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Review and Update of Occupancy Factors for UK homes

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Review and Update of Occupancy Factors for UK homes

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Abstract

Occupancy factors are an important element in assessing the exposure from indoor radon in UK homes and are included in the UK validation scheme. Passive radon detectors are placed in 2 inhabited rooms called living area and bedroom to represent the rooms where most time is spent. The annual average radon concentration for a house is calculated using the results of these 2 rooms weighted by their occupancy factors. The occupancy factor for a room is the proportion of indoor time spent in this room.

The existing occupancy factors were based on work published in 1986. Since that time it is likely that time spent indoors has changed and an update appropriate.

The purpose of this study is to review the time spent indoors in the living area and bedroom for UK homes. This was achieved by reviewing the most recent published data for the UK. The population was divided into 6 groups and the occupancy levels were assessed taking into account their population weight. The new weighted average occupancy factors for the living area and bedroom were found to be 0.42 and 0.58, respectively, showing a slightly higher weighting towards bedroom occupancy since the original estimates were made.

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1 Introduction

The objective of this report is to estimate the current domestic occupancy factors for the general public in the UK taking into account the updated information about time spent indoors by members of the public. It is important to assess the current occupancy in UK homes because the lifestyle of people is likely to have changed significantly since the earlier study of occupancy levels (Francis, 1986). The 1986 study showed that on average people in the UK spent around 77% of their time indoors, with the proportions of time spent indoors estimated to be 0.45 and 0.55 in the living area and bedroom, respectively.

A study in Northamptonshire reported indoor occupancy in the home of 72% (Denman *et al*, 2000) and more recently it was found that the average time spent at home was 70% of the total free time for homes in Great Britain (The Time Use Survey, 2005). From the above it is evident that the time spent indoors at home has decreased. It is also possible that the proportion of time spent in different areas of the home may have changed as the way people live in their homes is likely to have changed since the initial estimates were made in the late 1980s. Therefore, a review of the current occupancy levels for different population groups is needed.

The results were included in the revised PHE Validation scheme (Daraktchieva *et al*, 2018).

2 Methods

The occupancy factors for UK homes were assessed by dividing the population into groups based on their working or study pattern. The weight for each group and the total population was estimated using the latest data published by the Office of National Statistics. The time spent by each population group away from home was estimated using various data sources and published materials. The time spent at home was calculated as the difference between the total time and time spent away from home. For the purpose of this study the time at home was considered to be spent in only two rooms, the living area and a bedroom. The time spent in the bedroom was estimated using the published advice on sleep requirements. The living area is considered as a proxy for every other room at home which is not a bedroom. The time spent in the living area and bedroom as a percentage of the time spent per year at home for each population group was estimated. The UK occupancy factors for the living area and bedroom were calculated as a weighted average, across the different population groups.

The population was divided into 3 main groups: people who are at work, people who stay at home and those that study. People who are at work were divided into 2 subgroups: people who are working full-time and people who are working part-time. People at study were divided to 2 subgroups: school children and children in early education. Children who stay at home were considered separately. In total the population was divided into 6 groups. The number of people in each of the 6 groups and their weight as a percentage of the total population was calculated using the most recent published statistics.

The time spent at work was estimated from the recent report on the UK Labour market (ONS, 2018a). The average working hours per week were taken as 37.5 hours for full-time and 16.3 hours for part-time workers (ONS, 2018b). When the time traveling to and from work was considered the average time away per day on work related matters was estimated to be 8.5 hours for full-time and 4.26 hours for part-time workers (ONS, 2018c). The number of working days per year was calculated taking into

account the working hours per week. It was estimated that there are 253 and 110 working days per year excluding Saturdays, Sundays and Public Holidays for the full-time and part-time workers, respectively. The average annual leave entitlement for full-time and part-time workers was estimated to be 20 and 9 days, respectively (Holiday entitlement, 2018). The calculations were based on the average working hours per week for these groups.

It was estimated that school children spent in a school day on average 8 hours away from home (The School day and year (England), 2016) while children in early education spent 7 hours (DfE, 2018). The time traveling to and from school was considered in the calculations. There are on average 190 school days per year excluding Saturdays, Sundays, and Public and school holidays (The School day and year (England), 2016).

The time spent in the bedroom was estimated for different population groups using the published advice and guidance. For example the average time spent in the bedroom was considered to be 7.5 hours for people who work full-time and 8 hours for people who work part-time or stay at home (NHS Live Well). For school children, children in early education and children who stayed at home the average time spent in the bedroom was taken as 10, 12 and 14 hours, respectively (Sleep Sisters, 2018).

The main source of information of the time spent at home was the Time Use Survey (Time Use Survey, 2005). For all population groups excluding children who stayed at home the average time spent at home was considered to be 70% of the total free time. The definition of total full-time for the purpose of this study was given in Section 3.2.

For children under 2 years old who stayed at home the average time spent outdoors was considered to be 3 hours per day (NHS choices). Therefore the average time spent indoors was estimated to be 87.5% (ie 21 hours per day) for this population group.

In addition to the above the following assumptions were made for calculation of time spent at home. Annual leave was considered as time away from home and therefore excluded from the calculation of the time spent at home. Children at school were considered to have the same holiday time as their full-time working parents while the children in early education and children who stayed at home were considered to have the same holiday time as their part-time working parents. People who stayed at home were assumed to have 6 days per year away from home (Eurostat, 2016).

3 Results

3.1 Population groups

The number of people who were working full-time, part-time and who stayed at home was estimated from the UK employment data published by Office of National Statistics (ONS, 2018a and ONS, 2018b). A summary of the data is given in Tables 1 and 2.

Table 1. Summary of UK labour market, June 2018

	Employed	Unemployed	Inactive
Number (thousands)			
Aged 16 to 64	31,172	1,394	8,651
Aged 65 and over	1,223	22	10,533
Total	32,395	1,416	19,184

Table 2. Summary of full-time and part-time employment, June 2018

Total at work	Total working full-time	Total working part-time
Number (thousands)		
32,394	23,758	8,636

The total population of the UK is taken to be 65.6 million (ONS, 2018d).

The number of people who stayed at home was estimated to be 20.6 million which included both the inactive (economically inactive are those not working and not seeking or available to work) and unemployed (Table 1).

The number of people working full-time was 23.8 million while people working part-time were 8.6 million (Table 2). Other types of employment, which applied to about 0.1 % of the population, were not included in this study because data were not available.

School children are defined as being between 4 and 18 years old. In total there were 10.2 million school children in the UK, comprising 8.7 million identified by the School Census in England (DfE, 2017a), 0.7 million identified by the summary statistics for schools in Scotland (Scottish Government, 2016a), 0.5 million in Wales (Welsh Government, 2017a) and 0.3 million identified from annual enrolments in schools in Northern Ireland (DoE Northern Ireland, 2017).

Children in early education are defined as being between 2 and 4 years old. The number of children who attended nurseries in the UK was estimated to be 1.7 million: 1.5 million in England identified by provision for children under 5 years of age in England (DfE, 2015), 0.1 million for Scotland identified by early learning and childcare (Scottish Government, 2016b), 0.1 million for Wales identified from childcare capacity in Wales (Welsh Government, 2017b) and 0.02 million from annual enrolments at schools and in funded pre-school education for Northern Ireland (DoE Northern Ireland, 2017).

Children who stayed at home are defined as those being under 2 years old. The number of these children was estimated to be 0.8 million on the assumption that this group is the remainder when other population groups in Table 3 are deducted from total population.

The number of people in each population group and their weight as a percentage of the total population are given in Table 3.

Table 3. Number of people at work, study or stay at home and as percent of population

Employed full-time	Employed part-time	Stay at home (unemployed and inactive)	School children	Children in early education	Children stay at home	Total population
Number (thousand)						
23,758	8,636	20,600	10,162	1,673	819	65,648
Percentage of population (%)						
36.2	13.2	31.4	15.5	2.5	1.2	100.0

3.2 Time spent at home by different population groups

Total numbers of hours per year is taken to be 8760 (based on 365 days in a year). The total free time for each population group was then estimated as the difference between the total number of hours per year and the total time away from home. The total time away from home was taken as the sum of time spent at work, study and holiday (Table 4).

The time spent at home was estimated from the total time taking into account the data on time spent away from home discussed in Section 2. The average time spent per year at home for the 6 population groups was estimated as 70 % of their total free time (The Time Use Survey, 2005). For children under 2 years old the time spent at home was calculated as 87.5 % of their total free time (Section 1). The results are summarised in Table 4.

Table 4. Time spent per year for different activities by different population groups

Population group	work/study (days)	work/study (hours per day)	total work/study (hours)	holiday (hours)	total time away from home (hours)	total free time (hours)	time spent at home (hours)
Full-time workers	253	8.5	2,151	480	2,631	6,129	4,290
Part-time workers	110	4.3	469	214	683	8,077	5,654
People who stayed at home	0	0	0	144	144	8,616	6,031
School children	190	8	1,520	480	2,000	6,760	4,732
Children in early education	190	7	1330	214	1,544	7,216	5,051
Children who stayed at home*	0	0	0	214	214	8,546	7,478

*For children who stayed at home 87.5 % occupancy levels was used.

The time spent in the living area and bedroom was calculated taking into account the data on time spent in the bedroom in Section 2 and the results for the time spent at home given in Table 4. The results are given in Table 5.

Table 5. Time spent per year at home, in living area and bedroom

	Time spent per year at home (hours)	Time spent per year in bedroom (hours)	Time spent per year in living area (hours)
Full-time worker	4,290	2,588	1,702
Part-time worker	5,654	2,849	2,805
People who stayed at home	6,031	2,872	3,159
School children	4,732	3,440	1,292
Children in early education	5,052	4,128	924
Children who stayed at home	7,478	5,040	2,438

*For children who stayed at home 87.5 % occupancy levels was used.

**Time spent per year in the living area was estimated from the time spent per year at home and time spent per year in bedroom

3.3 Occupancy factors

The weighted average method was used to estimate the occupancy factors for UK homes. Different population groups spent different amounts of time indoors at home (Table 5). These groups also have different contributions to the UK occupancy levels due to their different weights as percentage of population.

The time spent in the living area and bedroom as a percent of the time spent per year at home for each population group was calculated using the data in Table 5.

The occupancy levels of the living area and bedroom for each population group were calculated as the product of the proportion of time in the room and the corresponding population weight using (1) and (2).

$$Occ_l = P_l \times W_p \quad (1)$$

$$Occ_b = P_b \times W_p \quad (2)$$

In (1) and (2) Occ_l is the occupancy levels for the living area, Occ_b is the occupancy levels for the bedroom and W_p is the population weight. The results are summarized in Table 6.

Table 6. Proportion of time in living area and bedroom, and the occupancy levels for different population groups

	Proportion of time in living area, P _l (%)	Proportion of time in bedroom, P _b (%)	Population weight, W _p (%)	Occupancy levels of living area, Occ _l	Occupancy levels of bedroom, Occ _b
Full-time worker	39.7	60.3	36.2	0.14	0.22
Part-time worker	49.6	50.4	13.2	0.07	0.07
People who stayed at home	52.4	47.6	31.4	0.17	0.15
School children	27.3	72.7	15.5	0.04	0.11
Children at early education	18.3	81.7	2.5	<0.01	0.02
Children who stayed at home	32.6	67.4	1.2	<0.01	0.01

The weighted average occupancy factor for the living area F_l using (3) is found to be 0.42, where Occ_l are the occupancy levels of the living area for the population groups given in Table 6.

$$F_l = \sum_i Occ_{li} \quad (3)$$

The weighted average occupancy factor for the bedroom F_b using (4) is found to be 0.58, where Occ_b are the occupancy levels of the bedroom for the population groups given in Table 6.

$$F_b = \sum_i Occ_{bi} \quad (4)$$

4 Discussion

In an earlier study (Francis, 1986) the population was divided into 3 groups – men, women and housewives. A more recent study (Denman *et al*, 2000) used 3 population groups - adults, housewives and schoolchildren to assess the indoor occupancy pattern.

In this study the population was divided according to their working or study patterns. 6 population groups were identified. The occupancy levels in the home were estimated for each population group. The average occupancy levels (Table 4) vary from 4,290 hours per year for full-time workers to 6,031 hours per year for people who stayed at home. The group of children who stayed at home were identified to have the highest occupancy levels of 7,478 hours. This group however did not influence the estimated UK average occupancy levels because it had the smallest population weight of 1.2 %.

The estimation of the average time spent at home by different population groups can be compared with data from another study (Denman *et al*, 2000). The time spent at home by school children was estimated to be 4,732 hours per year (Table 4) which is 13.7 hours per day excluding holidays. This result is in a very good agreement with 14.4 hours per day reported by Denman *et al*. In the same

study the average occupancy levels in the home for full-time working adults were reported to be 14 hours which is in a good agreement with the 12.4 hours per day (excluding holidays) estimated from this study (see Table 4). The time spent by people who stayed at home was estimated to be 6,031 hours per year (Table 4) which is 16.8 hours per day. Again, the result is in very good agreement with 17.3 hours per day reported for a sample of adults in Northampton (Denman *et al*, 2000).

The new occupancy factors F_l and F_b were estimated to be 0.42 for the living area and 0.58 for the bedroom. The weighted average methodology allowed assessing the individual contribution of each population group to the total occupancy level. When comparing the new factors with the previous ones (Howarth C B and Miles J C H, 2008) it became evident that the contribution of the time spent in the bedroom increased from 0.55 to 0.58. This was the result of the total time spent indoors decreasing while the amount of time spent in the bedroom did not change.

5 Conclusion

The occupancy levels in the UK were assessed by reviewing recent published data. 6 population groups were identified and their occupancy levels were assessed. The new UK occupancy factors, estimated as a weighted average, for the living area and bedroom were found to be 0.42 and 0.58, respectively.

A comparison of the new occupancy factors with the factors derived previously revealed that the factors have not changed significantly. Nevertheless, they are the best estimate for the current population and, therefore, are recommended for use when assessing the annual average indoor radon concentration in the home.

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