



Digital

Health Survey for England 2016

Trend Tables – Population Number Estimates User Guide

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People working in public health, policy officials, commissioners of health and care services and the public may be interested in this user guide and the tables which show estimates of the numbers of adults and children in the population who are overweight or obese, and of the numbers who smoke, drink alcohol, eat fruit and vegetables, and take recommended levels of physical exercise.

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Tables are available in an Excel file at <https://digital.nhs.uk/pubs/hse2016>.

Introduction

The Health Survey for England series

The Health Survey for England is a series of annual surveys designed to measure health and health-related behaviours in adults and children living in private households in England. The survey is currently commissioned by NHS Digital (formerly the Health and Social Care Information Centre (HSCIC)), and before April 2005 was commissioned by the Department of Health. Since 1994, the survey has been carried out by NatCen Social Research and the Research Department of Epidemiology and Public Health at UCL.

The survey consists of an interview and nurse visit. It has a series of core elements that are included every year or alternate years, and special topics that are included in selected years. These areas are currently included every year:

- General health
- Social care
- Smoking
- Alcohol consumption
- Height measurements
- Weight measurements
- Prescribed medicines
- Doctor diagnosed hypertension and diabetes
- Waist and hip measurements
- Blood pressure measurements
- Adult blood samples
- Child saliva samples

Other areas are covered regularly, including well-being, fruit and vegetable consumption, and saliva and urine samples from adults. Special topics covered in selected years include cardiovascular disease (CVD), physical activity, accidents, lung function measurement and certain blood analytes.

Each annual survey has covered the adult population aged 16 and over living in private households in England. Since 1995, the surveys have also covered children aged 2 to 15, and since 2001, infants aged under 2 have been included. In some years a boost sample is used to increase the proportion of participants from certain population groups. There was no sample boost in 2016.

In 2016, interviews were completed with 8,011 adults and 2,056 children.¹

¹ See the report Health Survey for England 2016: Methods for a full description of the survey methodology, including sampling and response, available at <https://digital.nhs.uk/pubs/hse2016>.

Reports on HSE data

Reports and tables are published on a selection of findings for each survey year, as well as a report giving full details of the survey methods and survey documentation.

Trend tables are updated each year to show survey estimates for a number of key measures (for example, the percentage of the population who are overweight or obese, the proportions of current smokers). The trend tables focus on key changes in core topics and measurements. A commentary on trends in adults' health, and a report focusing on trends in children's health are available.

The population number estimates tables show estimates of the numbers of people in the population for key variables such as body mass index (BMI), smoking and drinking alcohol. This user guide introduces the tables, and explains how they are produced.

All HSE 2016 reports and tables are available at <https://digital.nhs.uk/pubs/hse2016>.

Population number estimates

The number estimates presented here convert the prevalence in the key trend tables into estimates of the numbers of people in the population in England that they represent. As an illustration, the obesity prevalence estimate of 26.2% for all adults aged 16 and over in 2016 has been converted into a number estimate of around 11.6 million (between 11,018,000 and 12,230,000). The tables in this series relate to characteristics and behaviours influencing health:

- Overweight and obesity
- Fruit and vegetable consumption
- Smoking
- Drinking
- Physical activity.

The number estimates cover 2003 to 2016. Estimates for adult physical activity, however, are only available for 2003, 2004, 2006, 2008, 2012 and 2016, and child physical activity for 2008, 2012 and 2015; results for 2008 onwards present a new method of estimating physical activity, and are based on the new guidelines introduced in 2011. Fruit and vegetable consumption was not covered in 2012 or, for adults, in 2014.

The trend tables present the results from the representative general population sample, and in some years boost sample data are also included to increase the precision of sub-group estimates (e.g. young adults in 2002, people aged 65 and over in 2005, and children in 2015).

For the number estimates, the prevalence estimates for each year (expressed as a proportion) were multiplied by a scaling factor equal to the total mid-year population

estimate,² then multiplied by the estimated proportion of people in the relevant age-sex group in the HSE. The mid-year population estimate was adjusted to represent the population living in private households excluding those aged 65 years and over living in institutions (44.4 million adults aged 16 and over in 2016).

Details of the method used to compute the number estimates and accompanying margin of error (i.e. the width of the 95% confidence interval divided by two) are provided in the technical annex.

How to use these tables

The eight tables show estimates of how many people in England, living in private households, have particular characteristics or behaviour. For instance the tables show the number of men and women who are estimated to be obese, who eat the recommended five or more portions of fruit and vegetables a day, or who currently smoke cigarettes. The tables also show breakdowns by age groups, for instance the number of children aged 8 to 10 who meet the government's recommendation of eating five or more portions of fruit and vegetables per day, or the number of 16 to 24 year olds who drink above recommended levels of alcohol.

Each table for adults shows results separately for men and women, usually within age categories, followed by results for all adults (men and women combined). Similarly tables for children show results for boys and girls within age groups, and then results for all children.

Numbers in all tables are presented in thousands, so 10,301 in the tables represents an estimate of 10,301,000 people in the population in England.

The Health Survey for England, in common with other surveys, collects information from a sample of the population. The sample is designed to represent the whole population as accurately as possible within practical constraints, such as time and cost. Consequently, statistics based on the survey are estimates, rather than precise figures, and are subject to a margin of error, which defines what is known as the 95% confidence interval.

The margin of error is shown for each estimate in the tables, again in thousands. For instance '± 389' in the tables represents ± 389,000. The lower and upper limits of the 95% confidence interval can be obtained from the margin of error as follows:

- Upper limit = estimate + margin of error
- Lower limit = estimate – margin of error

A different sample might have given a different estimate, but we expect that the true value of the statistic in the population would be within the range given by the 95% confidence interval in 95 cases out of 100. Thus for the estimate of 10,301,000 people and a margin of error of ± 389,000, the true number in the population is expected to lie between 9,912,000 and 10,690,000 in 95 cases out of 100.

Confidence intervals are affected by the size of the sample on which the estimate is based. Generally, the larger the sample, the smaller the confidence interval, and

² Mid-year population estimates are published by the Office for National Statistics (ONS), and can be found at:

<https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2016>

hence the more precise the estimate. For a large sample such as all men or all women, the confidence interval is narrower than for an estimate based on a smaller sample, for instance when looking at a particular age group, reflecting the larger uncertainty in the estimation. Estimates for adults aged 16 and over based on a general population sample of 15,000 to 16,000 adults (2003, 2006 and 2008) have a narrower confidence interval than in years with smaller samples (2004, 2005, 2007 and 2009 onwards).

The ONS mid-year population estimate bases for 2003-2016 are shown in Tables 9 and 10 for adults and children respectively. It should be noted that there may be slight differences between the sum of estimates in the tables and the bases in the final two tables. (For instance the sum of the % low levels of physical activity, % doing some activity and % meeting recommendations may not sum to the exact population size). The reason for this is the rounding of estimates to the nearest thousand.

Before 2003, no weighting was applied to the adult sample, whereas from 2003 survey estimates have been weighted for non-response.³ The sample of children each year was weighted to adjust for the probabilities of selection,⁴ and from 2003 non-response weighting was also introduced for children. While the trend tables show estimates from 1993 onwards, the number estimates series are published from 2003 onwards. Number estimates before 2003 are not shown because the change in weighting means a different calculation must be used for the confidence intervals, as described in the technical annex.

Non-response weighting brings the profile of the survey sample very close to the profile of the total population. Estimates for the 2016 prevalence trends have been computed on a non-response weight based on 2016 mid-year population estimates.⁵ Similarly, the number estimates have been computed using a grossing-up factor calculated from the ONS mid-year population estimates; for the 2012 number estimates, the grossing-up factor was calculated from the 2011 census.

The adult population of England living in private households has increased from around 39.7 million in 2003 to 44.4 million in 2016. For any given category in the tables, changes in the projected population numbers from one year to the next will be affected by changes in the population size as well as changes in prevalence (i.e. the percentage of the population) for that category. These population figures should be read in conjunction with the key trends in the health of adults and children since 1993, to see whether changes in numbers are due to changes in estimated proportions for that category or merely reflect the change in the overall population over time.

³ Sproston K, Primatesta P (eds). *Health Survey for England 2003: Volume 3 Methodology and documentation*: The Stationery Office, London, 2004.

⁴ Until 2014, up to two children per household were interviewed, and in households with three or more children, two were selected at random. From 2015, up to four children per household can be interviewed. Therefore weighting is required to ensure that children in larger households are not under-represented in the sample. The non-response weighted estimates from 2003 onwards include the necessary adjustment for child selection.

⁵ <https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates>

Technical annex

Introduction

This section provides a technical description of the methods used to calculate the number estimates and accompanying margins of error. The section is followed by a worked example. The method used is valid only from the introduction of non-response weighting into the HSE series. The number estimates are, therefore, presented for years 2003 onwards.

Number estimates

For each indicator, the prevalence data presented in the trend tables were multiplied by a scaling factor to estimate the number of people with particular characteristics or behaviour (number obese, number of current smokers etc.). The scaling factor was based on two figures. The first was the ONS mid-year population estimate for the relevant year, adjusted to represent the population living in private households (i.e. excluding those aged 65 years and over living in institutions).⁶ The second figure used was an estimate of the proportion of people in the relevant age-sex group (e.g. percentage of the adult population who were male aged 16 to 24). The proportions in each age-sex group were calculated from HSE data (with the non-response weight applied). It should be noted that a different estimate of this second figure is calculated for each table as only the respondents to the relevant question are included in the calculation. This means that the age-sex distribution estimated from HSE data does not correspond exactly to the age-sex distribution available from the ONS figures.⁷ The

⁶ The ONS mid-year population estimates for those aged 65+ were adjusted to remove the proportion in that age group who were living in institutions according to the 2011 Census.

⁷ The weighted age-sex distribution of HSE respondents does not exactly match the corresponding distribution available from the ONS mid-year population estimates. In 2016, this is because the prevalence estimates are subject to item non-response. For example, the BMI categories are based on respondents with a valid height and weight measurement. There is some non-response among interviewed respondents to height and weight measurements, and the weighting applied to interview data does *not* correct for this element of non-response. The age profile for the achieved sample with a valid BMI measurement in 2016 is shown below, compared with the ONS population estimates for 2016 (adjusted for institutional populations), shown in the shaded column.

ONS and HSE (valid BMI) age profiles

Age group	ONS	HSE
	2016	2016
	%	%
16-24	13.83	14.07
25-34	17.03	16.70
35-44	15.98	16.65
45-54	17.47	17.60
55-64	14.21	14.72
65-74	12.09	12.11
75+	9.39	8.15

calculation chosen allows the prevalence estimates to be re-created from the number estimate tables.

The weighting variable can be denoted as w_{ij} where i denotes the age-sex group of the HSE respondent (e.g. men aged 16 to 24) and j denotes the HSE respondents to the question within each age-sex group.

Then the weighted number of respondents to the question can be expressed as:

$$w = \sum_{i,j} w_{ij} \quad [1]$$

and the weighted number of respondents of a particular age-sex group as:

$$w_i = \sum_j w_{ij} \quad [2]$$

Dividing [2] by [1], therefore, gives the estimate of the proportion of the population belonging to a particular age-sex group.

If the overall (i.e. men and women combined) ONS mid-year population estimate is labelled as P , then the HSE estimate of the number of persons belonging to age-sex group i (labelled M_i) can be expressed as:

$$M_i = P \left(\frac{w_i}{w} \right) \quad [3]$$

This is the scaling factor described above: the ONS mid-year population total (P) multiplied by the estimate of the proportion of people in the relevant age-sex group. Note that due to item non-response (e.g. refusals and don't knows) the proportion will be slightly different for each table.

Finally, if the number estimate for age-sex group i and health lifestyle indicator k is labelled N_{ik} , and the corresponding prevalence estimate is labelled ϕ_{ik} , then the number estimate can be derived as follows:

$$N_{ik} = P \frac{w_i}{w} \phi_{ik} \quad [4]$$

In other words, the estimated number of, say, obese men aged 16 to 24, can be expressed as the overall ONS population estimate P , multiplied by the proportion of respondents with a valid BMI who were male aged 16 to 24, multiplied by the estimated obesity prevalence for men aged 16 to 24.

Using this calculation method allows the estimates in the prevalence trend tables to be reproduced from the number estimates, ensuring consistency between the two sets of tables.

It should be noted, therefore, that the only ONS mid-year population estimate that can be reproduced from these figures is the *overall* population figure, P (i.e. total population aged 16 and over in the relevant year). The proportion of people in the relevant age-sex group is taken from the HSE (and not ONS) data.

The implication of this is that the prevalence estimates cannot (and should not) be derived by dividing the number estimate for each age-sex group by the corresponding ONS age-sex population estimate.⁸ For prevalence estimates users are advised to consult the prevalence trend tables.

Margin of error

The margin of error (MoE) of the number estimates is calculated by multiplying the MoE of the prevalence by M_i , the scaling factor used to create the number estimates.

If E_{ik} is the MoE for a number estimate and ε_{ik} is the MoE of the associated prevalence then:

$$E_{ik} = \frac{Pw_i\varepsilon_{ik}}{w} \quad [5]$$

The standard error of the prevalence is calculated using Stata's survey module commands which take into account the complex sample design. The MoE is then calculated by multiplying the standard error by 1.96.

In order to use equation 5, it must be assumed that no further uncertainty is added to the number estimate when the prevalence is multiplied by the scaling factor, in other words that the scaling factor $P\frac{w_i}{w}$ is constant. It is assumed that the ONS estimates P have small enough variance to discount.

The same assumption can be made for the factor $\frac{w_i}{w}$. This assumption is justified by considering that $\frac{w_i}{w}$ is the weighted proportion of respondents for a particular age-sex group. The purpose of the weighting is to correct the figures for non-response. The weighting scheme uses several variables including age and sex. The weighting is chosen to make $\frac{w_i}{w}$ approximately equal to a fixed value, taken from the ONS population estimates. That is, although the age-sex distribution of the sample is prone to sampling error, the weighting 'fixes' the values of $\frac{w_i}{w}$ to be approximately equal to the ONS population estimates.

It should be noted that the variance of $\frac{w_i}{w}$ is not exactly zero. Due to the impact of other variables included in the weighting and differential item non-response⁸ the value of $\frac{w_i}{w}$ is not exactly the same for all possible samples. This means the assumption causes a slight underestimate in the value of the MoE. However, the variation is small and the assumption allows considerable computational efficiency gains.

⁸ See footnote 7 for details.

Worked example

This worked example illustrates the method used to convert the prevalence estimates in some of the standard trend tables into estimates of the numbers of people in the population in England that they represent. The example used is obesity (including morbidly obese) for men using HSE 2016. Table A shows the calculation of the number estimates; Table B the calculation of the margin of error.

Table A: 2016 number estimates (obesity for men)

Age group	ONS population estimate P	Prevalence of obesity ϕ_{ik}	Weighted number of respondents w	Weighted number of respondents of age-sex group w_i	HSE number estimate age-sex group M_i	Estimated number obese N_{ik}
	Column					
	1	2	3	4	5	6
16-24	44,393,432	0.098	6,566	482	3,255,930	319,056
25-34	44,393,432	0.184	6,566	565	3,819,125	701,031
35-44	44,393,432	0.290	6,566	551	3,726,924	1,082,019
45-54	44,393,432	0.316	6,566	583	3,941,258	1,245,844
55-64	44,393,432	0.344	6,566	464	3,139,039	1,079,831
65-74	44,393,432	0.327	6,566	387	2,616,112	855,622
75+	44,393,432	0.253	6,566	246	1,659,956	419,421

Data in columns 2, 3 and 4 have been rounded, and the numbers shown are not exact.

- Column 1 shows the overall ONS population estimate for adults, showing 44.4 million adults aged 16 and over living in private households in England on 30 June 2016.
- Column 2 shows the estimated prevalence of obesity for each of the seven age groups (expressed as a proportion). 25.3% of men aged 75+ were classed as obese, compared with 10.0% of men aged 16 to 24.
- Column 3 shows the weighted number of HSE respondents with a valid BMI measurement (using the non-response main interview weight, which is scaled to the achieved sample size, resulting in the weight being standardised around an average of one).⁹

⁹ Weighted totals may not sum to a whole number.

- Column 4 shows the weighted number of HSE respondents in each age-sex group. Of all HSE 2016 respondents aged 16 and over (with valid BMI), about 7.3% were men aged 16 to 24 (column 4 divided by column 3).⁹
- Column 5 shows that applying the proportion of HSE respondents in each age-sex group to the ONS population estimate P gives an HSE estimate of the number of persons in the population in each age-sex group: equation [3] above.
- Applying the proportion of HSE respondents who were male aged 16 to 24 ($482/6,566 = 0.073$) to the ONS population estimate gives an estimated number of 3,255,930 men aged 16 to 24.

$$HSE\ estimate_{men,16-24} = 44,393,432 \left(\frac{482}{6,566} \right) = 3,255,930$$

- Column 6 shows the number estimate of men in England who were classed as obese in 2016, which can be calculated using equation [4].

As an illustration, for men aged 16 to 24, the estimate of the number who were obese can be calculated as follows:

$$obese_{men,16-24} = 44,393,432 \left(\frac{482}{6,566} \right) 0.098 = 319,056 \text{ (rounded to 319,000)}$$

- The number in the population estimated to be obese can be expressed as the prevalence (0.098 for men aged 16 to 24) multiplied by a scaling factor equal to the ONS mid-year population estimate (44.4 million) multiplied by the HSE estimate of the proportion of people in the male 16 to 24 category ($482/6,566 = 0.073$).
- Note, therefore, that the HSE estimate of the proportion of the population in England in each age-sex group does not match exactly the equivalent ONS mid-year estimate (see footnote 7). The only ONS mid-year population estimate that can be reproduced is the *overall* population figure.

Table B: Estimated margin of error

Age group	Prevalence of obesity ϕ_{ik}	Estimated standard error SE	HSE number estimate (age-sex group) M_i	Standard error of estimated number obese	Margin of error (unrounded)
Column					
	1	2	3	4	5
16-24	0.098	0.019	3,255,930	62,041	121,601
25-34	0.184	0.019	3,819,125	72,102	141,321
35-44	0.290	0.023	3,726,924	85,819	168,206
45-54	0.316	0.022	3,941,258	85,922	168,408
55-64	0.344	0.022	3,139,039	69,142	135,518
65-74	0.327	0.023	2,616,112	59,592	116,801
75+	0.253	0.026	1,659,956	42,917	84,118

- Columns 1 and 2 show the estimated prevalence of obesity and accompanying standard error (SE) respectively (both expressed as a proportion).
- Column 3 shows the HSE estimate of the number of residents in England in each age-sex group (described above).
- Column 4 shows the SE of the estimated number that were obese. It is calculated by multiplying the SE of the prevalence by the estimated number of people in the relevant age-sex group (column 2 \times column 3).

For men aged 16 to 24, the estimated SE of the number who were obese can be calculated as follows:

$$SE\ number\ obese_{men,16-24} = 0.019 \times 3,255,930 = 62,041$$

- Column 5 gives the margin of error (MoE): the estimated SE of the number estimate multiplied by 1.96.

For men aged 16 to 24 the MoE is as follows:

$$MoE\ number\ obese_{men,16-24} = 62,041 \times 1.96 = 121,601\ (rounded\ to\ \pm\ 122,000)$$

Note that in these two worked examples, all figures based on survey estimates or weighted survey data have been rounded and so the estimated population projections and margins of error cannot be exactly calculated step-by-step as presented here.

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