paying Off  
 1001 *(Please tick one box only)*

1002

1003

1004 13. How long have you been at your current address?

1005

1006 \_\_\_\_\_

1007

1008

1009 14. Please write today's date

1010 \_\_\_\_\_day\_\_\_\_\_month\_\_\_\_\_year

1011

1012  
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1020

15. What suburb/area do you live in? _____ What is your postcode?
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THANK YOU!