Health Survey for England 2016 Methods

Published 13 December 2017

This report provides details of the methodology of the Health Survey for England 2016. It covers the sample design, topic coverage, fieldwork procedures, quality control, ethical approval, survey response, weighting and data analysis.

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ISBN: 978-1-78734-099-2

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ISBN 978-1-78734-099-2

This report may be of interest to members of the public, policy officials, people working in public health and to commissioners of health and care services who wish to see the details of the methodology of the Health Survey for England 2016.

1 Introduction

1.1 The Health Survey for England series

The Health Survey for England (HSE) comprises a series of annual surveys, of which the 2016 survey is the twenty–sixth. 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 as well as older children.

The HSE is part of a programme of surveys commissioned since 2005 by the Health and Social Care Information Centre (NHS Digital since August 2016). Before April 2005, the survey series was commissioned by the Department of Health. The surveys provide regular information that cannot be obtained from other sources about the public's health and associated factors. The series of Health Surveys for England was designed to:

- provide annual data from nationally representative samples to monitor trends in the nation's health;
- estimate the proportion of people in England who have specified health conditions;
- estimate the prevalence of certain risk factors associated with these conditions;
- examine differences between subgroups of the population (e.g. by age, sex or income) in their likelihood of having specified conditions or risk factors;
- assess the frequency with which particular combinations of risk factors are found, and in which groups these combinations most commonly occur;
- monitor progress towards health targets;
- (since 1995) measure the height of children at different ages, replacing the National Study of Health and Growth; and
- (since 1995) monitor the prevalence of overweight and obesity in children.

Each survey in the series includes core questions, and measurements such as blood pressure, height and weight measurements and analysis of blood and saliva samples. In addition there are modules of questions on specific issues that vary from year to year. In some years, the core sample has also been augmented by an additional boosted sample from a specific population subgroup, such as minority ethnic groups, older people or children; there was no such boost in 2016.

The HSE has been designed and carried out since 1994 by the Joint Health Surveys Unit of NatCen Social Research and the Research Department of Epidemiology and Public Health at University College London (UCL).

1.2 The 2016 survey

1.2.1 Subject coverage

The survey series covers some core topics every year, including general health, longstanding illness, key lifestyle behaviours that influence health, and social care. In 2016, there were additional questions for adults on the following topics:

- physical activity;
- weight management;
- kidney and liver disease;
- problem gambling.

In 2016, urine samples were collected from adult participants.

1.2.2 Summary of survey design

As in previous years, the HSE 2016 used a stratified random probability sample of households. The sample comprised 9,558 addresses selected at random in 531 postcode sectors. Adults and children were interviewed in households identified at the selected addresses. To limit the burden of responding for parents, no more than four children in each household were selected at random: up to two children aged between 0 and 12, and up to two aged between 13 and 15. For further details on the sample design, see Section 2 of this report.

Data collection comprised an interview, followed by a visit from a specially trained nurse for all those who agreed. The nurse visit included additional questions, measurements, collection of blood and urine samples from adults, and collection of saliva samples from children aged between 4 and 15.

Addresses were issued from January to December 2016. Fieldwork was completed in March 2017. A household response rate of 59% was achieved. In total, 8,011 adults and 2,056 children were interviewed, including 5,049 adults and 1,117 children who had a nurse visit.

1.2.3 Ethical approval

Ethical approval for the 2016 survey was obtained from the East Midlands Nottingham 2 Research Ethics Committee (Reference no 15/EM/0254).

1.3 Reports on the Health Survey for England 2016

Findings from the HSE 2016 are published online and can be accessed via https://digital.nhs.uk/pubs/hse2016.

Six topic report are available, each accompanied by tables in Excel format.

- Adult overweight and obesity
- Kidney and liver disease
- Physical activity in adults
- Prescribed medicines

- Social care for older adults
- Well-being and mental health.

All these reports refer to the health and lifestyles of adults aged 16 and over, except for the Social Care report, which looks at care for adults aged 65 and over.

In addition, tables showing health trends for adults, have been published with an accompanying commentary. These cover the following health measures and lifestyle behaviours, shown by age, sex and survey year:

- blood pressure;
- mean height and weight;
- body mass index, prevalence of overweight and obesity;
- mean waist circumference;
- weekly alcohol consumption;
- maximum alcohol consumption on any day in the last week;
- cigarette smoking;
- fruit and vegetable consumption;
- general health, longstanding illness and acute sickness;
- prevalence of ischaemic heart disease (IHD) or stroke;
- prevalence of diabetes;
- levels of physical activity; and
- well-being.

There is also a report focusing on children's health, including trend data. It covers the following topics:

- mean height and weight;
- body mass index and the prevalence of overweight and obesity;
- cigarette smoking;
- drinking alcohol;
- fruit and vegetable consumption;
- general health, longstanding illness and acute sickness; and
- levels of physical activity.

Population estimates are available for some of the trend estimates for adults and children covering 2016 and past years. For adults, these comprise:

- body mass index categories;
- cigarette smoking;

- maximum alcohol consumption on any day in the last week;
- fruit and vegetable consumption; and
- levels of physical activity.

For children, population estimates are shown for:

- prevalence of overweight and obesity;
- fruit and vegetable consumption; and
- levels of physical activity.

1.4 Availability of data sets

The HSE is a long survey and only some of the results are included in the reports and trend tables. Copies of the anonymised and disclosure controlled datasets can be made available for specific research projects through the UK Data Service at https://www.ukdataservice.ac.uk/. These cover answers to more questions than can be covered in the reports. Full documentation is available in the archive, including a list of all the variables and definitions for derived variables. For further information go to: http://discover.ukdataservice.ac.uk/series/?sn=2000021

2 Sample design

2.1 Overview of the sample design

The sample for HSE 2016 comprised the core sample only; there was no boost sample. A reserve sample was built into the sample design and issued in the final quarter of the 2016 survey year. An additional reserve sample was drawn in August 2016 to ensure the target number of interviews was achieved, given the lower than expected household response rate. Again, this additional sample was issued across the final quarter of fieldwork.

The core sample was designed to be representative of the population living in private households in England. Those living in institutions were outside the scope of the survey. This should be borne in mind when considering survey findings since the institutional population is likely to be older and, on average, less healthy than those living in private households.

Like previous surveys in the HSE series, the 2016 survey adopted a multi-stage stratified probability sampling design. At the first stage, a random sample of primary sampling units (PSUs), based on postcode sectors, was selected. Within each selected PSU, a random sample of postal addresses (known as delivery points) was then drawn.

2.2 Selection of primary sampling units

2.2.1 Definition of primary sampling units

The sampling frame was the small user Postcode Address File (PAF). The very small proportion of households living at addresses not on PAF (estimated to be less than 1%) was not covered.

Postcode sectors with fewer than 500 PAF addresses were combined with neighbouring sectors to form the PSUs. This was done to prevent addresses being too clustered within a PSU. To maximise the precision of the sample, it was selected using a method called stratified sampling. The list of PSUs in England was sorted by former Government Office Regions (described throughout the report as regions) and, within each region, by local authority ordered by the percentage of adults in the 2011 Census from NS-SEC groups 1 and 2.[1] PSUs in smallest regions (the North East and East Midlands) were over-sampled to provide a minimum sample size (of approximately 700 adults).

Initially 504 PSUs were selected with probability proportional to the total number of addresses within them. Selecting PSUs with probability proportional to number of addresses and sampling a fixed number of addresses in each ensures that an efficient (equal probability) sample of addresses is obtained.

[1] NS-SEC is a social classification system that attempts to classify groups on the basis of employment relations, based on characteristics such as career prospects, autonomy, mode of payment and period of notice. Participants are assigned to an NS-SEC category based on the current or former occupation of the household reference person. For a full explanation of NS-SEC and its derivation see the Glossary in this volume, and *The National Statistics Socio-economic Classification User Manual 2002,* ONS, 2002. Groups 1 and 2 in NS-SEC are higher managerial and higher professional occupations.

Once selected, the PSUs in each group were randomly allocated to the 12 months of the year so that each quarter provided a nationally representative sample. Each month the PSUs were evenly distributed by month in each fieldwork area.

The initial sample design included a 'reserve' for the final quarter of the year. The intention was that, if the response rate achieved in early months of fieldwork reached 64% (and the target number of 8,000 achieved interviews with adults was likely to be exceeded) eight PSUs could be withdrawn in the final quarter of the year without affecting the representative coverage of the sample. Eight additional PSUs were selected to be withdrawn in case of a response rate of 65%. In the event, not only were the reserve points issued, but an additional sample of 27 PSUs was released in the final quarter of fieldwork due to lower than expected response rate. Therefore a total of 531 PSUs were issued.

2.3 Sampling addresses, dwelling units and households

Within each of the PSUs, a fixed number of addresses was selected. Table 2.1 summarises the number of PSUs and addresses issued for the main and additional sample. In total, 9,558 addresses were issued.

Table 2.1: Number of PSUs and addresses issued for HSE 2016

	Number of PSUs	Number of addresses per PSU	Number of addresses issued
Main sample	504	18	9,072
Additional sample	27	18	486
Total sample	531	18	9,558

When visited by interviewers, 10% of the selected addresses were found not to contain private households. These included businesses and institutions, vacant properties, demolished properties and those still being built. These addresses were thus ineligible and were excluded from the survey sample.

Tables A1, A2

Most addresses selected from the PAF contained a single dwelling unit and/or household.[2] However, a small proportion of addresses (about 1%) were multi-occupied. At addresses with more than one dwelling unit (with a separate entrance), one was selected at random by the interviewer to be included in the survey. For dwelling units with more than one household, again, one was selected at random.[3]

Household-level survey response is discussed in detail in Section 6 of this report.

[2] A household is defined as one person living alone or a group of people (not necessarily related) living at the same address who share cooking facilities AND share a living room or dining area.

[3] In the HSE 2009, the survey design was changed to select a single household at dwelling units with more than one household; previously interviewers carried out interviews at up to three households per dwelling unit. The change was made because the impact on the sample efficiency was negligible, and the procedures for interviewing at more than one household per dwelling unit were cumbersome and error prone for interviewers. The procedures used to select households were unchanged in 2009 and subsequent years.

2.4 Sampling individuals within households

In the HSE sample, all adults aged 16 years and over at each household were selected for the interview (up to a maximum of ten adults per household). However, a limit of four was placed on the number of interviews carried out with children: up to two aged between 0 and 12 years and up to two aged between 13 and 15 years. For households at which there were three or more children in the relevant age range, interviewers selected two children at random.[4]

To compensate for the omission of children in households with more than two children in relevant age bands, selection weights were applied to the data (see Section 7). Otherwise children from large households would be under-represented in the survey estimates.

[4] This reflects a change in the selection procedures since HSE 2014 when up to two children aged between 0 and 15 were selected. The adjustment was necessary to make the sample more efficient by yielding more child interviews per household, while having a minimal impact on the clustering effect and the burden on parents or guardians.

3 Topic coverage

3.1 Documentation

Copies of the survey data collection documents are available, along with protocols for measurement and for the collection of blood, urine and saliva samples. They can be accessed at https://digital.nhs.uk/pubs/hse2016.

3.2 The Stage 1 interview

Information was collected at household level and at individual level. The household interview included questions on household size, composition and relationships; type of dwelling, tenure, and the number of bedrooms; car ownership; smoking within the home; the economic status and occupation of the household reference person; and household income. Any household members with learning difficulties were also identified at this stage.[5]

Adults were asked core modules of questions, including general health, social care, alcohol consumption and smoking. In 2016, adults were also asked detailed questions about physical activity. The interview concluded with additional questions about personal circumstances, and participants were asked for consent to link their survey data to other records held by the NHS.

Interviews for children aged 0 to 12 were carried out with a parent; children aged 13 to 15 were interviewed directly. The interview for children included questions on general health, fruit and vegetable consumption, exposure to second-hand smoke and ethnicity.

The content of the interview for different age groups is shown in Figure 3.1.

During the interview, participants aged 8 and over were asked to answer questions about alcohol, smoking, weight and other topics within a self-completion booklet. There were four booklets for different age groups. The booklets for young adults aged 16 to 17 asked about smoking and drinking behaviour as well as other questions. Interviewers also had the option of using this booklet for those aged 18 to 24 if they felt that it would be difficult for anyone in this age group to give honest answers to the questions face-to-face with other household members present. The content of the self-completion booklets for different age groups is shown in Figure 3.2.

Interviewers measured the weight of all participants and the height of everyone aged 2 and over.

[5] Adults with learning difficulties who were not considered capable of giving informed consent were not interviewed.

Figure 3.1: Content of interview by age group

Age in years	0-1	2-4	5-15	16-64	65+
General health, longstanding illness, limiting longstanding illness	•	•	•	•	•
Personal care plans				•	•
Self-reported height and weight				•	•
Doctor diagnosed hypertension and diabetes				•	•
Receipt of social care					•
Physical activity				•	•
Fruit and vegetable consumption			•	•	•
Smoking[a]				•[a]	•
Exposure to second-hand smoke	•	•	•		
Drinking[a]				•[a]	•
Height and weight measurements		•	•	•	•
Economic status, occupation				•	•
Educational attainment				•	•
Ethnic origin, national identity	•	•	•	•	•
Consent to link data to health records				•	•

[a] Questions about smoking and drinking were included in the self-completion questionnaires for young adults aged 16 to 17. Interviewers also had the option of using this booklet for those aged 18 to 24 if they felt that they would be inhibited from giving honest answers to the questions face-to-face with other household members present.

Figure 3.2: Content of self-completion booklets by age group

Age in years	8-12	13-15	16-17	18+
Smoking[a]	•	•	•	
Drinking[a]	•	•	•	
General Health Questionnaire (GHQ-12)		•	•	•
ONS measure of life satisfaction			•	•
Well-being (Warwick Edinburgh Mental Well-being Scale)			•	•
Gambling			•	•
Sexual orientation			•	•
National identity	•	•	•	
Religion	•	•	•	•
Perception of own weight	•	•	•	•
Perception of child's weight			•	•

[a] Interviewers had the option of using the booklet for 16 and 17 year olds for those aged 18 to 24 if they felt that they would be inhibited from giving honest answers to the questions about smoking and drinking face-to-face with other household members present.

3.3 The Stage 2 nurse visit

Nurse visits were offered to all participants who were interviewed.

At the nurse visit, questions were asked about prescribed medicines, and adults were asked about folic acid and nicotine replacement products. In 2016, adults were additionally asked about kidney and liver disease and weight control, including the use of aids and advice from health professionals.

Nurses took waist and hip measurements for those aged 11 and over and measured the blood pressure of those aged 5 and over.

Adults were also asked to provide non-fasting blood samples[6] for the analysis of total cholesterol and HDL cholesterol and glycated haemoglobin. In 2016, blood samples

[6] For some blood sample analyses it is necessary for participants to fast for a period before the sample is taken as the composition of the blood sample is affected by recent intake of food or drink. However, for the analytes in the HSE, 'non-fasting' blood samples can be used and participants do not have to fast before the nurse visit.

were also analysed for markers of kidney and liver disease.[7] Adult participants were asked for samples of urine, which were analysed for the albumin and creatinine ratio, an alternative indicator of kidney disease. Samples of saliva were taken from children aged 4 and over for the analysis of cotinine (a derivative of nicotine that shows recent exposure to tobacco or tobacco smoke). Written consent was obtained for these samples. Details of the analysis of these samples are provided in Section 9.

[7] Serum creatinine and cystatin C were used as indicators of kidney disease; aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were used as indicators of liver disease. For full details see the HSE 2016 Kidney and liver disease report.

4 Fieldwork procedures

4.1 Advance letters

Each sampled address was sent an advance letter which introduced the survey and stated that an interviewer would be calling to seek permission to interview. A leaflet was also enclosed providing general information about the survey and some of the findings from previous surveys.

A small token of appreciation, in the form of a £10 voucher, was enclosed with the advance letter to encourage participation.

4.2 Making contact

At initial contact, the interviewer established the number of dwelling units and/or households at an address, and made any selection necessary (see Section 2.3).

The interviewer then made contact with each selected household and attempted to interview all adults (up to a maximum of ten) and up to four children aged 0 to 15 (see Section 2.4). The interviewer sought parents' consent and children's assent to interview the selected children aged up to 15.

4.3 Collecting data

Both interviewers and nurses used computer assisted personal interviewing (CAPI).

At each co-operating eligible household, the interviewer first completed a household questionnaire. Information was obtained from the household reference person (HRP)[8] or their partner wherever possible. This questionnaire obtained information about all members of the household, regardless of age. If there were one or two children aged under 16, they were automatically included in the sample for an interview. If there were three or more children aged under 16, two were selected.

An individual interview was carried out with all selected adults and children. In order to reduce the amount of time spent in a household, interviews could be carried out concurrently, the program allowing for up to four participants to be interviewed in a session.

Height and weight measurements were obtained towards the end of the interview.

At the end of the interview, participants were asked for their agreement to the second stage of the survey, the follow-up visit by a nurse. In the case of children aged under 16, the parent's permission was sought (see Section 4.4 for details). Wherever possible, an appointment was made for the nurse to visit within a few days of the interview. At this visit the nurse carried out the measurements described in Section 3.3 and obtained blood and saliva samples from those eligible and willing to provide these samples.

In addition to the advance letter and leaflet, participants were given two further leaflets describing the purpose of the survey and the associated measurements. Interviewers initially handed out a leaflet describing the purpose of the interview. At the end of the interview, they handed out a leaflet explaining the nurse visit to those who had agreed

[8] The household reference person (HRP) is defined as the householder (the person in whose name the property is owned or rented); if there is more than one, the person with the highest income. If there are two householders with equal income, then the household reference person is the oldest.

to this next stage. Copies of the leaflets are available via https://digital.nhs.uk/pubs/hse2016.

4.4 Obtaining informed consent

It is important to ensure that participants aged 16 and over give informed consent for all stages of the interview and nurse visit process. For some elements of the survey, verbal consent was sought: for taking part in the survey at all, for answering modules of questions (and any individual question), for completing the self-completion booklet, and for measurements such as height, weight, blood pressure and waist and hip circumference. Verbal consent was not recorded; it is assumed that those who took part in the survey, and answered individual questions or provided physical measurements had consented to do so. A proportion of participants did decline to take part in some of these survey elements, although they had consented to take part in the study and complete other elements. Section 6 provides details of response at different stages of the interview and nurse visit.

Written consent was required for:

- taking biological measurements (blood, urine and saliva samples)
- passing on information to others, for instance sending biological sample results to the participant's GP
- storing blood samples for future use
- using personal details for matching to administrative data.

Written consent was obtained in a booklet (available via https://digital.nhs.uk/pubs/hse2016) which was signed by the participant and countersigned by the interviewer or nurse. These consents were recorded in the CAPI interview. The consent booklets were supplemented by information leaflets, and by information provided by the interviewer or nurse.

Parents gave consent on behalf of their children aged up to 15 years; children also had to give their assent for an element to go ahead. This is described in more detail in the next section.

4.5 Interviewing and measuring children

Children aged 13 to 15 were interviewed directly, after permission was obtained from the child's parent or guardian. Interviewers were instructed to ensure that the child's parent or guardian was present in the home throughout the interview. Information about younger children was collected from a parent. Whenever possible, younger children were present while their parent answered questions about their health. This was partly because the interviewer had to measure their height and weight and, in the case of those aged 8 and over, to ask the child to complete a short self-completion booklet during the interview. It also ensured that the child could contribute information where appropriate.

Permission for a nurse to carry out any measurements on a child aged under 16 had to be obtained from the child's parent or someone else with legal parental responsibility for that child. This person had to be present during the nurse visit. The child's assent was also required.

Written consent to collect a saliva sample from a child, and to send their blood pressure results to their GP, was obtained from the parent. Children indicated their

assent to these procedures by initialling a box on their consent form, if they were able to do so; if not, parents initialled to indicate that the child had given their assent.[9]

4.6 Interview length

Interviews could be conducted with between one and four persons per session; the most common session types were with one or two individuals. The median (average) interview length for a single adult was 41 minutes, and for two people (including at least one adult) median interview length was 64 minutes. Nurse visits were conducted with a single individual at a time, and the nurse visit for adults who took part in all the measurements averaged 35 minutes.[10]

Interviews with children were shorter than with adults, and the interview length varied with age as some modules were only asked of older children. When children were interviewed without adults, for a single child aged 8 to 15 the median interview length was 17 minutes and the median length of the nurse interview was 16 minutes.

4.7 Feedback to participants

Each participant was given a Measurement Record Card in which the interviewer entered the participant's height and weight, and the nurse entered waist, hip and blood pressure measurements. Participants who saw a nurse were asked if they would like their blood pressure and blood and urine sample results sent to their GP. If they did want results to go to their GP, written consent was obtained.

Nurses were issued with a set of guidelines to follow when commenting on participants' blood pressure readings. (For the text, see the protocols via https://digital.nhs.uk/pubs/hse2016). If an adult's blood pressure reading was severely raised, nurses were instructed to contact the Survey Doctor at the earliest opportunity after leaving the participant's home. For children, they were instructed not to comment on a high reading but to contact the Survey Doctor to assess whether any action was required. Where permission had been given for results to be sent to a participant's GP, the Survey Doctor contacted the GP if any blood pressure results were markedly abnormal. Where permission was not obtained, the Survey Doctor wrote to the participant where this was deemed clinically appropriate.

[9] Adults and parents were required to give fully informed consent. Assent from children indicated that they had been given an age-appropriate explanation that they could understand (even if not as comprehensive as for an adult), and that the child was happy for the procedure to go ahead.

[10] The median is the value of a distribution which divides it into two equal parts such that half the cases have values below the median and half the cases have values above the median. It may be a better indicator of interview length than the mean, which can be disproportionately influenced by a relatively small number of cases with very high values (i.e. very long interviews). This can happen because of interruptions, because the respondent has a great deal of information to impart or because the pace of the interviewer is slower than usual, for example because the respondent has difficulties in comprehending questions or instructions.

5 Fieldwork quality control

5.1 Training interviewers and nurses

Interviewers were fully briefed on the administration of the survey. They were given training, including a practice session, on measuring height and weight, and were required to pass an accreditation test for these measures before working on the study.

All nurses were professionally qualified and proficient in taking blood samples before joining the NatCen team. They attended a two day training session at which they received equipment training and were briefed on the specific requirements of the survey with respect to taking blood pressure, taking waist and hip measurements and taking blood and saliva samples.

Full sets of written instructions, covering both survey procedures and measurement protocols, were provided for both interviewers and nurses; see https://digital.nhs.uk/pubs/hse2016.

Interviewers and nurses who had worked on the previous year's Health Survey attended full day refresher training sessions, where the emphasis was on updating them on new topic coverage, improving measurement skills and gaining respondent participation.

All interviewers and nurses new to the Health Survey were accompanied by a supervisor during the early stages of their work to ensure that interviews and protocols were being correctly followed. Routine supervision of 10% of the work of both interviewers and nurses was carried out subsequently.

5.2 Checking interviewer and measurement quality

A large number of quality control measures were built into the survey at both data collection and subsequent stages to check on the quality of interviewer and nurse performance.

Recalls to check on the work of both interviewers and nurses were carried out at 10% of households where interviews were taken.

The computer program used by interviewers had in-built soft checks (which can be suppressed) and hard checks (which cannot be suppressed); these included messages querying uncommon or unlikely answers as well as answers out of an acceptable range. For example, if someone aged 16 or over had a height entered in excess of 1.93 metres, a message asked the interviewer to confirm that this was a correct entry (a soft check), and if someone said they had carried out an activity on more than 28 days in the last four weeks the interviewer would not be able to enter this (a hard check). For children, the checks were age specific.

At the end of each survey month, the measurements made by each interviewer and nurse were inspected. Any problems (such as higher than average proportions of measurements not obtained, insufficient samples and so on) were discussed with the relevant nurse or interviewer and their supervisor.

6 Survey response

6.1 Introduction to response analysis

This section looks at the response of households in the sample (Section 6.2), and at the response of eligible individuals within those households, first for adults (Section 6.3) and then for children (Section 6.4). Individual response for adults and children is examined in two ways: overall response for all eligible individuals in the 'set' sample, and response for individuals within co-operating households.

Participants were asked to co-operate in a sequence of survey stages. Adults and children were asked to take part in a face-to-face interview, as well as measurement of height and weight. Those who were interviewed were offered a nurse visit, including various measurements and a request for a urine sample and blood samples from adults and a saliva sample from children. Individual non- response is therefore accumulated through the survey stages.

Not every measurement obtained by an interviewer or a nurse was subsequently considered valid for analysis purposes. Individual topic reports give further details of the numbers of measurements used for analysis, the numbers of exclusions and the reasons for them.

Detailed tables can be found in Appendix A of this report.

6.2 General population sample: household response

Table A1 shows household response by calendar quarter. The row labelled 'Total eligible households' shows the number of private residential households found at the selected addresses (after selection of a single dwelling unit, and a single household when necessary). 90% of selected addresses were eligible.

59% of eligible households (5,096) were described as 'co-operating'; households in this category are those where at least one eligible person was interviewed at the interviewer stage.

46% of eligible households were described as 'all interviewed' where all eligible persons were interviewed.

40% of eligible households were 'fully co-operating' where all eligible persons were interviewed, had height and weight measured and agreed to the nurse visit. (Households where a participant was ineligible for a height or weight measurement because of a functional impairment or pregnancy are not counted as fully co-operating for this response analysis).

Non-respondents to the survey fall into two groups, those living in households where no-one co-operated with the survey, and those living in households where at least one person was interviewed.

10% of selected addresses were ineligible. Table A2 gives detailed outcomes for these and other non-responding households.

Tables A1, A2

6.3 General population sample: individual response for adults

6.3.1 Overall response

There were 8,011 individual interviews with adults, and 5,049 adults had a nurse visit.

To calculate the response rate for individuals, this number of interviews should be expressed as a proportion of the total number of adults in the sampled households. However, the total number of adults in the sampled households is not known, and must be estimated. There are three groups of households to consider:

- co-operating households (9,459 adults in 5,096 households, average 1.86 per household)
- non co-operating households where information on the number of adults is known (3,688 adults in 2,609 households, average 1.41)
- non co-operating households about which nothing is known (878 households).

In the absence of other evidence it was assumed that the last group had the same average number of adults (1.71) as for all households where the number of adults was known (the sum of the first two groups); this gives an estimate of 1,498 adults in these households. In combination with the first two groups, this gives an estimated total of 14,645 eligible adults, known as the 'set sample'.

A further assumption was needed to provide separate set samples for men and women. In non co-operating households where the number of adults was known, the numbers of men and women were not usually obtained. It was assumed that the proportion of men and women in the estimated total sample was the same as for the adults in the 5,096 co-operating households. The proportions were 47% men and 53% women. Applying these proportions to the estimated total of adults gives set samples of 6,938 men and 7,707 women.

Minimum response rates for adults were estimated using the estimated total number of adults in sampled households (the adult set sample) as a denominator. The response to the interview was 55%, being 51% among men and 58% among women. Response rates to different stages of the survey are shown in Table A5, and summarised in Table 6.1.

Table A5

6.3.2 Adult response in co-operating households

As adults' ages and other personal characteristics are not known in non co-operating households, indications of differences in response by these characteristics are confined to co-operating households. Tables A7 to A9 show the proportion of men, women and all adults in co-operating households who participated in the key survey stages, by age. These are summarised in Table 6.2 below.

In co-operating households, 85% of adults were interviewed. Response was highest among the oldest age groups (94% of men and 95% of women aged 75 and over were interviewed), and lowest among those aged 16 to 24 (60% of men and 68% of women were interviewed).

It should be noted that, although a lower proportion of men than women had height or weight measured, saw a nurse or had any of the nurse measures, this difference is

because a lower proportion of men than women was interviewed. As a proportion of those interviewed, co-operation rates were very similar among men and women for each measure.

Tables A7 to A9

Table 6.1: Response among all adults

	Men	Women	All adults
	%	%	%
Interviewed	51	58	55
Height measured	44	50	47
Weight measured	43	48	46
Saw a nurse	32	37	34
Waist and hip measured	31	35	33
Blood pressure measured	31	36	34
Gave blood sample	25	28	26
Gave urine sample	28	32	30

Table 6.2: Response among adults in co-operating households

	Men	Women	All adults
	%	%	%
Interviewed	79	90	85
Height measured	68	77	72
Weight measured	67	74	71
Saw a nurse	49	57	53
Waist and hip measured	48	54	51
Blood pressure measured	49	55	52
Gave blood sample	38	43	41
Gave urine sample	43	49	46

6.4 Individual response for children aged 0 to 15

6.4.1 Overall response among children

Interviews were carried out with 2,056 children (1,038 boys and 1,018 girls) aged between 0 and 15. 1,117 children were seen by a nurse.

The response rate for children was calculated in a similar way to that for adults, using the number of eligible children in sampled households (the 'set sample') as the denominator. The number of eligible children was estimated by assuming that the proportion of households and the number of children was the same for all households, whether or not this information was available.[11] This resulted in a set sample of 3,302 children. This is likely to be an over-estimate, since non-contacted households have fewer children on average than those contacted. Response rates computed for children are therefore conservative.

Response to the interview was 62% among boys and 63% among girls, 62% in total. Height measurements were limited to those aged 2 and over. On the assumption that the age distribution of children in the set sample is the same as that of children living in interviewed households, response rates were as shown in Table A6 and summarised in Table 6.3 below.

Table A6

Table 6.3: Response among all children

	Boys	Girls	All children
	%	%	%
Interviewed	62	63	62
Height measured	41	42	41
Weight measured	46	48	47
Saw a nurse	32	36	34

6.4.2 Response in co-operating households

Child response rates, like adult response rates, have also been calculated based on co-operating households to allow analysis by age. Among selected children aged 0 to 15 in co-operating households, the proportion who were interviewed was high, 89% of eligible boys and 91% of eligible girls. The proportion interviewed was lower among

[11] The set sample of children is calculated as follows:

- In the 5,096 co-operating households, 1,407 households had children (614 with one child, 561 with two, 166 with three, and 66 with four or more), giving 2,498 eligible children in total in these households. Note that up to four children were eligible in any household, although their eligibility was age-dependent (see Section 2.4), so this is an over-estimate of eligible children.
- In the 2,609 non co-operating households where some information about residents was established, there were 173 households with one child, 185 with two, 33 with three and 12 with four or more children; this gave a total of 690 eligible children.
- In the 878 households where no information was known, it has been assumed that the proportion of households with children, and the number of children per household, was as for households where this was known, giving an estimate of 114 eligible children.
- The set sample is therefore 3,302 children.
- Sex of children was only known in co-operating households; 51% of the children were boys and 49% were girls. These proportions have been applied to the total set sample of children, giving 1,680 boys and 1,622 girls.

children aged 11 to 15 (80% of boys and 87% of girls) than among those aged under 11 (93% of both boys and girls).

Tables A10 to A12 show the proportion of boys, girls and all children in co-operating households who participated in the key survey stages, by age. These are summarised in Table 6.4 below.

The majority of children who were eligible (i.e. those interviewed for height and weight, and those of the appropriate age having a nurse visit for the other measurements) co-operated with the measurements. 49% of children co-operated with the nurse visit.

Tables A10 to A12

Table 6.4: Response among all children in co-operating households

	Boys	Girls	All children
	%	%	%
Interviewed	89	91	90
Height measured (aged 2 and over)	67	70	69
Weight measured	66	70	68
Saw a nurse	46	53	49
Gave saliva sample (aged 4 and over)	31	37	34
Blood pressure measured (aged 5 and over)	39	47	43
Waist and hip measured (aged 11 and over)	35	44	39

6.5 Variations in survey response

6.5.1 Regional variations in response

As in previous years, response varied by region. Household response was highest in the North East (64%) and was lowest in London (56%).

Table A3

6.5.2 Response by type of dwelling

Table A4 shows household response by the type of building in which the address was found, as classified by interviewers. Response was highest among households living in detached houses (64%), and lowest among households living in converted flats (51%).

Table A4

6.6 Age and sex profile of the sample

Tables A13 and A14 compare the age and sex profiles of responding adults and children in the general population sample at the two survey stages (interview and nurse visit) with the mid-2016 population estimates.

Overall the 2016 HSE sample over-represented women relative to men (56% and 44% respectively, compared with 49% of men and 51% of women in the mid-year population estimates). This is a response pattern found on a number of surveys. Men aged under 35 were under-represented at both interview and nurse visit relative to their proportions in the population, while men aged 55 and over were over-represented. Women under 25 were under-represented at both stages, and women aged between 55 and 74 were over-represented at the nurse visit.

Table A13

As Table A14 shows, among children aged 0 to 15, both the sex and age profiles of the achieved HSE sample were generally close to the population estimates.

Table A14

7 Weighting the data

7.1 Background

Before 2003, the weighting strategy for the HSE sample was to apply selection weights only and no attempt was made to reduce non-response bias through weighting. However, following a review of the weighting for the HSE 2003, non-response weighting has been incorporated into the weighting strategy (as well as selection weights). This same strategy has been followed for weighting the HSE 2016 data.

7.2 Calculation of the general population sample weights

7.2.1 Address selection weights

The least populated regions (the North East and East Midlands) were over-sampled to ensure a minimum sample size of approximately 700 adults. Address selection weights (w_{add}) were calculated that corrected for this over-sampling so that the weighted number of addresses in each region was in the correct proportion.

7.2.2 Dwelling unit selection weights

Most addresses selected from the PAF contain a single dwelling unit, i.e. with a separate entrance. At addresses with more than one dwelling unit, only one is selected; interviewers carry out a selection procedure to identify which dwelling unit to include in the sample using a Kish grid.[12]

The dwelling unit selection weights (w_{du}) adjust for this selection at addresses with more than one dwelling unit. The weights were calculated as the number of dwelling units identified at the address.

The dwelling unit selection weights ensure that in addresses containing more than one dwelling unit, these are not under-represented in the issued sample.

7.2.3 Household selection weights

Most dwelling units selected via the PAF contain a single household. At dwelling units with more than one household, only one is selected; interviewers carry out a selection procedure to identify which household to include in the sample using a Kish grid.

The household selection weights (w_{hh}) adjust for this selection of households and ensure that households in multi-occupied dwelling units are not under-represented in the issued sample. The weights were calculated as the number of households identified at the dwelling unit.

Composite selection weights were calculated as the product of the dwelling unit selection weights (w_{du}) and household selection weights (w_{hh}). The composite selection weights were trimmed at 4 to avoid any large values. These were combined with the address selection weights (w_{add}) to give the initial weights for the calibration weighting (w_1).

[12] A Kish grid is a framework to ensure that the dwelling unit is selected without interviewer bias. The number of dwelling units is listed across the top of the grid, with a random number below to indicate which dwelling unit should be selected.

7.2.4 Calibration weighting

Calibration weighting was used to ensure that the weighted distribution of household members in participating households matched Office for National Statistics (ONS) 2016 mid-year population estimates for sex/age groups and region as shown in Tables 7.1 and 7.2 below. Note that the population estimates were adjusted to remove people aged 65 and over living in institutions (communal establishments), who are not eligible for the HSE; this was estimated using data from the 2011 Census. The composite selection weights (w_1), described in Section 7.2.3, were used as initial values when generating the calibration weights (w_2).

The aim of the calibration weighting is to reduce non-response bias resulting from differential non-response at the household level. The calibration weights generated (w_2) were re-scaled so that the sum of the weights equalled the number of participating households to give the household weights for the sample (wt_hhld). Thus the final household weight adjusts for dwelling unit and household selection, and for the age/sex and region profiles of participating households.

Table 7.1: 2016 ONS mid-year population estimates by age and sex (adjusted)

Age (grouped)	Men		Women	
	N	%	N	%
0-4	1,757,639	6.5	1,671,407	6.0
5-10	2,089,068	7.7	1,990,342	7.2
11-15	1,546,680	5.7	1,473,964	5.3
16-24	3,148,246	11.6	2,989,586	10.8
25-34	3,799,113	14.0	3,762,097	13.6
35-44	3,530,273	13.0	3,562,004	12.8
45-54	3,831,407	14.1	3,924,767	14.2
55-64	3,107,024	11.4	3,201,609	11.5
65-74	2,584,681	9.5	2,783,047	10.0
75+	1,806,923	6.6	2,362,460	8.5
Total	27,201,054		27,721,283	

Table 7.2: 2016 ONS mid-year population estimates by region (adjusted)

Region	N	%
North East	2,620,353	4.8
North West	7,174,461	13.1
Yorkshire and the Humber	5,391,800	9.8
East Midlands	4,694,883	8.5
West Midlands	5,764,447	10.5
East of England	6,092,192	11.1
London	8,732,919	15.9
South East	8,969,833	16.3
South West	5,481,448	10.0
Total	54,922,336	

7.2.5 Child selection and adjustment weights

In each participating household up to two children aged 0 to 12 and up to two children aged 13 to 15 were selected for the core sample. In order that children in larger households were not under-represented in the sample, selection weights (w_3) were calculated as the number of children within the household divided by the number selected, for each age group. The weights were trimmed at 3 to avoid any large weights.

The selection of children within the participating households and differential non-response mean that the age/sex distribution of the achieved sample of children does not match that of all children in participating households. Unless corrected, this would result in bias for estimates. Child adjustment weights (w_4) were therefore calculated by dividing the number of children in the issued households (weighted by wt_hhld) by the number of children in the achieved sample (weighted by wt_hhld x w_3), within each age year for girls and boys separately.

Thus these weights both adjust for the probability of selection for children in larger households, and ensure that the profile of children selected for the survey matches the profile of all children. As the level of response for obtaining a child interview in participating households in the sample was relatively high (90%), no additional non-response weighting was undertaken for the sample of children.

7.2.6 Non-response weights for adults

There were no selection weights for adult participants in the sample since all adults in responding households were selected. However, non-response weights were calculated to reduce bias from adult non-response within households with more than one adult (81% of adults responded in these households). Participants in single adult households were not included in the model and were given a non-response weight of 1.

To obtain the non-response weights, a logistic regression model (weighted by wt_hhld) was fitted for all adults in participating households, excluding single-adult households. The outcome variable was whether or not the interview was completed. The following variables were entered as covariates: age group by sex,[13] household type,[14] region, and social class of household reference person (HRP).[15] The adult non- response weights (w_5) were calculated as the inverse of the predicted probabilities of response estimated from the regression model. The non-response weights for adults were trimmed at the upper 1% tail to remove extreme values.

7.2.7 Combining the weights

The interview weights for the general population sample of adults and children were then calculated as:

wt_int = wt_hhld x w_5 for adults; and wt_int = wt_hhld x w_3 x w_4 for children.

The interview weights for all responding adults and children were re-scaled so that the weighted sample size is the same as the achieved sample size. Therefore, the final interview weights adjust for selection, non-response and population profile for all those interviewed.

7.2.8 Nurse visit weights

Not all those interviewed went on to have a nurse visit and further non-response bias may be introduced. For data relating to nurse visits, two logistic regression models

[13] The age/sex groups used for the weighting were:

Male 16-24	Female 16-24
Male 25-34	Female 25-34
Male 35-44	Female 35-44
Male 45-54	Female 45-54
Male 55-64	Female 55-64
Male 65-74	Female 65-74
Male 75+	Female 75+

[14] The household types used for the weighting were:

Two adults, both 16-59, no children
Small family
Large family
Large adult household
Two adults, one or both aged 60+, no children

[15] The social classes of household reference person used for the weighting were:

Higher managerial and professional occupations
Lower managerial and professional occupations
Intermediate occupations
Small employers and own account workers
Lower supervisory and technical occupations
Semi-routine occupations
Routine occupations
Never worked and long term unemployed
Other

were fitted, weighted by interview weight (wt_int); one for adults and one for children. The outcome variable was whether or not a nurse visit was undertaken, with the following as covariates: age group by sex, household type, region, social class of HRP, smoking status (for adults) and general health.

The weights for non-response to the nurse visit (w_6) were calculated as the reciprocal of the predicted probability of a nurse visit being undertaken, estimated from the regression models.

The weights were trimmed at the 0.5% tails to remove extreme values; this was done separately for adults and children. The weights for the nurse visit sample were calculated as wt_nurse = wt_int x w_6. These weights were re-scaled so that the weighted sample size for the nurse visit is the same as the achieved sample size. They adjust for selection, non-response and population profile for the sample that receives the nurse visit.

7.2.9 Blood weights

Almost all adults that had a nurse visit were eligible to have a blood sample taken, but not all those eligible agreed or were able to do so. A logistic regression model was fitted, weighted by wt_nurse. The outcome variable was whether or not a usable blood sample was obtained, and the following were included as covariates: age group by sex, household type, region, social class of HRP, smoking status and general health.

The weights for non-participation for the blood sample (w_7) were calculated as the reciprocal of the predicted probability of blood being obtained, estimated from the regression models.

The weights were trimmed at the 0.5% tails to remove extreme values. The weights for the blood sample were calculated as wt_blood = wt_nurse x w_7. These weights were re-scaled so that the weighted blood sample size was the same as the achieved sample size.

7.2.10 Urine weights

Almost all adults that had a nurse visit were eligible to have a urine sample taken, but not all those eligible agreed or were able to do so. A logistic regression model was fitted, weighted by wt_nurse. The outcome variable was whether or not a usable urine sample was obtained, and the following were included as covariates: age group by sex, household type, region, social class of HRP, smoking status and general health.

7.2.11 Cotinine weights

Children aged 4 to 15 that had a nurse visit were eligible to have a sample of saliva taken, but not all gave a valid sample. A regression model weighted by wt_nurse was fitted with the outcome variable whether or not a usable saliva sample was obtained, and the following covariates: age group, sex, household type, region, social class of HRP and general health.

The weights for non-participation for the saliva sample (w_9) were calculated as the reciprocal of the predicted probability of a saliva sample being obtained, estimated from the regression model.

The weights were trimmed at the 1% tails to remove extreme values. The weights for the saliva sample were calculated as wt_cotinine = wt_nurse x w_9. These weights were

re-scaled so that the weighted cotinine sample size is the same as the achieved sample size.

7.2.12 Gambling module weight

The questions about gambling were included in the self-completion booklet for adults (aged 16 and over). Weighting was applied to adjust for non-response to the self-completion booklet, and also for whether the problem gambling screen in the self-completion booklet was completed.

A logistic regression model was fitted for those participants that were eligible to fill in the self-completion booklet. The outcome variable was whether or not the booklet was filled in. The covariates in the model were age group by sex, household type, social class of HRP, smoking status and general health.

The weights for not filling in the self-completion booklet (w_{10}) were calculated as the reciprocal of the predicted probability of the self-completion booklet being filled in, estimated from the regression models.

The weights were trimmed at the 0.5% tails to remove extreme values. The weights for the self-completion booklet sample were then calculated as wt_sc = wt_int x w_{10}. The weights were re-scaled so that the size of the weighted self-completion booklet sample was the same as the achieved sample size.

The same approach was used to generate the non-response weights for the problem gambling screen sampling. The weights for that component of non-response, i.e. not completing the problem gambling screen (w_{11}), were generated from a logistic regression model with the same covariates.

The weights were trimmed at the 0.5% tails to remove extreme values. The weights for the problem gambling screen sample were then calculated as wt_gambling = wt_sc x w_{11}. The weights were re-scaled so that the size of the weighted problem gambling screen sample was the same as the achieved sample size.

7.3 Effect of the weights on the precision of the estimates

A design effect (DEFF) for each weight has been calculated to provide an approximate guide to the effect of the weighting on the precision of estimates. The DEFF is calculated as the average squared weight divided by the square of the average weight.

For instance, the DEFF of 1.16 for the interview weight indicates that the standard error of estimates is assumed to increase by 16%, with a corresponding loss of precision. Consequently these weighted estimates have same level of precision as an estimate based on a simple random sample, unweighted, of around 84% of the size of the actual sample. This is known as the effective sample size.

Table 7.3 summarises the effect of each weight on the precision of the estimates.

Table 7.3: Effect of HSE weights on the precision of survey estimates

	N	Effective sample size	DEFF
Interview weight (wt_int)	10067	8696	1.16
Self-completion sample (wt_sc)	7899	6683	1.18
Gambling module sample (wt_gambling)	6691	5600	1.19
Nurse weight (wt_nurse)	6166	4848	1.27
Blood weight (wt_blood)	3836	2781	1.38
Urine sample (wt_urine)	4386	3280	1.34
Cotinine sample (wt_cotinine)	656	572	1.15

Note that design effects and true standard errors have also been calculated for selected survey estimates presented in the topic chapters; see Section 8.2 and the Methods tables, available via https://digital.nhs.uk/pubs/hse2016.

7.4 Selecting the appropriate weight

Seven different weights have been provided, for data from different stages of the survey:

- Interview stage (*wt_int*): for adults and children from the core sample
- Nurse visit (*wt_nurse*): for adults and children from the core sample, for questions from the nurse visit
- Self-completion sample (*wt_sc*): for adults who completed the self-completion booklet
- Gambling module sample (*wt_gambling*): for adults who completed the problem gambling screen in the self-completion booklet
- Blood sample (*wt_blood*): for adults who have given a blood sample
- Urine sample *(wt_urine*): for adults who have given a saliva sample
- Cotinine sample *(wt_cotinine*): for children aged 4-15 who have given a saliva sample.

If questions from different stages of the survey are combined in analysis, the weights for the latest stage of the survey should be used (that is, the latest in the list above). For instance, if blood sample results are being cross-tabulated with questions from the interview stage, the blood sample weight should be used; or if waist circumference results (from the nurse visit) are cross-tabulated with BMI data from the interview, the nurse visit weight should be used.

8 Data analysis and reporting

8.1 Accuracy and reliability of survey estimates

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, also known as a 95% confidence interval. For example the survey estimate might be 24% with a 95% confidence interval of (22% to 26%). 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.

Where differences are commented on in this report, these reflect the same degree of certainty that these differences are real, and not just within the margins of sampling error. These differences can be described as statistically significant.[16]

Confidence intervals are quoted for key statistics within this report and are also shown in more detail in the Excel tables accompanying the Methods report. 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 hence the more precise the estimate.

8.2 Design effects and true standard errors

The HSE 2016 used a clustered, stratified multi-stage sample design. In addition, weights were applied when obtaining survey estimates. One of the effects of using the complex design and weighting is that standard errors and confidence intervals for survey estimates are generally larger than those that would be derived from an unweighted simple random sample of the same size. The calculations of standard errors shown in tables, and comments on statistical significance throughout the report, have taken the clustering, stratification and weighting into account.

The ratio of the standard error of the complex sample to that of a simple random sample of the same size is known as the design factor. Put another way, the design factor (or 'deft') is the factor by which the standard error of an estimate from a simple random sample has to be multiplied to give the true standard error of the complex design.

The true standard errors and defts for the HSE 2016 have been calculated using a Taylor Series expansion method.[17] The deft values and true standard errors (which are themselves estimates subject to random sampling error) have been calculated for selected survey estimates; see the Excel tables that accompany this report.

[16] Statistical significance does not imply substantive importance; differences that are statistically significant are not necessarily meaningful or relevant.

[17] The Taylor Series expansion method is a mathematical technique to simplify the computation of infinite series. It is the default method of calculating standard errors used by the STATA analysis software. http://www.stata.com/manuals13/svy.pdf For further information, see Wolter KM. *Introduction to Variance Estimation*. 2nd ed. 2007.New York, Springer.

8.3 Survey limitations

The HSE is a cross-sectional survey of the population. It examines associations between health states, personal characteristics and behaviour. However, such associations do not necessarily imply causality. In particular, associations between current health states and current behaviour need careful interpretation, as current health may reflect past, rather than present, behaviour (for instance, current liver disease may reflect previous heavy drinking, although no alcohol is currently consumed). Similarly, current behaviour may be influenced by advice or treatment for particular health conditions (for instance, not smoking currently because of advice relating to lung disease caused by previous smoking).

8.4 Weighted and unweighted data and bases in report tables

Non-response weighting was introduced to the HSE in 2003, and has been used in all subsequent years. All 2016 data in this report are weighted (apart from response tables). Both weighted and unweighted bases are given in each table in the report.[18] The unweighted bases show the number of participants involved, in other words the size of the sample on which the estimate is based. The size of the unweighted base influences the precision of the estimates derived from it; in general, the larger the unweighted base, the more precise is the estimate and the narrower the confidence interval around it.

The weighted bases show the relative sizes of the various sample elements after weighting, reflecting their proportions in the population in England, so that data from different columns can be combined in their correct proportions. The absolute size of the weighted bases has no particular significance, since they have been scaled to the achieved sample size.

Children's data each year have been weighted to adjust for the probability of selection, since a maximum of four children are selected in each household (see Section 7.2.5). This ensures that children from larger households are not under-represented. Since 2003, as for adults, non-response weighting has also been applied. A full discussion of the effects of non-response weighting can be found in the 2003 HSE report.[19]

8.5 Reporting age variables

8.5.1 Defining age for data collection

Some sections of the data collected in the HSE 2016 are age specific, with different questions directed to different age groups. This was based on the participant's date of birth which was ascertained early in the interview. For data collection purposes, a participant's age was defined as their age on their last birthday before the interview. The nurse, who visited later, treated the participant as being of the same age as at the interview, even if he or she had an intervening birthday.

[18] In the adult trend tables, unweighted bases are provided for years up to 2002, and weighted bases for 2003 onwards (the year from which non-response weighting was introduced). In the children's trend tables, for years up to 2002 weighted bases are shown, adjusted for probability of selection (since a maximum of two children per household is selected); from 2003 weighted bases are shown corrected for selection and non-response.

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

In the present report all references to age are age at last birthday.

8.6 Age standardisation

Adult data have been age-standardised throughout the 2016 report to allow comparisons between groups after adjusting for the effects of any differences in their age distributions. When different sub-groups are compared in respect of a variable on which age has an important influence, any differences in age distributions between these sub-groups are likely to affect the observed differences in the proportions of interest.

It should be noted that all age-standardised analyses in the report are presented separately for men and women, and age standardisation was undertaken within each sex, expressing male data to the overall male population and female data to the overall female population. When comparing data for the two sexes, it should be remembered that no standardisation has been introduced to remove the effects of the sexes' different age distributions.

Age standardisation was carried out using the direct standardisation method. The standard population to which the age distribution of sub-groups was adjusted was the mid-year 2013 population estimates for England. The age-standardised proportion p' was calculated as follows, where p_i is the age- specific proportion in age group *i* and N_i is the standard population size in age group *i*:

$$p' = \frac{\sum_i N_i p_i}{\sum_i N_i}$$

Therefore p' can be viewed as a weighted mean of p_i using the weights N_i. Age standardisation was carried out using the age groups 16-24, 25-34, 35-44, 45-54, 55-64, 65-74 and 75 and over; and in some cases the final age group was split into two further groups, 75-84 and 85+. The variance of the standardised proportion can be estimated by:

$$var(p') = \frac{\sum_i (N_i^2 p_i q_i / n_i)}{(\sum_i N_i)^2}$$

where $q_i = 1 - p_i$, and n_i is the sample number in age-sex group *i*.

8.7 Standard analysis breakdowns

8.7.1 Introduction

For most tables in this report, two standard analysis breakdowns have been used as well as age. These are region and Index of Multiple Deprivation (IMD). The reports covering social care for older adults and well-being and mental health also include analysis by equivalised household income.

8.7.2 Region

Analysis by region is based on the former Government Office Regions.

Both observed and age-standardised data are provided by region in the tables. Observed data can be used to examine actual prevalence or mean values within a region, needed, for example, for planning services. Age-standardised data are required for comparisons between regions to exclude age-related effects, and are discussed in the report text.

It should be noted that base sizes for regions can be relatively small, and caution should be exercised in examining regional differences. In 2016, the smallest region (the North East) was over-sampled to provide a minimum unweighted sample size of approximately 700 adults; the weighting process adjusted for this.

8.7.3 Index of Multiple Deprivation

The Index of Multiple Deprivation 2015 combines a number of indicators, chosen to cover a range of economic, social and housing issues, into a single deprivation score for each small area in England. This allows each area to be ranked relative to others according to their level of deprivation.[20] Seven distinct domains have been identified in the English Indices of Deprivation:

- income deprivation
- employment deprivation
- health deprivation and disability
- education skills and training deprivation
- barriers to housing and services
- living environment deprivation
- crime.

Individual domains can be used in isolation as measures of each specific form of deprivation, as well as using the single overall Index of Multiple Deprivation (IMD).

The IMD is used widely to analyse patterns of deprivation, identify areas that would benefit from special initiatives or programmes and as a tool to determine eligibility for specific funding streams. In this report quintiles of IMD are used to give an area-level measure of socio-economic status, as opposed to the household-level measure of equivalised household income.

Further details about the IMD are given in the Glossary (Appendix B).

8.7.4 Equivalised household income

Household income was established by means of a show card.[21] This can be used directly as an analysis variable, but it can also be adjusted to take account of the number of persons in the household; this is called equivalised household income. To derive this, each household member is given a score. For adults, this is based on the number of adults apart from the household reference person, and for dependent children, it is based on their age. The total household income is divided by the sum of the scores to provide the measure of equivalised household income. All individuals in

[20] https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015
[21] The show card containing the banded income categories is included in the survey documentation, available on the HSE 2016 report web page, https://digital.nhs.uk/pubs/hse2016.

each household were allocated to the equivalised household income quintile to which their household had been allocated.

It should be noted that around 17% of adults live in households where no information was provided on income, and are therefore excluded from the breakdown by equivalised household income.

Further details about equivalised household income are given in the Glossary (Appendix B).

8.8 Testing for statistical significance

Significance testing is carried out on the results in the 2016 report. The term 'significant' refers to statistical significance at the 95% level and is not intended to imply substantive importance.

The significance tests are carried out in order to test the relationship between variables in a cross tabulation, usually an outcome variable nested within sex, cross-tabulated with an explanatory variable such as age (in categories), income groups or region. The test is for the main effects only (using a Wald test[22]). For example the test might examine whether there is a statistically significant relationship between smoking prevalence and age (after controlling for sex) and between smoking prevalence and sex (after controlling for age).

It is worth noting that the test does not establish whether there is a statistically significant difference between any particular pair of subgroups (e.g. the highest and lowest subgroups). Rather it seeks to establish whether the variation in the outcome between groups that is observed could have happened by chance or whether it is likely to reflect some 'real' differences in the population.

A p-value is the probability of the observed result occurring due to chance alone. A p-value of less than 5% is conventionally taken to indicate a statistically significant result ($p<0.05$). It should be noted that the p-value is dependent on the sample size, so that with large samples differences or associations which are very small may still be statistically significant.

Using this method of statistical testing, differences which are significant at the 5% level indicate that there is sufficient evidence in the data to suggest that the differences in the sample reflect a true difference in the population.

A second test of significance looks at the interaction between sex and the variable under consideration. If the interaction is statistically significant ($p<0.05$) this indicates that there is likely to be an underlying difference in the pattern of results for men and women, and this will normally be commented on in the report text.

[22] The Wald test is statistical test used to calculate the significance of parameters in a statistical model. The Wald test is used in analysis of HSE data in this report to establish whether the association among particular variables is statistically significant. For example the test might help to establish whether there is a statistically significant relationship between smoking prevalence and age (after controlling for sex) and between smoking prevalence and sex (after controlling for age). The test calculates the statistical significance of parameters in a logistic regression model of smoking prevalence in order to establish whether age and sex are significantly associated with smoking prevalence.

9 Quality control of blood and saliva analytes

9.1 Introduction

9.1.1 Key conclusions

This section describes the assay of analytes for the HSE 2016 biological samples and the quality control and quality assessment procedures that were carried out during the survey period. Details of procedures used in the collection, processing and transportation of the specimens are described in the Documentation https://digital.nhs.uk/pubs/hse2016.

The overall conclusion for the data provided in this chapter is that methods and equipment used for the measurement of blood, urine and saliva analytes produced internal quality control (IQC) and external quality assessment (EQA) results within expected limits. The results of the analyses for each of the main blood and urine analytes and saliva cotinine levels were acceptable for the HSE 2016.

9.1.2 Analysing laboratories

As in previous years, the Royal Victoria Infirmary (RVI), Newcastle upon Tyne Hospitals NHS Foundation Trust, was the analysing laboratory used in the HSE 2016 for the blood and urine sample analyses. Salivary cotinine analyses for the HSE 2016 were conducted by ABS Laboratories in Welwyn Garden City, Hertfordshire.

9.1.3 Non-fasting blood samples

Following written consent from eligible participants, non-fasting blood samples were collected by the survey nurses from adults aged 16 and over into two tubes, a 6ml plain tube (no anticoagulant) and 4ml EDTA (ethylene diamine tetra-acetic acid) tube. The order of priority for collecting samples was first the 6ml plain tube, followed by the 4ml EDTA tube. After collection, the tubes were posted to the Blood Sciences Department at the RVI, which acted as the co-ordinating department for transport of samples to the individual departments undertaking the analyses.

Samples collected in the 6ml plain tube for serum
Samples in the plain tube were used for analysis of total cholesterol, high density lipoprotein (HDL) cholesterol, aspartate aminotransferase (AST), alanine aminotransferase (ALT), creatinine and cystatin C in the serum. If written consent was given by the participant, a minimum of 0.5ml of the remaining serum was stored in a freezer at -40°C (± 5°C) for possible future analysis.

Samples collected in the 4ml EDTA tube
Samples in the EDTA tube were used for the glycated haemoglobin, haemoglobin and platelet analyses.

9.1.4 Saliva samples

A saliva sample was obtained by the survey nurses from participants aged between 4 and 15. Saliva samples were collected for analysis of cotinine (a metabolite of nicotine that shows recent exposure to tobacco or tobacco smoke). A saliva collection tube was used for this purpose.

9.1.5 Urine samples

A mid-flow spot urine sample was obtained from adults aged 16 and over, for analysis of sodium, potassium, creatinine and albumin. A special urine collection syringe was used for this purpose.

9.2 Methods

9.2.1 Laboratory procedures

All analyses were carried out according to Standard Operating Procedures by State Registered Biomedical Scientists (BMS) under the supervision of a Senior BMS. All results were routinely checked by the duty biochemist and highly abnormal results were notified to the survey doctor. In such cases the survey doctor notified and advised the participant and, where prior consent had been obtained, their general practitioner as appropriate.

A schedule of Planned Preventative Maintenance was used for each item of analytical equipment. These plans were carried out jointly by the manufacturers and the laboratories. Records were kept of when maintenance was due and carried out.

Table A15 shows reference ranges used for each of the blood analytes measured in the HSE 2016. Values within these reference ranges were considered to be clinically 'normal' while those outside were treated as clinically 'abnormal' (either too high or too low). For total and HDL cholesterol, where a large proportion of the population have values which are statistically within the normal distribution but are not ideal for good health, the term 'desirable' rather than 'normal' was used when results were sent to participants and/or their GPs.

Ranges are also given for salivary cotinine and urine albumin:creatinine ratio. No reference ranges are available for spot urine samples for sodium, potassium and creatinine.

Table A15

9.2.2 Blood sample analytical methods and equipment

Total cholesterol
Measurement of total cholesterol was carried out in the Blood Sciences Department at the RVI using a Cholesterol Oxidase assay method on a Roche Cobas 702 analyser. This is the same equipment that was used from June 16th 2015 onwards in HSE 2015. The effect of that change of equipment was that measured concentrations of total cholesterol were on average 0.1mmol/L lower.[23] A previous change had occurred on 12th April 2010, resulting in an average increase of 0.1mmol/L cholesterol. Unadjusted total cholesterol values are therefore comparable before 12th April 2010 and after 16th June 2015, including HSE 2016 results. (Values were very slightly higher in the period between these dates.).[24]

[23] 40 random patient samples were tested with both the Roche Cobas 702, and the Roche Modular P analyser. An average 0.1mmol/L in difference (decrease) in total and HDL cholesterol was shown. There was no significant bias: an adjustment of 0.1mmol/L is appropriate for high and low cholesterol results.

[24] In the HSE 2015 dataset, a variable CHOLFLAG3 showed whether the cholesterol was collected pre or post 16th June 2015. From this date onwards, the variables CHOLVAL3 and CHOLVAL13 have been used instead of CHOLVAL and CHOLVAL1, to indicate this revised measurement.

HDL cholesterol

HDL-cholesterol analysis was carried out in the Blood Sciences Department at the RVI using a direct method (no precipitation) on a Roche Cobas 702 analyser. This is the same equipment that was used from June 16th 2015 onwards in HSE 2015, which resulted in the recorded concentrations of HDL cholesterol being on average 0.1mmol/L lower than those previously measured.[25] A previous change had occurred on 12th April 2010, resulting in an average decrease of 0.1mmol/L cholesterol from the previous measures. Consequently, reported HDL cholesterol was on average 0.2mmol/L lower after June 16th 2015 than before April 12th 2010.[26]

Glycated haemoglobin

Glycated haemoglobin (HbA_{1c}) analysis was carried out in the Blood Sciences Department at the RVI using the Tosoh G8 analyser throughout HSE 2016. The Tosoh G8 analyser has been used in HSE since 26th August 2010; before this a Tosoh G7 analyser was used, but the change made no impact on measured concentrations. Both were calibrated using Diabetes Control and Complications Trial (DCCT) standards until 3rd October 2011, when the International Federation of Clinical Chemistry (IFCC) standardisation was introduced. Since the introduction of IFCC standardisation, TOSOH calibrator values have been assigned using various IFCC calibrators, dependent on the availability of specific IFCC calibrator lot numbers. On September 19th 2013 there was a change to using a TOSOH calibrator assigned using IFCC calibrator (Lot California 2012.102). Comparisons made by the manufacturer TOSOH indicated that the change caused variations of 1.4-2.2 mmol/mol, which is deemed acceptable.[27,28] The calibrator used after 19th September 2013 produced lower glycated haemoglobin results compared with the previous one.[29]

Aspartate aminotransferase (AST) and alanine aminotransferase (ALT)

AST and ALT analyses were carried out in the Blood Sciences Department at the RVI using an optimised International Federation of Clinical Chemistry (IFCC) method, without pyridoxal phosphate activation, on a Roche Cobas 702 analyser.

Creatinine

Measurement of serum creatinine was by the enzymatic Roche Creatinine Plus method on a Roche Cobas 702 analyser.

Cystatin C

Cystatin C analysis was carried out in the Blood Sciences Department at the RVI using a Tina-quant particle enhanced immunoturbidimetric assay, standardised against ERM-DA471/IFCC reference material, on the Cobas 702 analyser.

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[25] See note 23.

[26] See note 24.

[27] Sacks DB, et al*. Guidelines and Recommendations for Laboratory Analysis in the Diagnosis and Management of Diabetes Mellitus*. Diabetes Care, 34:e61-e99, 2011

[28] Little et al. *Status of HbA1c measurement and goals for improvement: from chaos to order for improving diabetes care.* Clin Chem 2011;57:205–14

[29] In the HSE 2013 archived dataset, a variable glyflag shows whether the sample was analysed before or after 19th September 2013. Samples analysed were labelled glyhbval and glyhbval2 (and iffcval and iffcval2) respectively. Adjusted variables glyhbvala and iffcvala can be used to compare trends over time: these adjust the later results to reflect those before the 19th September 2013.

Haemoglobin and platelets
Measurement of haemoglobin and platelets was carried out in the Blood Sciences Department at the RVI. The analytical equipment was upgraded during the course of HSE 2016. Platelets and haemoglobin were measured using Sysmex XE2100 analysers until May 2016, after which a Sysmex XN was used. There was no difference in results following this change.

9.2.3 Urine sample analytical methods and equipment

Urinary sodium, potassium, creatinine, albumin
Urinary sodium, potassium, creatinine and albumin were analysed at the RVI on the Roche Cobas 702 analyser. Urinary sodium and potassium were analysed using the indirect ion-selective electrode (ISE) method; urinary creatinine using the enzymatic Roche Creatinine Plus method; and urine albumin using a Tina-quant particle enhanced immunoturbidimetric assay.

9.2.4 Saliva sample analytical methods and equipment

Cotinine
Saliva samples received at the RVI were checked for correct identification, assigned a laboratory accession number, and stored at 4^{o}C. Samples were checked for details and despatched fortnightly in polythene bags (20 samples per bag) by courier for overnight delivery to ABS Laboratories, where cotinine analysis was carried out. This laboratory specialises in accurate measurement of low levels of cotinine and therefore takes special precautions to ensure no contamination by environmental tobacco smoke occurs.

The method of analysis used was a high performance liquid chromatography coupled to tandem mass spectrometry with multiple reaction monitoring (LC-MS/MS).[30] A Tomtec Quadra was used to allow for the automation of some of the sample preparation. All methods were validated before use.

An advantage of the LC-MS/MS assay is that it is less prone than other methods to non-specific interference when assaying low levels of cotinine as seen due to passive smoking. This assay is therefore preferable for samples from non-smokers.[30]

A disadvantage of LC-MS/MS is that it does not have the dynamic range of the GC-NPD assay used in earlier HSE years.[30] Therefore since 2011 the laboratory has been informed whether the samples were from self-reported smokers or not. All the samples from self-reported smokers were first assayed using the high calibration range assay of 1 to 750ng/ml, and any that were below 1ng/ml were then re-assayed with the low range assay. All the remaining samples were first assayed using the low range assay of 0.1-50ng/ml. Any of these that were over-range were then re-assayed using the high calibration range assay of 1 to 750ng/ml, provided there was sufficient saliva available from that participant.

[30] Bernert JT, Jacob III P, Holiday DB et al. *Interlaboratory comparability of serum cotinine measurements at smoker and nonsmoker concentration levels: A round robin study.* Nicotine Tob Res. 2009;11:1458-66.

9.3 Internal quality control (IQC)

9.3.1 Introduction

The purpose of IQC is to ensure reliability of an analytical run. IQC helps to identify and prevent the release of any errors in an analytical run. IQC is also used to monitor trends over time. For example, there were a few occasions on which the IQC for urinary albumin yielded unsatisfactory results. No samples were therefore tested on those 'runs'.

For each analyte or group of analytes, the laboratory obtains a supply of commercial quality control materials, usually at more than one concentration of analyte. Target values and target standard deviations (SD) are assigned for each analyte. Target assignment includes evaluation of values obtained by the laboratory from replicate measurements (over several runs) in conjunction with target values provided by manufacturers of IQC materials, if available. The standard deviation and the coefficient of variation (CV) are measures of imprecision and are presented in the tables. IQC values are assessed against an acceptable range and samples are re-analysed if any of the Westgard rules have been violated.[31,32,33]

The tables providing IQC results show the assayed value compared with the target value, and the acceptable range is also provided so that, where the assayed and target values differ, it is possible to check that they are still within expected limits. The final columns of the tables show the SD and CV. Results are provided only for IQC for 'runs' in which HSE samples were tested.

9.3.2 Non-fasting blood samples

Total and HDL cholesterol, AST, ALT and creatinine
Two levels of IQC were assayed throughout the day. Tables A16 and A17 show the monthly IQC results for total and HDL cholesterol and Tables A19 to A21 show monthly IQC results for AST, ALT and creatinine.

Tables A16, A17, A19 to A21

Glycated haemoglobin (HbA1c)
Before October 2011, the analytical methods used for glycated haemoglobin measurement in the United Kingdom were required to be traceable to the work carried out on the DCCT part of the National Glycohemoglobin Standardisation Program (NGSP) in the USA. The Secondary Reference Laboratory (SRL) in the University of

[31] Westgard rules are a statistical approach to evaluation of day-to-day analytical performance. The Westgard multi-rule quality control procedure uses five different control rules to judge the acceptability of an analytical run. This differs from the single criterion or single set of control limits used by single-rule quality control systems, such as a Levey-Jennings chart with control limits set as either the mean plus or minus 2 standard deviations or the mean plus or minus 3 standard deviations. Westgard rules are generally used with two or four control measurements per run. This means they are appropriate when two different control materials are measured once or twice per material, which is the case in many chemistry applications. Some alternative control rules are more suitable when three control materials are analysed, which is common for applications in haematology. More detail is available at www.westgard.com/mltirule.htm#westgard

[32] Westgard JO, Barry PL, Hunt MR, Groth T. *A multi-rule Shewhart chart for quality control in clinical chemistry.* Clin Chem. 1981;**27**:493-501.

[33] Westgard JO, Klee GG. *Quality Management.* Chapter 16 in Burtis C (ed.). *Fundamentals of Clinical Chemistry.*4th edition. Philadelphia: WB Saunders Company, 1996, pp.211-23.

Minnesota was the main analytical laboratory for the DCCT work. The IQC results for glycated haemoglobin were DCCT standardised until October 2011, when the standard changed to IFCC values.

Two levels of internal quality control were run at the beginning and end of each run and at regular intervals throughout. Table A18 shows the monthly IQC results for glycated haemoglobin.

Table A18

Cystatin C
Three levels of IQC were assayed throughout the day. Table A22 shows the monthly IQC results.

Table A22

Haemoglobin and platelets
Three levels of IQC were assayed daily. Tables A23 to A26 show the monthly IQC results for haemoglobin and platelets. Results using Sysmex XE2100 up until May are presented in the first tables (with separate results for both analysers in use at that time), followed by results using Sysmex XN from June onwards in the next tables for haemoglobin and platelets, respectively.

Table A23 to A26

9.3.4 Urine samples

Sodium, potassium, creatinine, albumin
Two levels of IQC were assayed throughout the day. The IQC results for sodium, potassium, creatinine, and albumin summarised monthly are shown in Tables A27 to A30.

Tables A27 to A30

9.3.3 Saliva samples

Cotinine
ABS laboratories ran 16 non-zero calibration standards for each batch of the low range assay (0.1-50ng/ml), and 16 for the high range assay (1-750ng/ml). Six QC samples, two each at a set concentration to represent Low, Medium and High levels for the calibration level used, were also analysed with each analytical batch.

For the results from any analytical batch to be acceptable, four out of the six QCs must have a bias of no greater than ±15%, with at least one from each QC level being within these acceptance criteria, and 75% of the calibration standards must have a bias of no greater than ±15% except at the lower limit of quantification (0.1ng/ml) where the bias must be no greater than ±20%. A summary of the quality control samples results is collated and presented in Tables A31 and A32.

Tables A31 and A32

9.4 External quality assessment (EQA)

9.4.1 Introduction

EQA permits comparison of results between laboratories measuring the same analyte. An EQA scheme for an analyte or group of analytes distributes aliquots of the same samples to participating laboratories, which are blind to the concentration of the analytes. The usual practice is to participate in a scheme for a full year during which samples are distributed at regular frequency (monthly or bimonthly for example); the number of samples in each distribution and the frequency differ between schemes. The samples contain varying concentrations of analytes. The same samples may or may not be distributed more than once.

Samples are assayed shortly after they arrive at the laboratory. Depending on the frequency of distribution, there may be weeks or months in which no EQA samples are analysed. Results are returned to the scheme organisers, who issue a laboratory specific report giving at least the following data:

- Mean values, usually both for all methods and for method groups;
- A measure of the between-laboratory precision;
- The bias of the results obtained by that laboratory.

EQA is a retrospective process of assessment of performance, particularly of inaccuracy or bias with respect to mean values; unlike IQC, it does not provide control of release of results at the time of analysis.

The RVI laboratory participates in the Welsh External Quality Assessment Schemes (WEQAS) and the United Kingdom National External Quality Assessment Schemes (UKNEQAS) on a routine basis. The WEQAS and UKNEQAS schemes do not include cotinine (tested by ABS laboratory); there is no EQA scheme for cotinine results.

For those blood and urine analytes where results are reported to the WEQAS scheme, the standard deviation index (SDI) is reported here in addition to the target and achieved values, to conform with best practice across Europe.[34] The SDI is an index of total error, including components of inaccuracy and imprecision. It is calculated as:

$$\text{SDI} = \frac{\text{(laboratory result – target value)}}{\text{(WEQAS standard deviation * method-specific comparability factor)}}$$

This adjustment ensures that each laboratory can compare their results with others using their own method, the peer reference method, and the overall mean of all groups. The target values reported in Tables A33 to A45 are the reference values, or (if reference values are absent from the report) the mean for the specific method used by RVI.

A score between -1 and 1 SDI is good; between 1 and 2 or between -2 and -1 SDI is acceptable. A score greater than 2 or below -2 is unacceptable and would trigger an investigation by the laboratory.[35] In two cases, the SDI indicated that the variation was

[34] Alfthan G, Sundvall J. '*Blood samples and laboratory analyses'.* Chapter 10 in Tolonen H (ed). *EHES Manual.* National Institute for Health and Welfare (THL), Helsinki, 2011.
[35] Welsh External Quality Assurance Scheme. *Participants' Manual.* WEQAS, Cardiff, 2016.

outside acceptable limits; the laboratory investigations suggested that despite the SDI value there was no particular cause for concern. Footnotes have been included in the tables relating to the specific instances.

Cystatin C, haemoglobin and platelet results were reported to UKNEQAS schemes.

For cystatin C percentage bias is calculated in the following way:

$$\% \text{ Bias} = \frac{(\text{laboratory result} - \text{target value})}{(\text{Target value})} \times 100$$

Since the scheme is new, UKNEQAS do not as yet quote acceptable limits for bias as there is insufficient historical data over a suitable range of concentrations to set limits.

For haemoglobin and platelets, an analytical performance score was calculated. For numerical data, this is a running score derived from the results for the most recent six specimens for which results have been returned.

$$\text{Deviation Index (DI)} = \text{Lab Result-Trimmed Mean/SD} \qquad (DI = R\text{-}M/SD)$$

The deviation index for each parameter is used to give a rolling Analytical Performance Score using the last six DIs. This is calculated by adding together the last six DI results and multiplying by a factor of 6 (any DIs >3.5 are truncated to 3.5). An Analytical Performance Score >100 is deemed to be unsatisfactory.

Each of the figures presented in Tables A33 to A45 corresponds to an individual EQA sample.

9.4.2 Non-fasting blood samples

The Blood Sciences laboratory participates in the WEQAS scheme for total and HDL cholesterol, glycated haemoglobin, creatinine, AST and ALT, Table A33 shows the monthly EQA results for total cholesterol, Table A34 for HDL cholesterol, Table A35 for glycated haemoglobin, Table A38 for creatinine, Table A36 for AST and Table A37 for ALT. The target and achieved values are shown, along with SDI.

The Blood Sciences laboratory participates in the UKNEQAS scheme for cystatin C and haemoglobin and platelets. The target and achieved values are shown, along with % bias for cystatin C and the analytical performance score for haemoglobin and platelets, in Tables A39 to A41.

Tables A33 to A41

9.4.3 Urine sample

The Clinical Biochemistry laboratory participates in the WEQAS scheme for the urine analytes (sodium, potassium, creatinine and albumin). Tables A43 to A45 show the monthly external quality assessment results for sodium, potassium, creatinine and albumin.

Tables A43 to A45

9.4.4 Saliva samples

Cotinine
There was no external quality control scheme available in 2016 for cotinine analysis but ABS Laboratories participates in inter-laboratory split analyses to ensure comparable results. The latest International inter-laboratory study was published in 2009.[36]

[36] See note 30.

Appendix A: Tables

List of tables

Table A1: HSE 2016: household response by calendar quarter

Address and household outcome	Survey quarter Jan-Mar		Apr-Jun		Jul-Sept		Oct-Dec		Total	
	N	%	N	%	N	%	N	%	N	%
Issued sample										
Selected addresses	2268		2268		2268		2754		9558	
Ineligible addresses	231	10	227	10	240	11	277	10	975	10
Total eligible	2037	90	2041	90	2028	89	2477	90	8583	90
Household response										
Co-operating households[1]	1277	63	1243	61	1163	57	1413	57	5096	59
All interviewed	986	48	928	45	914	45	1140	46	3968	46
Fully co-operating[2]	865	42	802	39	796	39	975	39	3438	40
Non-responding households	757	37	798	39	862	43	1063	43	3480	41
No contact	44	2	25	1	61	3	85	3	215	3
Unknown eligibility	8	0	9	0	18	1	19	1	54	1
Refusal	615	30	658	32	670	33	825	33	2768	32
Other non-response	90	4	106	5	113	6	134	5	443	5
Bases: all eligible households	*2037*		*2041*		*2028*		*2477*		*8583*	

1 Households where at least one person was interviewed.
2 All eligible household members were interviewed, had height and weight measured and had a nurse visit.

Table A2: HSE 2016: detailed outcomes for non-responding households

	N	%
Ineligible		
Vacant/empty	639	6.7
Address occupied, but no resident household	139	1.5
Non-residential address	152	1.6
Demolished/derelict	34	0.4
Not yet built/under construction	11	0.1
Total ineligible	*975*	*10.2*
No contact		
No contact with anyone at address after 6+ calls	188	2.2
Unable to locate address	12	0.1
Inaccessible/ not attempted (including reissue)	17	0.2
Total no contact	*217*	*2.5*
Unknown eligibility		
Contact made, but not with responsible resident	48	0.6
Unknown whether address is eligible or residential due to non-contact	4	0.0
Unable to confirm eligibility due to language barrier	0	0.0
Other unknown eligibility	2	0.0
Total unknown eligibility	*54*	*0.6*
Refusal		
Office refusal (household contacted office before interviewer made contact)	426	5.0
Information refused about number of dwelling units at address	23	0.3
Information refused about people in household	157	1.8
Information refused about whether resident(s) are eligible	0	0.0
Refusal before household interview	1909	22.2
Refusal after completion of household questionnaire	6	0.1
Broken appointment - no recontact	251	2.9
Total refusals	*2772*	*32.3*
Others with no interview		
Physically unable/incompetent	31	0.4
Mentally unable/incompetent	60	0.7
Language difficulties	89	1.0
Away/in hospital throughout field work period	46	0.5
Ill at home during survey period	39	0.5
Full or partial interview but respondent requested data be deleted	1	0.0
Other reasons why unproductive	178	2.1
Total other	*444*	*5.2*

Table A3: HSE 2016: household response by region

Address and household outcome	Region																Total	
	North East		North West		Yorks & the Humber		East Midlands		West Midlands		East of England		London		South East		South West	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Issued sample																		
Selected addresses	828		1256		936		843		961		1013		1278		1477		966	
Ineligible addresses	89	11	139	11	95	10	70	8	93	10	82	8	164	13	126	9	117	12
Total eligible	739	89	1117	89	841	90	773	92	868	90	931	92	1114	87	1351	91	849	88
Household response																		
Co-operating households[1]	474	64	709	63	478	57	460	60	498	57	555	60	620	56	797	59	505	59
All interviewed	347	47	592	53	373	44	384	50	394	45	434	47	436	39	582	43	426	50
Fully co-operating[2]	275	37	525	47	325	39	322	42	346	40	383	41	381	34	505	37	376	44
Non-responding households	265	36	408	37	363	43	313	40	370	43	376	40	494	44	554	41	344	41
No contact	23	3	17	2	30	4	13	2	27	3	16	2	37	3	24	2	30	4
Unknown eligibility	7	1	2	0	4	0	6	1	3	0	4	0	7	1	13	1	8	1
Refusal	217	29	354	32	274	33	248	32	257	30	324	35	370	33	460	34	268	32
Other non-response	18	2	35	3	55	7	46	6	83	10	32	3	80	7	57	4	38	4
Bases: all eligible households	*739*		*1117*		*841*		*773*		*868*		*931*		*1114*		*1351*		*849*	

1 Households where at least one person was interviewed.
2 All eligible household members were interviewed, had height and weight measured and had a nurse visit.

Table A4: HSE 2016: household response in eligible households, by dwelling type

Address and household outcome	Dwelling type: Detached house	Semi-detached house	Terraced house	Purpose-built flat or maisonette	Converted flat or maisonette	Other	Total
	%	%	%	%	%	%	%
Co-operating households[1]	64	61	61	56	51	17	53
All interviewed	49	46	46	49	45	14	42
Fully co-operating[2]	43	39	39	44	40	12	36
Non-responding households	36	39	39	44	49	83	41
No contact	1	1	2	6	8	13	3
Unknown eligibility	0	1	1	1	1	1	1
Refusal	32	33	31	30	33	53	32
Other non-response	3	3	5	4	6	15	4
Bases: all eligible households	*1781*	*2632*	*2456*	*1229*	*290*	*187*	*8575*

1 Households where at least one person was interviewed.
2 All eligible household members were interviewed, had height and weight measured and had a nurse visit.

Table A5: HSE 2016: summary of adults' individual response to the survey, by sex

	Sex					
Individual response	**Men**		**Women**		**All adults**	
	N	**%**	**N**	**%**	**N**	**%**
Interviewed	3552	51	4459	58	8011	55
Non responders:						
In co-operating households	929	13	519	7	1448	10
In non-responding households	2457	35	2729	35	5186	35
Responded to:						
Self-completion	3221	46	4115	53	7336	50
Height	3025	44	3821	50	6846	47
Weight	3006	43	3673	48	6679	46
Nurse visit	2210	32	2839	37	5049	34
Waist/hip	2148	31	2678	35	4826	33
Blood pressure	2181	31	2747	36	4928	34
Blood sample	1710	25	2126	28	3836	26
Urine sample	1930	28	2456	32	4386	30
Bases: set sample[1]	*6938*		*7707*		*14645*	

1 For the method of estimating the adult 'set sample', see Section 6.3.1. Estimated bases have been rounded to whole numbers

Table A6: HSE 2016: summary of children's individual response to the survey, by sex

	Sex					
Individual response	**Boys**		**Girls**		**All children**	
	N	**%**	**N**	**%**	**N**	**%**
Interviewed	1038	62	1018	63	2056	62
Non responders:						
In co-operating households	134	8	106	7	240	7
In non-responding households	508	30	498	31	1006	30
Responded to:						
Height[1]	687	41	681	42	1368	41
Weight	772	46	775	48	1547	47
Nurse visit	531	32	586	36	1117	34
Bases: set sample[2]	*1680*		*1622*		*3302*	

1 Aged 2 to 15.
2 For the method of estimating the child 'set sample', see Section 6.4.1. Estimated bases have been rounded to whole numbers

Table A7: HSE 2016: men in co-operating households: response to the stages of the survey, by age

	Age group							Total
Individual response	**16-24**	**25-34**	**35-44**	**45-54**	**55-64**	**65-74**	**75+**	
	%	**%**	**%**	**%**	**%**	**%**	**%**	**%**
Interviewed								
Interviewed	60	73	75	78	85	93	94	79
Not contacted/refused	40	27	25	22	15	7	6	21
Height								
Measured	51	63	65	67	72	79	78	68
Refused	5	7	6	8	8	7	6	7
Measurement not attempted	4	3	4	4	5	6	11	5
Not contacted/not obtained[1]	40	27	25	22	16	8	6	21
Weight								
Measured	51	63	64	66	71	79	77	67
Refused	5	7	6	8	8	7	6	7
Measurement not attempted	4	3	4	5	6	6	11	5
Not contacted/not obtained[1]	41	27	25	22	16	8	6	21
Nurse visit								
Co-operated with nurse visit	28	37	46	46	56	67	70	49
Refused/no contact at nurse visit	19	20	15	16	11	8	7	14
Not interviewed	53	42	39	38	32	25	23	36
Waist/hip								
Measured	27	37	45	45	54	65	68	48
Refused/not obtained	1	1	1	1	2	2	2	1
No nurse visit[2]	72	63	54	54	44	33	30	51
Blood pressure								
Measured	27	37	45	45	56	66	69	49
Refused/not obtained	1	0	0	1	0	1	1	1
No nurse visit[2]	72	63	54	54	44	33	30	51
Blood sample								
Sample taken	18	28	36	39	46	52	49	38
Ineligible – medical grounds	1	2	1	2	2	4	4	2
Unsuccessful attempt at sample	1	1	0	1	3	5	13	3
Refused	7	6	8	3	5	5	3	5
No nurse visit[2]	73	63	55	55	45	34	31	51
Urine sample								
Measured	22	33	40	40	49	61	60	43
Refused/not obtained	6	4	6	6	7	6	10	6
No nurse visit[2]	72	63	54	54	44	33	30	51
Bases: Men aged 16 and over in co-operating households	*568*	*664*	*666*	*803*	*732*	*595*	*453*	*4481*

1 Includes non-responders to the interview as well as those whose measurements were not obtained.
2 Includes non-responders to the interview.

Table A8: HSE 2016: women in co-operating households: response to the stages of the survey, by age

Individual response	Age group 16-24	25-34	35-44	45-54	55-64	65-74	75+	Total
	%	%	%	%	%	%	%	%
Interviewed								
Interviewed	68	89	93	91	91	96	95	90
Not contacted/refused	32	11	7	9	9	4	5	10
Height								
Measured	61	77	83	77	81	81	74	77
Refused	5	8	8	11	7	9	6	8
Measurement not attempted	2	4	3	3	3	6	14	5
Not contacted/not obtained[1]	32	11	7	9	9	5	6	11
Weight								
Measured	57	71	78	75	80	79	73	74
Refused	6	9	9	12	8	9	7	9
Measurement not attempted	3	7	4	4	3	7	14	6
Not contacted/not obtained[1]	34	13	9	10	9	5	5	12
Nurse visit								
Co-operated with nurse visit	34	51	57	59	66	68	62	57
Refused/no contact at nurse visit	22	25	20	15	11	8	9	16
Not interviewed	44	24	23	25	24	24	29	27
Waist/hip								
Measured	32	47	53	57	63	65	57	54
Refused/not obtained	1	1	2	2	2	4	5	2
No nurse visit[2]	68	52	45	41	34	32	38	44
Blood pressure								
Measured	32	48	54	58	65	67	61	55
Refused/not obtained	1	0	1	1	1	1	2	1
No nurse visit[2]	68	52	45	41	34	32	38	44
Blood sample								
Sample taken	19	34	45	47	55	53	42	43
Ineligible – medical grounds	4	4	3	6	4	5	5	4
Unsuccessful attempt at sample	3	4	3	2	1	4	8	3
Refused	8	8	6	5	4	5	6	6
No nurse visit[2]	66	51	44	41	36	33	39	44
Urine sample								
Measured	26	41	50	54	61	60	49	49
Refused/not obtained	6	7	5	5	5	9	13	7
No nurse visit[2]	68	52	45	41	34	32	38	44
Bases: Women aged 16 and over in co-operating households	*574*	*825*	*776*	*857*	*760*	*653*	*533*	*4978*

1 Includes non-responders to the interview as well as those whose measurements were not obtained.
2 Includes non-responders to the interview.

Table A9: HSE 2016: all adults in co-operating households: response to the stages of the survey, by age

Individual response	Age group 16-24	25-34	35-44	45-54	55-64	65-74	75+	Total
	%	%	%	%	%	%	%	%
Interviewed								
Interviewed	64	82	85	85	88	94	95	85
Not contacted/refused	36	18	15	15	12	6	5	15
Height								
Measured	56	71	74	72	77	80	76	72
Refused	5	8	7	9	7	8	6	7
Measurement not attempted	3	3	3	4	4	6	13	5
Not contacted/not obtained[1]	36	18	15	15	12	6	6	16
Weight								
Measured	54	67	72	70	75	79	75	71
Refused	5	8	8	10	8	8	7	8
Measurement not attempted	4	5	4	4	4	7	13	6
Not contacted/not obtained[1]	38	20	16	15	12	6	5	16
Nurse visit								
Co-operated with nurse visit	31	45	52	53	61	68	66	53
Refused/no contact at nurse visit	20	23	17	16	11	8	8	15
Not interviewed	48	32	31	31	28	24	26	31
Waist/hip								
Measured	30	42	49	51	59	65	62	51
Refused/not obtained	1	1	2	2	2	3	4	2
No nurse visit[2]	70	57	49	47	39	32	34	47
Blood pressure								
Measured	30	43	50	52	61	67	65	52
Refused/not obtained	1	0	1	1	0	1	1	1
No nurse visit[2]	70	57	49	47	39	32	34	47
Blood sample								
Sample taken	18	31	41	43	51	53	45	41
Ineligible – medical grounds	3	3	2	4	3	5	4	3
Unsuccessful attempt at sample	2	2	2	2	2	4	10	3
Refused	8	7	6	4	4	5	5	6
No nurse visit[2]	69	56	49	48	40	33	36	48
Urine sample								
Measured	24	38	45	48	55	60	54	46
Refused/not obtained	6	6	6	5	6	7	12	7
No nurse visit[2]	70	57	49	47	39	32	34	47
Bases: All adults aged 16 and over in co-operating households	*1142*	*1489*	*1442*	*1660*	*1492*	*1248*	*986*	*9459*

1 Includes non-responders to the interview as well as those whose measurements were not obtained.
2 Includes non-responders to the interview.

Table A10: HSE 2016: boys in co-operating households: response to the stages of the survey, by age

Individual response	Age group 0-1	2-4	5-6	7-10	11-15	Total
	%	%	%	%	%	%
Interviewed						
Interviewed	94	96	92	91	80	89
Not contacted/refused	6	4	8	9	20	11
Height						
Measured		65	70	74	62	67
Refused		8	4	5	5	6
Measurement not attempted		18	18	11	12	14
Not contacted/not obtained[1]		9	8	9	21	13
Weight						
Measured	55	70	69	73	62	66
Refused	8	8	4	5	5	6
Measurement not attempted	30	17	18	11	12	16
Not contacted/not obtained[1]	7	6	8	10	21	12
Nurse visit						
Co-operated with nurse visit	56	50	46	45	39	46
Refused/no contact at nurse visit	23	26	27	28	23	25
Not interviewed	21	25	27	27	38	29
Saliva						
Obtained		14	37	42	34	31
Not obtained		4	10	4	5	5
No nurse visit		82	54	55	61	63
Blood pressure						
Measured			39	41	36	39
Refused/not obtained			7	4	2	4
No nurse visit[2]			54	55	61	58
Waist/hip						
Measured					35	35
Refused/not obtained					4	4
No nurse visit[2]					61	61
Bases: all eligible boys in co-operating households						
Aged 0-15 (interview, nurse visit, weight measurement)	*145*	*246*	*142*	*274*	*358*	*1165*
Aged 2-15 (height measurement)		*246*	*142*	*274*	*358*	*1020*
Aged 4-15 (saliva sample)		*79*	*142*	*274*	*358*	*853*
Aged 5-15 (blood pressure)			*142*	*274*	*358*	*774*
Aged 11-15 (waist and hip measurement)				*274*	*358*	*632*

1 Includes non-responders to the interview as well as those whose measurements were not obtained.
2 Includes non-responders to the interview.

Table A11: HSE 2016: girls in co-operating households: response to the stages of the survey, by age

	Age group					Total
Individual response	**0-1**	**2-4**	**5-6**	**7-10**	**11-15**	
	%	**%**	**%**	**%**	**%**	**%**
Interviewed						
Interviewed	96	92	93	93	87	91
Not contacted/refused	4	8	7	7	13	9
Height						
Measured		60	76	78	67	70
Refused		9	5	4	7	6
Measurement not attempted		18	12	9	12	13
Not contacted/not obtained[1]		12	7	8	14	11
Weight						
Measured	68	63	75	77	66	70
Refused	6	9	5	4	7	6
Measurement not attempted	22	17	12	10	12	14
Not contacted/not obtained[1]	4	10	7	9	15	10
Nurse visit						
Co-operated with nurse visit	59	52	55	56	46	53
Refused/no contact at nurse visit	25	22	21	25	22	23
Not interviewed	16	26	24	19	32	25
Saliva						
Obtained		9	46	49	42	37
Not obtained		6	9	7	4	6
No nurse visit		85	45	44	54	57
Blood pressure						
Measured			47	52	43	47
Refused/not obtained			8	4	2	4
No nurse visit[2]			45	44	54	48
Waist/hip						
Measured					44	44
Refused/not obtained					2	2
No nurse visit[2]					54	54
Bases: all eligible girls in co-operating households						
Aged 0-15 (interview, nurse visit, weight measurement)	*142*	*235*	*164*	*267*	*306*	*1114*
Aged 2-15 (height measurement)		*235*	*164*	*267*	*306*	*972*
Aged 4-15 (saliva sample)		*79*	*164*	*267*	*306*	*816*
Aged 5-15 (blood pressure)			*164*	*267*	*306*	*737*
Aged 11-15 (waist and hip measurement)				*267*	*306*	*573*

1 Includes non-responders to the interview as well as those whose measurements were not obtained.
2 Includes non-responders to the interview.

Table A12: HSE 2016: all children in co-operating households: response to the stages of the survey, by age

	Age group					Total
Individual response	**0-1**	**2-4**	**5-6**	**7-10**	**11-15**	
	%	**%**	**%**	**%**	**%**	**%**
Interviewed						
Interviewed	95	94	92	92	83	90
Not contacted/refused	5	6	8	8	17	10
Height						
Measured		63	73	76	64	69
Refused		9	5	5	6	6
Measurement not attempted		18	15	10	12	13
Not contacted/not obtained[1]		10	8	9	18	12
Weight						
Measured	62	67	72	75	64	68
Refused	7	9	5	5	6	6
Measurement not attempted	26	17	15	11	12	15
Not contacted/not obtained[1]	6	8	8	9	18	11
Nurse visit						
Co-operated with nurse visit	57	51	51	51	42	49
Refused/no contact at nurse visit	24	24	24	26	23	24
Not interviewed	19	26	25	23	35	27
Saliva						
Obtained		11	42	45	38	34
Not obtained		5	9	6	4	6
No nurse visit		83	49	49	58	60
Blood pressure						
Measured			43	46	40	43
Refused/not obtained			8	4	2	4
No nurse visit[2]			49	49	58	53
Waist/hip						
Measured					39	39
Refused/not obtained					3	3
No nurse visit[2]					58	58
Bases: all eligible children in co-operating households						
Aged 0-15 (interview, nurse visit, weight measurement)	*287*	*481*	*306*	*541*	*664*	*2279*
Aged 2-15 (height measurement)		*481*	*306*	*541*	*664*	*1992*
Aged 4-15 (saliva sample)		*158*	*306*	*541*	*664*	*1669*
Aged 5-15 (blood pressure)			*306*	*541*	*664*	*1511*
Aged 11-15 (waist and hip measurement)				*541*	*664*	*1205*

1 Includes non-responders to the interview as well as those whose measurements were not obtained.
2 Includes non-responders to the interview.

Table A13: HSE 2016: age distribution of responding adult sample compared with mid-2016 population estimates for England, by sex

	HSE responding adult sample		2016 mid-year population estimates[1]
Age group	**At interview**	**At nurse visit**	
	%	**%**	**%**
Men			
16-24	10	7	15
25-34	14	11	17
35-44	14	14	16
45-54	18	17	18
55-64	17	19	14
65-74	16	18	12
75 and over	12	14	8
All men[2]	44	44	49
Women			
16-24	9	7	13
25-34	17	15	17
35-44	16	15	16
45-54	17	18	17
55-64	16	18	14
65-74	14	16	12
75 and over	11	12	10
All women[2]	56	56	51
Bases:			
Men	*3552*	*2210*	*21,808*
Women	*4459*	*2839*	*22,586*

1 Mid-year population estimates for England, excluding those living in institutions (Source: ONS). Bases shown in thousands.
2 The percentages for age groups within sex are based on participants of that sex. The percentages for 'all men' and 'all women' are based on all participants.

Table A14: HSE 2016: age distribution of responding child sample compared with mid-2016 population estimates for England, by sex

	HSE responding child sample		2016 mid-year population estimates[1]
Age group	**At interview**	**At nurse visit**	
	%	**%**	**%**
Boys			
0-1	13	15	13
2-3	15	15	13
4-5	14	15	13
6-7	13	14	13
8-9	12	10	13
10-11	12	12	12
12-13	10	9	11
14-15	11	11	12
All boys[2]	50	48	51
Girls			
0-1	13	14	13
2-3	14	15	13
4-5	15	15	13
6-7	14	13	13
8-9	12	13	13
10-11	12	11	12
12-13	11	10	11
14-15	9	9	12
All girls[2]	50	52	49
Bases:			
Boys	*1038*	*531*	*5393*
Girls	*1018*	*586*	*5136*

1 Mid-year population estimates for England, excluding those living in institutions (Source: ONS). Bases shown in thousands.
2 The percentages for age groups within sex are based on participants of that sex. The percentages for 'all boys' and 'all girls' are based on all participants.

Table A15: HSE 2016: reference intervals for blood, urine and saliva analytes

Analyte	Reference interval	Units
Serum[1]		
Total cholesterol		
Males	3.5-5.1	mmol/L
Females	3.5-5.1	mmol/L
HDL cholesterol		
Males	0.9-1.4	mmol/L
Females	1.1-1.7	mmol/L
Blood[1]		
Total glycated haemoglobin (HbA_{1c})		
Males	Non diabetic: <48	mmol/mol
Females	Non diabetic: <48	mmol/mol
Glomerular Filtration Rate (eGFR)		
Creatinine eGFR	>60	ml/min/1.73m^2
Cystatin C eGFR	>60	ml/min/1.73m^2
Aspartate aminotransferase (AST)	0-40	IU/L
Alanine aminotransferase (ALT)	0-40	IU/L
Platelets	150-450	x10^9/L
Urine[1,2]		
Albumin:Creatinine ratio[3]		
Males	<2.5	mg/mmol
Females	<3.5	mg/mmol
Saliva[4]		
Cotinine[5]		
No exposure to tobacco	Undetectable (<0.1)	ng/ml
Passive smoking	0.1 to less than 12	ng/ml
Personal tobacco use	≥ 12	ng/ml

1 Analyses by Clinical Biochemistry and Haematology Laboratories, Royal Victoria Infirmary, Newcastle upon Tyne Hospitals NHS Foundation Trust.
2 No reference ranges are available for spot urines for sodium, potassium, creatinine.
3 The laboratory provides different reference ranges for males and females, which were used in the HSE 2009 and 2010 reports. However, NICE criteria for classification of chronic kidney disease use 3.0 mg/mmol as the threshold in both men and women.
4 Analyses by ABS Laboratories, Welwyn Garden City.
5 Jarvis MJ, Fidler J, Mindell J, Feyerabend M, West R. *Assessing smoking status in children, adolescents and adults: cotinine cutpoints revisited.* Addiction 2008;103:1553-61.

Table A16: HSE 2016: internal quality control results for total cholesterol

Month	Target value (mmol/L)	Assayed value (mmol/L)	Acceptable range (mmol/L)	SD[1] (mmol/L) achieved	CV[2] (%) achieved
January 2016	3.2	3.14	(3.1-3.3)	0.04	1.18
	6.8	6.73	(6.6-6.9)	0.07	1.06
February[3]	3.1	3.18	(3.0-3.2)	0.05	1.48
	6.7	6.79	(6.5-6.9)	0.06	0.85
March	3.1	3.14	(3.0-3.2)	0.05	1.65
	6.7	6.72	(6.5-6.9)	0.09	1.28
April	3.1	3.11	(3.0-3.2)	0.04	1.13
	6.7	6.69	(6.5-6.9)	0.06	0.95
May	3.1	3.14	(3.0-3.2)	0.03	0.98
	6.7	6.74	(6.5-6.9)	0.05	0.81
June	3.1	3.11	(3.0-3.2)	0.03	0.93
	6.7	6.66	(6.5-6.9)	0.05	0.69
July	3.1	3.10	(3.0-3.2)	0.04	1.13
	6.7	6.65	(6.5-6.9)	0.05	0.74
August	3.1	3.10	(3.0-3.2)	0.03	1.10
	6.7	6.66	(6.5-6.9)	0.05	0.80
September	3.1	3.15	(3.0-3.2)	0.05	1.50
	6.7	6.76	(6.5-6.9)	0.08	1.18
October	3.1	3.14	(3.0-3.2)	0.04	1.33
	6.7	6.75	(6.5-6.9)	0.06	0.90
November	3.1	3.15	(3.0-3.2)	0.04	1.38
	6.7	6.77	(6.5-6.9)	0.07	1.00
December	3.1	3.12	(3.0-3.2)	0.03	0.80
	6.7	6.69	(6.5-6.9)	0.05	0.72
January 2017[3]	3.3	3.26	(3.2-3.4)	0.04	1.18
	7.4	7.28	(7.1-7.6)	0.06	0.81
February	3.3	3.32	(3.2-3.4)	0.04	1.31
	7.4	7.43	(7.1-7.6)	0.07	0.95
March[3]	3.3	3.34	(3.2-3.4)	0.04	1.14
	7.5	7.50	(7.3-7.7)	0.05	0.72

1 Standard deviation.
2 Coefficient of variation.
3 The target values changed in these months.

Table A17: HSE 2016: internal quality control results for HDL cholesterol

Month	Target value (mmol/L)	Assayed value (mmol/L)	Acceptable range (mmol/L)	SD[1] (mmol/L) achieved	CV[2] (%) achieved
January 2016	1.5	1.44	(1.4-1.6)	0.02	1.24
	2.8	2.73	(2.7-3.0)	0.05	1.78
February	1.5	1.44	(1.4-1.6)	0.03	2.17
	2.8	2.73	(2.7-3.0)	0.05	1.72
March	1.5	1.50	(1.4-1.6)	0.02	1.40
	2.8	2.84	(2.7-3.0)	0.05	1.61
April	1.5	1.49	(1.4-1.6)	0.02	1.24
	2.8	2.83	(2.7-3.0)	0.04	1.32
May	1.5	1.50	(1.4-1.6)	0.02	1.53
	2.8	2.86	(2.7-3.0)	0.04	1.30
June	1.5	1.51	(1.4-1.6)	0.02	1.50
	2.8	2.87	(2.7-3.0)	0.04	1.38
July	1.5	1.44	(1.4-1.6)	0.04	2.62
	2.8	2.75	(2.7-3.0)	0.07	2.71
August	1.5	1.49	(1.4-1.6)	0.02	1.10
	2.8	2.84	(2.7-3.0)	0.03	1.02
September	1.5	1.50	(1.4-1.6)	0.02	1.35
	2.8	2.87	(2.7-3.0)	0.04	1.37
October	1.5	1.49	(1.4-1.6)	0.02	1.45
	2.8	2.84	(2.7-3.0)	0.04	1.54
November	1.5	1.48	(1.4-1.6)	0.02	1.41
	2.8	2.82	(2.7-3.0)	0.05	1.80
December	1.5	1.49	(1.4-1.6)	0.03	1.76
	2.8	2.84	(2.7-3.0)	0.04	1.30
January 2017[3]	1.6	1.63	(1.5-1.7)	0.02	1.29
	3.1	3.07	(2.9-3.2)	0.05	1.54
February	1.6	1.58	(1.5-1.7)	0.03	2.03
	3.1	2.99	(2.9-3.2)	0.04	1.45
March	1.6	1.62	(1.5-1.7)	0.03	1.93
	3.0	3.06	(2.8-3.2)	0.05	1.60

1 Standard deviation.
2 Coefficient of variation.
3 The target values changed in these months.

Table A18: HSE 2016: internal quality control results for glycated haemoglobin (HbA_{1c})

Month	Target value (mmol/mol)	Assayed value (mmol/mol)	Acceptable range (mmol/mol)	SD[1] (mmol/mol) achieved	CV[2] (%) achieved
January 2016	35	35.0	(34-36)	0.7	1.9
	84	81.1	(81-87)	0.8	1.0
February	35	34.9	(34-36)	0.5	1.5
	84	81.1	(81-87)	0.6	0.8
March	35	34.7	(34-36)	0.8	2.2
	84	81.2	(81-87)	1.2	1.4
April	35	34.8	(34-36)	0.7	2.0
	84	81.7	(81-87)	0.6	0.7
May	35	34.5	(34-36)	0.8	2.2
	84	81.0	(81-87)	0.8	1.0
June[3]	35	35.4	(33-37)	0.9	2.7
	82	82.8	(78-85)	1.0	1.2
July	35	34.7	(33-37)	0.8	2.3
	82	81.9	(78-85)	0.7	0.8
August	35	35.1	(33-37)	0.7	1.9
	82	82.6	(78-85)	0.6	0.7
September	35	34.5	(33-37)	0.8	2.3
	82	81.5	(78-85)	0.7	0.9
October	35	34.2	(33-37)	1.0	2.9
	82	81.2	(78-85)	0.8	1.0
November	35	33.8	(33-37)	0.9	2.7
	82	81.1	(78-85)	1.1	1.4
December	35	33.3	(33-37)	0.9	2.6
	82	80.7	(78-85)	0.6	0.7
January 2017[3]	34	34.1	(32-36)	0.9	2.7
	81	80.9	(79-84)	1.0	1.3
February	34	33.4	(32-36)	0.8	2.3
	81	80.9	(79-84)	0.8	0.9
March	34	33.4	(32-36)	1.0	2.9
	81	80.7	(79-84)	0.8	1.0

1 Standard deviation.
2 Coefficient of variation.
3 The target values changed in these months.

Table A19: HSE 2016: internal quality control results for aspartate aminotransferase (AST)

Month	Target value (IU/L)	Assayed value (IU/L)	Acceptable range (IU/L)	SD[1] (IU/L) achieved	CV[2] (%) achieved
January 2016	45	43.7	(42-47)	1.4	3.3
	215	211.8	(210-220)	3.1	1.5
February[3]	44	44.4	(40-47)	1.1	2.4
	213	214.2	(204-222)	2.0	0.9
March	44	44.2	(40-47)	1.0	2.2
	213	211.9	(204-222)	2.0	0.9
April	44	44.0	(40-47)	0.9	2.0
	213	212.6	(204-222)	1.7	0.8
May	44	43.1	(40-47)	1.1	2.6
	213	214.0	(204-222)	2.3	1.1
June	44	42.6	(40-47)	1.2	2.9
	213	208.5	(204-222)	2.0	1.0
July	44	44.3	(40-47)	0.8	1.7
	213	214.0	(204-222)	1.3	0.6
August	44	44.2	(40-47)	0.8	1.9
	213	214.8	(204-222)	1.4	0.7
September	44	43.4	(40-47)	1.2	2.7
	213	214.0	(204-222)	2.2	1.0
October	44	42.9	(40-47)	0.8	2.0
	213	212.5	(204-222)	1.7	0.8
November	44	42.8	(40-47)	1.1	2.6
	213	211.8	(204-222)	1.9	0.9
December	44	42.7	(40-47)	0.9	2.2
	213	212.5	(204-222)	1.8	0.8
January 2017[3]	38	38.5	(35-41)	1.2	3.0
	216	216.9	(207-224)	1.6	0.7
February	38	39.2	(35-41)	1.0	2.6
	216	215.9	(207-224)	1.8	0.8
March[3]	38	39.0	(35-41)	1.3	3.4
	210	205.7	(201-218)	2.6	1.3

1 Standard deviation.
2 Coefficient of variation.
3 The target values changed in these months.

Table A20: HSE 2016: internal quality control results for alanine aminotransferase (ALT)

Month	Target value (IU/L)	Assayed value (IU/L)	Acceptable range (IU/L)	SD[1] (IU/L) achieved	CV[2] (%) achieved
January 2016	32	31.6	(30-34)	0.7	2.3
	198	198.0	(194-202)	2.2	1.1
February	32	31.3	(29-35)	0.7	2.3
	196	196.8	(188-204)	1.7	0.9
March	32	30.9	(29-35)	0.9	2.8
	196	196.1	(188-204)	2.5	1.3
April	32	31.6	(29-35)	0.9	3.0
	196	195.5	(188-204)	5.0	2.5
May	32	30.8	(29-35)	0.9	2.9
	196	191.2	(188-204)	1.8	0.9
June[3]	32	30.8	(29-35)	1.1	3.5
	196	191.2	(188-204)	1.7	0.9
July	32	31.4	(29-35)	0.9	3.0
	196	193.7	(188-204)	2.8	1.5
August	32	31.8	(29-35)	1.0	3.0
	196	195.7	(188-204)	1.5	0.8
September	32	31.9	(29-35)	0.9	2.9
	196	196.2	(188-204)	1.6	0.8
October	32	32.1	(29-35)	0.9	2.9
	196	197.7	(188-204)	1.7	0.9
November	32	32.0	(29-35)	1.1	3.5
	196	195.5	(188-204)	3.4	1.8
December	32	32.2	(29-35)	0.9	2.8
	196	193.6	(188-204)	1.6	0.8
January 2017[3]	36	35.4	(33-39)	1.4	3.9
	201	203.9	(193-209)	3.1	1.5
February	36	37.3	(33-39)	1.2	3.1
	201	199.6	(193-209)	2.2	1.1
March[3]	36	37.7	(33-39)	1.3	3.5
	181	181.5	(174-188)	2.3	1.3

1 Standard deviation.
2 Coefficient of variation.
3 The target values changed in these months.

Table A21: HSE 2016: internal quality control results for creatinine

Month	Target value (mmol/L)	Assayed value (mmol/L)	Acceptable range (mmol/L)	SD[1] (mmol/L) achieved	CV[2] (%) achieved
January 2016	51	50.1	(47-54)	1.1	2.2
	424	421.0	(410-437)	4.6	1.1
February[3]	51	49.6	(48-54)	1.1	2.2
	425	416.7	(408-442)	4.5	1.1
March	51	50.6	(48-54)	1.1	2.1
	425	419.5	(408-442)	4.1	1.0
April	51	49.1	(48-54)	1.6	3.3
	425	418.4	(408-442)	4.4	1.0
May	51	51.0	(48-54)	1.1	2.2
	425	422.2	(408-442)	4.0	1.0
June	51	50.6	(48-54)	1.0	2.0
	425	422.7	(408-442)	4.1	1.0
July	51	51.5	(48-54)	1.4	2.6
	425	429.8	(408-442)	7.9	1.8
August	51	49.5	(48-54)	1.3	2.6
	425	420.7	(408-442)	5.3	1.3
September	51	50.2	(48-54)	1.3	2.6
	425	422.0	(408-442)	6.2	1.5
October	51	50.1	(48-54)	1.0	1.9
	425	419.8	(408-442)	5.1	1.2
November	51	51.3	(48-54)	1.3	2.5
	425	426.2	(408-442)	3.9	0.9
December	51	52.4	(48-54)	0.8	1.5
	425	425.7	(408-442)	3.6	0.8
January 2017[3]	60	60.2	(56-63)	1.0	1.6
	428	428.4	(411-445)	3.4	0.8
February	60	59.4	(56-63)	1.2	2.0
	428	428.6	(411-445)	3.3	0.8
March	60	59.8	(56-63)	1.0	1.7
	428	423.4	(410-445)	5.2	1.2

1 Standard deviation.
2 Coefficient of variation.
3 The target values changed in these months.

Table A22: HSE 2016: internal quality control results for cystatin C

Month	Target value (mg/L)	Assayed value (mg/L)	Acceptable range (mg/L)	SD[1] (mg/L) achieved	CV[2] (%) achieved
January 2016	0.90	0.95	(0.81-0.99)	0.02	1.80
	1.60	1.66	(1.44-1.76)	0.03	1.80
	4.02	4.20	(3.76-4.28)	0.06	1.49
February	0.90	0.94	(0.81-0.99)	0.02	1.84
	1.60	1.67	(1.44-1.76)	0.02	1.34
	4.02	4.16	(3.76-4.28)	0.05	1.13
March	0.90	0.96	(0.81-0.99)	0.02	2.46
	1.60	1.68	(1.44-1.76)	0.06	3.43
	4.02	4.25	(3.76-4.28)	0.09	2.21
April[3]	0.90	0.96	(0.81-0.99)	0.01	0.94
	1.51	1.57	(1.35-1.67)	0.02	1.13
	4.02	4.22	(3.76-4.28)	0.03	0.74
May	0.90	0.95	(0.81-0.99)	0.03	2.69
	1.51	1.61	(1.35-1.67)	0.04	2.69
	4.02	4.25	(3.76-4.28)	0.07	1.59
June[3]	0.90	0.94	(0.81-0.99)	0.02	1.69
	1.60	1.67	(1.44-1.76)	0.02	1.27
	4.02	4.22	(3.76-4.28)	0.06	1.31
July	0.90	0.93	(0.81-0.99)	0.04	4.61
	1.60	1.64	(1.44-1.76)	0.07	4.16
	4.02	4.17	(3.76-4.28)	0.16	3.85
August[3]	0.90	0.92	(0.81-0.99)	0.03	2.81
	1.51	1.60	(1.35-1.67)	0.04	2.50
	4.02	4.15	(3.76-4.28)	0.11	2.63
September[3]	0.90	0.91	(0.81-0.99)	0.03	3.09
	1.60	1.58	(1.44-1.76)	0.04	2.49
	4.02	4.08	(3.76-4.28)	0.11	2.66
October	0.90	0.91	(0.81-0.99)	0.01	0.70
	1.60	1.59	(1.44-1.76)	0.02	1.17
	4.02	4.12	(3.76-4.28)	0.02	0.57
November[3]	0.87	0.93	(0.78-0.96)	0.03	3.42
	1.53	1.61	(1.41-1.65)	0.03	1.80
	3.99	4.25	(3.73-4.25)	0.08	1.83
December[4]	0.87	0.95	(0.78-0.96)	0.03	2.70
	1.53	1.65	(1.41-1.65)	0.04	2.07
	3.99	4.41	(3.73-4.25)	0.08	1.90
January 2017[3]	0.87	0.94	(0.74-1.00)	0.03	3.64
	1.56	1.71	(1.32-1.80)	0.05	2.83
	4.02	4.37	(3.63-4.41)	0.07	2.50
February[3]	1.08	1.14	(0.93-1.23)	0.03	2.52
	1.78	1.85	(1.51-2.05)	0.06	3.04
	4.18	4.43	(3.76-4.60)	0.10	2.20
March	1.08	1.11	(0.93-1.23)	0.04	3.99
	1.78	1.83	(1.51-2.05)	0.06	3.40

1 Standard deviation.
2 Coefficient of variation.
3 The target values changed in these months.
4 There were assay problems during this period, IQC was outside acceptable limits and sample analysis was suspended for a period of 6 days. These were fully investigated with Roche. New lot numbers of reagent and IQC were provided but there was no change in IQC performance. The laboratory considered the assay to be performing satisfactorily as IQC levels 1 and 2 showed satisfactory performance, as did EQA. During this time period no participants had cystatin C results around the concentration of the level 3 IQC (approximately 4.0 mg/L) .The vast majority of participant results were below 2.0mg/L where the IQC results were within acceptable limits.

Table A23: HSE 2016: internal quality control results for haemoglobin (using Sysmex XE2100)[1]

Month	Target value (g/L)	Sysmex 1[1] Assayed value (g/L)	Acceptable range (g/L)	SD[b] (g/L) achieved	CV[c] (%) achieved	Sysmex 2[1] Assayed value (g/L)	Acceptable range (g/L)	SD[2] (g/L) achieved	CV[3] (%) achieved
January 2016	63	63	(60-66)	0.8	1.3	63	(60-66)	0.8	1.30
	126	126	(122-130)	1.2	1.0	126	(122-130)	1.2	1.00
	167	167	(162-172)	1.4	0.8	167	(162-172)	1.4	0.80
February	58	57	(56-60)	0.6	1.1	57	(56-60)	0.6	1.10
	123	121	(119-127)	1.4	1.2	121	(119-127)	1.4	1.20
	165	165	(160-170)	1.6	1.0	165	(160-170)	1.6	1.00
March	58	58	(56-60)	0.6	1.0	58	(56-60)	0.6	1.00
	123	123	(119-127)	1.2	1.0	123	(119-127)	1.2	1.00
	165	166	(160-170)	1.3	0.8	166	(160-170)	1.3	0.80
April	60	60	(58-62)	0.6	1.0	60	(58-62)	0.6	1.00
	122	121	(118-126)	1.4	1.2	121	(118-126)	1.4	1.20
	163	165	(158-168)	1.3	0.8	165	(158-168)	1.3	0.80
May	60	60	(58-62)	0.6	1.0	60	(58-62)	0.6	1.00
	122	121	(118-126)	1.1	0.9	121	(118-126)	1.1	0.90
	163	165	(158-168)	1.3	0.8	165	(158-168)	1.3	0.80

1 Platelets and haemoglobin were measured using two Sysmex XE2100 analyser until May 2016 when a Sysmex XN was used (Table A24). There was no difference in results following this change. IQC results for each of the two Sysmex XE2100 analysers are presented in this table.
2 Standard deviation.
3 Coefficient of variation.

Table A24: HSE 2016: internal quality control results for haemoglobin (using Sysmex XN)[1]

Month	Target value (x 10^9/L)	Assayed value (x 10^9/L)	Acceptable range (x 10^9/L)	SD[2] (x 10^9/L) achieved	CV[3] (%) achieved
June[4]	62	63	(60-64)	0.9	1.4
	123	125	(119-127)	0.8	0.7
	167	171	(162-172)	0.9	0.5
July[5]	62	[5]	(60-64)	[5]	[5]
	123	125	(119-127)	0.8	0.6
	167	[5]	(162-172)	[5]	[5]
August[4]	59	59	(56-62)	0.6	1
	123	124	(119-127)	0.8	0.6
	167	169	(162-172)	0.8	0.5
September	59	60	(56-62)	0.6	1
	123	125	(119-127)	0.7	0.6
	167	170	(162-172)	1.1	0.7
October	59	60	(56-62)	0.5	0.9
	123	125	(119-127)	0.7	0.6
	167	170	(162-172)	0.8	0.5
November[4]	60	60	(58-62)	0.8	1.4
	125	123	(121-129)	1.1	0.9
	170	171	(165-175)	1.3	0.8
December[4]	61	62	(59-63)	0.5	0.8
	126	126	(122-130)	1	0.8
	166	166	(161-171)	1.1	0.6
January 2017	61	62	(59-63)	0.6	0.9
	126	126	(122-130)	0.7	0.5
	166	166	(161-171)	1.1	0.6
February[4]	60	60	(58-62)	0.5	0.9
	126	126	(122-130)	0.7	0.6
	169	169	(164-174)	0.8	0.5
March	60	60	(58-62)	0.6	1.1
	126	126	(122-130)	1.1	0.8
	169	169	(164-174)	1.2	0.7

1 Platelets and Haemoglobin were measured using a Sysmex XE2100 analyser until May 2016, when a Sysmex XN was used where samples were processed through one analyser. There was no difference in results following this change.
2 Standard deviation.
3 Coefficient of variation.
4 The target values changed in these months.
5 Sysmex could supply only one level of IQC reagent this month. Quality was monitored using daily precision checks.

Table A25: HSE 2016: internal quality control results for platelets (using Sysmex XE2100)[1]

Month	Sysmex 1[1] Target value (x 10^9/L)	Sysmex 1[1] Assayed value (x 10^9/L)	Sysmex 1[1] Acceptable range (x 10^9/L)	Sysmex 1[1] SD[2] (x 10^9/L) achieved	Sysmex 1[1] CV[3] (%) achieved	Sysmex 2[1] Assayed value (x 10^9/L)	Sysmex 2[1] Acceptable range (x 10^9/L)	Sysmex 2[1] SD[2] (x 10^9/L) achieved	Sysmex 2[1] CV[3] (%) achieved
January 2016	57	58	(34-80)	2.4	4.1	57	(34-80)	2.1	3.7
	221	217	(197-245)	5.0	2.3	221	(197-245)	5.3	2.4
	504	494	(459-549)	6.4	1.3	501	(459-549)	9.6	1.9
February	53	52	(32-74)	1.8	3.5	52	(32-74)	2.3	4.4
	217	212	(193-241)	3.9	1.8	215	(193-241)	5.3	2.5
	502	488	(457-547)	6.8	1.4	492	(457-547)	7.1	1.4
March	53	53	(32-74)	1.9	3.6	53	(32-74)	1.9	3.6
	217	211	(193-241)	3.5	1.7	216	(193-241)	4.1	1.9
	502	493	(457-547)	8.3	1.7	493	(457-547)	6.6	1.3
April	55	54	(33-77)	2.2	4.1	53	(33-77)	1.9	3.6
	218	213	(194-242)	4.5	2.1	216	(194-242)	4.7	2.2
	507	494	(461-553)	5.6	1.1	497	(461-553)	8.4	1.7
May	55	56	(33-77)	3.3	5.9	56	(33-77)	3.2	5.7
	218	215	(194-242)	5.0	2.3	219	(194-242)	3.4	1.6
	507	500	(461-553)	12.5	2.5	502	(461-553)	11.5	2.3

1 Platelets and haemoglobin were measured using two Sysmex XE2100 analyser until May 2016 when a Sysmex XN was used (Table A26). There was no difference in results following this change. IQC results for each of the two Sysmex XE2100 analysers are presented in this table.

2 Standard deviation.

3 Coefficient of variation.

Table A26: HSE 2016: internal quality control results for platelets (using Sysmex XN)[1]

Month	Target value (x 10^9/L)	Assayed value (x 10^9/L)	Acceptable range (x 10^9/L)	SD[2] (x 10^9/L) achieved	CV[3] (%) achieved
June[4]	55	58	(33-77)	4.0	7.0
	244	248	(207-281)	4.3	1.7
	562	588	(511-613)	7.5	1.3
July[5]	55	[5]	(33-77)	[5]	[5]
	244	250	(207-281)	5.2	2.1
	562	[5]	(511-613)	[5]	[5]
August[4]	89	88	(54-124)	4.7	5.3
	244	249	(207-281)	5.1	2.0
	554	568	(504-604)	8.1	1.4
September	89	88	(54-124)	4.8	5.4
	244	259	(207-281)	6.1	2.3
	554	572	(504-604)	8.4	1.5
October	89	90	(54-124)	4.5	5.0
	244	261	(207-281)	7.2	2.7
	554	571	(504-604)	5.9	1.0
November[4]	88	91	(53-123)	4.2	4.7
	241	249	(205-277)	6.6	2.7
	576	590	(524-628)	7.7	1.3
December[4]	88	88	(53-123)	4.7	5.4
	253	256	(215-291)	6.3	2.5
	563	577	(512-614)	10.9	1.9
January 2017	88	86	(53-123)	5.8	6.7
	253	258	(215-291)	7.9	3.0
	563	577	(512-614)	10.4	1.8
February[4]	87	62	(52-122)	9.4	15.1
	246	248	(209-283)	6.0	2.4
	556	556	(506-606)	7.8	1.4
March	87	74	(52-122)	11.1	15.0
	246	250	(209-283)	6.8	2.7
	556	569	(506-606)	14.5	2.6

1 Platelets and Haemoglobin were measured using a Sysmex XE2100 analyser until May 2016, when a Sysmex XN was used where samples were processed through one analyser. There was no difference in results following this change.
2 Standard deviation.
3 Coefficient of variation.
4 The target values changed in these months.
5 Sysmex could supply only one level of IQC reagent this month. Quality was monitored using daily precision checks.

Table A27: HSE 2016: internal quality control results for urinary sodium

Month	Target value (mmol/L)	Assayed value (mmol/L)	Acceptable range (mmol/L)	SD[1] (mmol/L) achieved	CV[2] (%) achieved
January 2016	88	88.7	(85-91)	1.5	1.7
	164	164.6	(160-168)	1.1	0.7
February	88	86.3	(85-91)	1.9	2.2
	164	163.4	(160-168)	1.9	1.2
March	88	86.3	(84-91)	3.0	3.4
	164	162.8	(159-169)	2.0	1.2
April	88	89.4	(84-91)	1.2	1.4
	164	164.9	(159-169)	1.1	0.7
May	88	90.7	(84-91)	1.1	1.3
	164	165.0	(159-169)	1.2	0.7
June	88	88.1	(84-91)	1.6	1.8
	164	164.3	(159-169)	1.2	0.7
July	88	88.0	(84-91)	1.5	1.7
	164	164.2	(159-169)	1.6	0.9
August	88	87.0	(84-91)	1.7	1.9
	164	163.1	(159-169)	1.5	0.9
September	88	85.3	(84-91)	3.7	4.3
	164	161.7	(159-169)	2.9	1.8
October	88	87.4	(84-91)	2.0	2.2
	164	163.4	(159-169)	1.7	1.0
November	88	87.6	(84-91)	1.2	1.3
	164	163.9	(159-169)	1.5	0.9
December	88	86.8	(84-91)	1.4	1.6
	164	163.2	(159-169)	1.5	0.9
January 2017	88	87.1	(84-91)	1.4	1.7
	164	163.4	(159-169)	1.4	0.9
February	88	87.2	(84-91)	1.3	1.5
	164	163.9	(159-169)	1.2	0.7
March	88	86.4	(84-91)	1.8	2.1
	164	163.7	(159-169)	2.1	1.3

1 Standard deviation.
2 Coefficient of variation.

Table A28: HSE 2016: internal quality control results for urinary potassium

Month	Target value (mmol/L)	Assayed value (mmol/L)	Acceptable range (mmol/L)	SD[1] (mmol/L) achieved	CV[2] (%) achieved
January 2016	17	16.7	(16-17)	0.1	0.7
	60	60.9	(58-62)	1.2	2.0
February	17	16.8	(16-17)	0.1	0.7
	60	62.0	(58-62)	0.8	1.4
March[3]	17	16.9	(16-18)	0.1	0.7
	63	63.4	(59-66)	0.9	1.4
April	17	16.9	(16-18)	0.1	0.8
	63	62.0	(59-66)	1.7	2.7
May	17	16.8	(16-18)	0.1	0.8
	63	60.7	(59-66)	1.6	2.6
June	17	16.9	(16-18)	0.1	0.6
	63	61.8	(59-66)	0.8	1.2
July	17	16.8	(16-18)	0.1	0.8
	63	62.0	(59-66)	0.9	1.4
August	17	16.9	(16-18)	0.1	0.6
	63	62.6	(59-66)	0.7	1.1
September	17	17.0	(16-18)	0.5	2.9
	63	62.4	(59-66)	1.0	1.7
October	17	16.9	(16-18)	0.1	0.7
	63	62.4	(59-66)	0.8	1.3
November	17	17.0	(16-18)	0.1	0.8
	63	63.3	(59-66)	0.7	1.2
December	17	16.9	(16-18)	0.1	0.7
	63	63.0	(59-66)	0.8	1.2
January 2017	17	16.9	(16-18)	0.1	0.8
	63	61.9	(59-66)	1.1	1.8
February	17	16.9	(16-18)	0.2	0.9
	63	62.0	(59-66)	0.9	1.4
March	17	16.9	(16-18)	0.2	1.1
	63	62.7	(59-66)	1.2	1.9

1 Standard deviation.
2 Coefficient of variation.
3 The target values changed in this month.

Table A29: HSE 2016: internal quality control results for urinary creatinine

Month	Target value (mmol/L)	Assayed value (mmol/L)	Acceptable range (mmol/L)	SD[1] (mmol/L) achieved	CV[2] (%) achieved
January 2016	6.7	6.7	(6.5-7.0)	0.1	2.2
	12.7	12.8	(12.2-13.1)	0.3	2.0
February	6.7	6.5	(6.5-7.0)	0.1	1.3
	12.7	12.4	(12.2-13.1)	0.2	1.3
March[3]	6.5	6.4	(6.1-6.9)	0.1	1.4
	12.4	12.3	(11.8-13.1)	0.2	1.6
April	6.5	6.4	(6.1-6.9)	0.1	1.6
	12.4	12.2	(11.8-13.1)	0.2	1.4
May	6.5	6.3	(6.1-6.9)	0.1	1.5
	12.4	12.1	(11.8-13.1)	0.2	1.4
June	6.5	6.3	(6.1-6.9)	0.1	1.2
	12.4	12.1	(11.8-13.1)	0.1	1.1
July	6.5	6.3	(6.1-6.9)	0.1	1.7
	12.4	12.2	(11.8-13.1)	0.2	1.9
August	6.5	6.2	(6.1-6.9)	0.1	1.5
	12.4	12.0	(11.8-13.1)	0.2	1.4
September[3]	6.3	6.1	(5.9-7.0)	0.2	2.7
	12.2	12.0	(11.6-12.8)	0.3	2.7
October	6.3	6.2	(5.9-7.0)	0.1	1.4
	12.2	12.0	(11.6-12.8)	0.2	1.5
November	6.3	6.1	(5.9-7.0)	0.1	1.5
	12.2	12.0	(11.6-12.8)	0.2	1.5
December	6.3	6.1	(5.9-7.0)	0.1	1.0
	12.2	11.9	(11.6-12.8)	0.1	1.0
January 2017	6.3	6.1	(5.9-7.0)	0.1	1.2
	12.2	11.9	(11.6-12.8)	0.1	1.2
February	6.3	6.1	(5.9-7.0)	0.1	1.1
	12.2	11.9	(11.6-12.8)	0.1	1.0
March	6.3	6.0	(5.9-7.0)	0.1	1.6
	12.2	11.6	(11.6-12.8)	0.2	1.8

1 Standard deviation.

2 Coefficient of variation.

3 The target values changed in this month.

Table A30: HSE 2016: internal quality control results for urinary albumin

Month	Target value (mmol/L)	Assayed value (mmol/L)	Acceptable range (mmol/L)	SD[1] (mmol/L) achieved	CV[2] (%) achieved
January 2016	17.8	18.4	(16.2-19.4)	0.8	4.6
	140.6	141.9	(130.2-151.0)	2.8	2.0
February	17.8	18.8	(16.2-19.4)	1.1	5.8
	140.6	142.1	(130.2-151.0)	4.1	2.9
March	18.9	18.1	(16.3-21.5)	0.5	3.0
	141.4	139.8	(131.4-151.4)	2.7	1.9
April	18.9	17.9	(16.3-21.5)	0.5	2.8
	141.4	136.8	(131.4-151.4)	2.7	1.9
May	18.9	18.1	(16.3-21.5)	1.1	6.1
	141.4	138.8	(131.4-151.4)	4.8	3.4
June	18.9	19.2	(16.3-21.5)	1.1	5.7
	141.4	139.3	(131.4-151.4)	2.8	2.0
July	18.9	18.4	(16.3-21.5)	0.6	3.4
	141.4	140.1	(131.4-151.4)	3.0	2.1
August	18.9	18.7	(16.3-21.5)	0.7	3.5
	141.4	142.3	(131.4-151.4)	2.8	1.9
September	18.9	18.9	(16.3-21.5)	1.3	6.8
	141.4	137.9	(131.4-151.4)	3.2	2.3
October	18.9	18.3	(16.3-21.5)	0.5	2.7
	141.4	138.8	(131.4-151.4)	3.3	2.4
November	18.9	18.7	(16.3-21.5)	0.8	4.4
	141.4	142.1	(131.4-151.4)	2.2	1.6
December	18.9	17.4	(16.3-21.5)	0.7	3.9
	141.4	136.8	(131.4-151.4)	3.3	2.4
January 2017	18.9	18.2	(16.3-21.5)	1.0	5.5
	141.4	137.5	(131.4-151.4)	3.9	2.8
February	18.9	18.1	(16.3-21.5)	0.9	5.1
	141.4	140.5	(131.4-151.4)	6.4	4.5
March	18.9	17.6	(16.3-21.5)	0.7	3.7
	141.4	134.3	(131.4-151.4)	3.2	2.4

1 Standard deviation.
2 Coefficient of variation.

Table A31: HSE 2016: internal quality control results for saliva cotinine – LC-MS/MS: low calibration range

Month	Target value (ng/ml)	Assayed value (ng/ml)	SD[1] achieved	CV[2] (%) achieved
February 2016	40	40	0.3	0.78
	8	8	0.1	1.83
	0.3	0.3	0.01	1.87
March	40	38	1.7	4.50
	8	8	0.2	3.05
	0.3	0.3	0.01	3.52
April	40	39	1.0	2.59
	8	8	0.2	3.25
	0.3	0.3	0.00	1.48
May	40	41	1.6	4.05
	8	8	0.0	0.15
	0.3	0.3	0.00	1.59
June	40	39	0.8	2.00
	8	8	0.1	1.20
	0.3	0.3	0.01	3.56
July	40	40	0.2	0.39
	8	8	0.1	1.20
	0.3	0.3	0.00	1.15
August	40	41	0.0	0.02
	8	8	0.2	2.50
	0.3	0.4	0.01	2.22
September	40	39	0.5	1.31
	8	8	0.2	2.01
	0.3	0.3	0.01	3.38
October	40	38	1.0	2.56
	8	8	0.2	1.96
	0.3	0.3	0.02	5.13
November	40	38	0.6	1.51
	8	8	0.2	2.39
	0.3	0.3	0.00	0.94
December	40	35	1.1	3.10
	8	7	0.1	1.79
	0.3	0.3	0.00	1.16
January 2017	40	35	0.4	1.10
	8	7	0.1	1.71
	0.3	0.3	0.00	1.33
February	40	38	0.8	2.17
	8	8	0.2	2.12
	0.3	0.3	0.03	11.00
March	40	38	0.4	1.06
	8	8	0.2	2.70
	0.3	0.3	0.02	5.51

1 Standard deviation.
2 Coefficient of variation.

Table A32: HSE 2016: internal quality control results for saliva cotinine – LC-MS/MS: high calibration range

Month	Target value (ng/ml)	Assayed value (ng/ml)	SD[1] achieved	CV[2] (%) achieved
June 2016	500	464	3.3	0.72
	200	200	1.4	0.68
	3	3.0	0.11	3.85
August[3]	500	433	[3]	[3]
	200	188	[3]	[3]
	3	2.7	[3]	[3]
February 2017	500	491	3.7	0.75
	200	209	0.1	0.03
	3	3.1	0.05	1.66

1 Standard deviation.
2 Coefficient of variation.
3 As only one batch was tested in August 2016, standard deviation and coefficient of variation cannot be calculated.

Table A33: HSE 2016: external quality assessment results for total cholesterol

Month	Target value (mmol/L)[1]	Assayed value (mmol/L)	WEQAS SDI[2]
January 2016	5.1	5.1	0.18
	2.8	2.8	-0.30
	6.0	5.9	-0.22
	5.5	5.4	-0.35
February	5.9	5.9	-0.08
	4.6	4.7	0.61
	4.2	4.2	0.13
	3.1	3.1	0.01
March	4.6	4.5	-0.40
	3.4	3.4	-0.14
	3.7	3.6	-0.35
	5.9	5.8	-0.48
April	5.9	6.0	0.31
	4.2	4.2	0.13
	3.7	3.7	0.29
	3.4	3.4	-0.14
May	4.9	4.9	0.17
	3.6	3.6	-0.31
	5.9	5.9	0.00
June	4.7	4.7	0.14
	4.2	4.1	-0.42
	5.6	5.5	-0.39
	3.3	3.3	-0.23
July	5.6	5.5	-0.34
	3.7	3.6	-0.46
	5.6	5.4	-0.81
	4.7	4.6	-0.35
August	4.0	4.0	-0.09
	6.5	6.5	-0.08
	3.7	3.7	0.16
	5.6	5.5	-0.39
September	5.6	5.4	-0.81
	4.5	4.5	0.05
	3.7	3.6	-0.46
	4.0	3.9	-0.67
October	4.0	4.0	-0.09
	5.6	5.6	0.03
	7.1	7.1	0.14
	3.3	3.3	-0.23
November[3]	7.7[3]	7.7	-0.13
	5.7[3]	5.6	-0.31
	4.2[3]	4.1	-0.36
	3.5[3]	3.4	-0.49
December	5.6	5.6	-0.12
	4.9	4.8	-0.29
	4.4	4.4	-0.14

1 Reference values.
2 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.
3 Method-specific mean used, as no reference value was given for this sample.

Table A34: HSE 2016: external quality assessment results for HDL cholesterol

Month	Target value (mmol/L)[1]	Assayed value (mmol/L)	WEQAS SDI[2]
January 2016	2.2	2.2	-0.19
	1.1	1.1	0.03
	0.9	0.7	-3.72[3]
	1.0	0.9	-0.93
February	1.0	1.0	-0.21
	1.2	1.1	-0.72
	1.1	1.1	0.07
	1.1	1.1	0.43
March	1.2	1.1	-0.72
	1.1	1.1	0.44
	1.7	1.7	-0.31
	1.0	1.0	-0.21
April	1.0	0.9	-1.46
	1.1	1.1	0.07
	1.7	1.7	-0.31
	1.1	1.1	0.44
May	1.1	1.1	0.25
	0.8	0.8	0.58
	1.3	1.4	1.05
June	0.9	0.9	-0.24
	1.1	1.1	0.07
	1.6	1.6	0.35
	0.9	0.9	0.37
July	2.1	2.2	0.74
	0.9	0.9	-0.16
	1.6	1.6	0.34
	0.9	0.9	-0.24
August	1.1	1.1	0.26
	1.6	1.5	-1.02
	0.9	0.9	-0.16
	1.6	1.6	0.34
September	1.6	1.6	0.35
	2.0	2.1	0.85
	0.9	0.9	-0.16
	1.1	1.1	0.26
October	1.1	1.1	0.26
	1.6	1.5	-0.47
	1.9	1.8	-0.63
	0.9	0.9	0.38

1 Reference values.
2 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.
3 Although the HDL result was outside 2 SDI, the laboratory's investigation showed that this was not considered to be significant: all users of the Roche method were negatively biased against the CDC reference target for this particular sample, including three other analysers in use in the Newcastle department. Other EQA samples in this distribution gave satisfactory performance and IQC was satisfactory. This was likely to be an issue with this EQA sample, experienced by all users of the Roche method.
4 Method-specific mean used, as no reference value was given for this sample.

Table A34 (continued)

Month	Target value (mmol/L)[1]	Assayed value (mmol/L)	WEQAS SDI[2]
November[4]	0.6[4]	0.6	N/S
	1.1[4]	1.1	-0.38
	1.3[4]	1.3	-0.29
	1.0[4]	1.0	-0.38
December	0.7	0.7	-0.27
	1.2	1.2	0.06
	1.4	1.4	0.34
January 2016	0.7	0.6	N/S
	1.4	1.4	-0.29
	1.6	1.6	0.25
	1.5	1.5	0.07
February	1.5	1.5	0.07
	1.3	1.4	0.55
	1.3	1.3	-0.21
	1.6	1.6	0.25
March	1.6	1.6	0.24
	2.4	2.4	0.03
	1.5	1.5	0.07
	1.3	1.3	-0.20

1 Reference values.
2 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.
3 Although the HDL result was outside 2 SDI, the laboratory's investigation showed that this was not considered to be significant: all users of the Roche method were negatively biased against the CDC reference target for this particular sample, including three other analysers in use in the Newcastle department. Other EQA samples in this distribution gave satisfactory performance and IQC was satisfactory. This was likely to be an issue with this EQA sample, experienced by all users of the Roche method.
4 Method-specific mean used, as no reference value was given for this sample.

Table A35: HSE 2016: external quality assessment results for glycated haemoglobin (HbA_{1c})

Month	Target value (mmol/mol)[1]	Assayed value (mmol/mol)	WEQAS SDI[2]
January 2016	51[3]	51	-0.18
	53[3]	52	-0.31
February	32	33	0.51
	35	36	0.49
	46	47	0.45
March	53	55	0.82
	34	35	0.59
April	44	45	0.29
	35	37	1.02
	54	56	0.58
May	49	51	0.79
	37	38	0.38
June	35	38	1.51
	34	35	0.55
	30	30	-0.16
July	63	64	0.37
	36	36	-0.14
August	33	34	0.40
	37	41	1.90
	46	47	0.50
September	57	58	0.33
	35	37	0.78
October	42	43	0.26
	59	59	0.10
November	53	53	0.15
	31	32	0.31
December[3]	30[3]	30	0.04
	72[3]	72	0.08
	37[3]	37	-0.21
January 2017	54	54	-0.07
	32	32	0.10
February	53	53	-0.04
	31	29	-0.85
	44	43	-0.42
March	31	30	-0.58
	31	32	0.79

1 Reference values.
2 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.
3 Method-specific mean used, as no reference value was given for this sample.

Table A36: HSE 2016: external quality assessment results for aspartate aminotransferase (AST)

Month	Target value (IU/l)[1,2]	Assayed value (IU/l)	WEQAS SDI[3]
January 2016	243	248	0.18
	163	168	0.34
	489	502	0.14
	7	7	-0.14
February	7	9	1.63
	161	163	0.14
	160	164	0.30
	483	497	0.16
March	564	564	0.00
	316	314	-0.06
	82	81	-0.14
	399	397	-0.03
April	10	12	1.19
	240	240	0.00
	395	395	0.00
	474	476	0.02
May	83	86	0.47
	312	319	0.18
	314	325	0.28
	545	558	0.12
June	81	79	-0.33
	455	447	-0.10
	155	151	-0.30
	302	295	-0.19
July	531	510	-0.20
	227	219	-0.32
	8	8	-0.27
	375	359	-0.29
August	8	8	-0.03
	447	461	0.19
	155	159	0.27
	152	154	0.16
September	369	376	0.13
	78	80	0.39
	297	301	0.10
	521	527	0.06
October	77	77	-0.08
	369	374	0.09
	445	447	0.03
	222	224	0.07
November	214	195	-0.87
	220	218	-0.11
	8	5	-1.90
	522	526	0.04

1 Reference values.
2 Method-specific mean used for each month, as no reference value was given for each sample.
3 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.

Table A36 (continued)

Month	Target value (IU/l)[1,2]	Assayed value (IU/l)	WEQAS SDI[3]
December	77	75	-0.32
	365	367	0.05
	294	296	0.05
	516	520	0.04
January 2017	218	222	0.16
	147	150	0.27
	435	446	0.15
	7	6	-0.71
February	7	8	0.96
	148	149	0.05
	148	149	0.08
	435	440	0.07
March	506	507	0.01
	286	285	-0.02
	74	73	-0.26
	356	358	0.04

1 Reference values.
2 Method-specific mean used for each month, as no reference value was given for each sample.
3 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.

Table A37: HSE 2016: external quality assessment results for alanine aminotransferase (ALT)

Month	Target value (IU/l)[1,2]	Assayed value (IU/l)[3]	WEQAS SDI[4]
January 2016	220	221	0.09
	147	147	-0.01
	447	447	-0.01
	4	<4	NNR[5]
February	4	<4	NNR[5]
	134	129	-0.59
	145	144	-0.10
	444	451	0.17
March	512	503	-0.15
	290	279	-0.51
	74	70	-0.82
	367	360	-0.23
April	6	<4	NNR[5]
	187	187	0.01
	311	315	0.16
	373	375	0.06
May	64	61	-0.62
	245	243	-0.13
	246	244	-0.13
	430	425	-0.11
June	62	59	-0.61
	357	347	-0.32
	121	117	-0.54
	237	230	-0.45
July	422	391	-0.76
	180	166	-1.29
	5	<4	NNR[5]
	300	277	-1.02
August	5	<4	NNR[5]
	357	363	0.20
	120	121	0.10
	120	122	0.28
September	292	290	-0.07
	60	60	-0.05
	233	234	0.04
	410	413	0.09
October	62	63	0.23
	300	308	0.36
	360	366	0.21
	179	183	0.33

1 Reference values.
2 Method-specific mean used for each month, as no reference value was given for each sample.
3 The method used is sensitive down to 4mg/l only, therefore any results below 4mg/l are inaccurate and reported as <4.
4 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.
5 NNR: Non Numerical Results, meaning an SDI could not be calculated.

Table A37 (continued)

Month	Target value (IU/l)[1,2]	Assayed value (IU/l)[3]	WEQAS SDI[4]
November	170	154	-1.62
	177	177	0
	5	NNR[5]	NNR[5]
	418	433	0.38
December	62	61	-0.23
	301	302	0.04
	241	243	0.10
	424	429	0.13
January 17	178	178	-0.04
	120	121	0.18
	358	365	0.24
	5	<4	NNR[5]
February	5	5	0.04
	114	114	0.05
	120	119	-0.15
	358	358	0.01
March	413	416	0.07
	237	234	-0.18
	61	59	-0.41
	295	296	0.06

1 Reference values.
2 Method-specific mean used for each month, as no reference value was given for each sample.
3 The method used is sensitive down to 4mg/l only, therefore any results below 4mg/l are inaccurate and reported as <4.
4 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.
5 NNR: Non Numerical Results, meaning an SDI could not be calculated.

Table A38: HSE 2016: external quality assessment results for creatinine

Month	Target value (mmol/L)[1]	Assayed value (mmol/L)	WEQAS SDI[2]
January 2016	276	288	1.12
	199	207	1.05
	507	517	0.41
	44	47	0.52
February	44	48	0.72
	199	178	-2.70[3]
	199	205	0.80
	507	514	0.29
March	583	594	0.33
	352	360	0.54
	121	126	0.88
	429	436	0.35
April	74	78	0.68
	289	292	0.29
	433	447	0.69
	506	518	0.46
May[4]	148[4]	150	0.35
	372[4]	376	0.29
	368[4]	370	0.11
	595[4]	591	-0.14
June	144	150	0.87
	506	518	0.46
	220	223	0.39
	363	366	0.21
July	576	613	1.13
	289	306	1.49
	74	80	1.05
	433	462	1.43
August	74	76	0.30
	506	524	0.70
	217	223	0.72
	220	220	0.04
September	433	453	0.98
	144	153	1.33
	363	377	0.93
	576	600	0.74
October	144	151	1.02
	433	444	0.54
	506	516	0.38
	289	295	0.54

1 Reference values.
2 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.
3 The investigation showed that that although the creatinine result was outside 2 SDI, it was considered to be acceptable as overall SDI was 1.13 and IQC performance was satisfactory.
4 Method-specific mean used, as no reference value was given for this sample.

Table A38 (continued)

Month	Target value (mmol/L)[1]	Assayed value (mmol/L)	WEQAS SDI[2]
November	285	297	1.06
	286	300	1.21
	74	79	0.86
	576	595	0.57
December	144	151	1.03
	433	451	0.88
	363	371	0.54
	576	597	0.64
January 2017	289	303	1.23
	220	231	1.31
	506	531	0.96
	74	80	1.05
February	74	77	0.49
	218	205	-1.59
	220	230	1.20
	506	535	1.12
March	576	599	0.70
	363	376	0.86
	144	153	1.33
	433	450	0.83

1 Reference values.
2 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.
3 The investigation showed that that although the creatinine result was outside 2 SDI, it was considered to be acceptable as overall SDI was 1.13 and IQC performance was satisfactory.
4 Method-specific mean used, as no reference value was given for this sample.

Table A39: HSE 2016: external quality assessment results for Cystatin C

Month	Target value (mg/l)[1,2]	Assayed value (mg/l)	% bias
March 2016	0.76	0.81	6.6
	0.77	0.8	3.9
	0.76	0.81	6.6
April	0.76	0.74	-2.6
	0.77	0.75	-2.6
	0.76	0.76	0.0
May	0.76	0.71	-6.6
	0.77	0.74	-3.9
	0.77	0.73	-5.2
June	0.76	0.77	1.3
	0.76	0.78	2.6
	0.76	0.78	2.6
July	0.62	0.66	6.5
	0.49	0.55	12.2
	0.38	0.43	13.2
August	0.76	0.77	1.3
	0.77	0.77	0.0
	0.58	0.62	6.9
September	0.76	0.77	1.3
	0.75	0.77	2.7
	0.73	0.62	-15.1
October	0.53	0.56	5.7
	0.6	0.62	3.3
	0.78	0.81	3.8
November	0.79	0.79	0.0
	0.78	0.8	2.6
	0.77	0.78	1.3
December[3]	[3]	[3]	[3]
	[3]	[3]	[3]
	[3]	[3]	[3]
January 2017	0.88	0.9	2.3
	4.57	5.07	10.9
	2.78	2.96	6.5
February	0.71	0.65	-8.5
	0.83	0.85	2.4
	0.94	1.04	10.6
March	0.63	0.67	6.3
	1.09	1.13	3.9
	3.44	3.78	9.9

1 Reference values.
2 Method-specific mean used, as no reference value was given for this sample.
3 No EQA samples were distributed this month.

Table A40: HSE 2016: external quality assessment results for haemoglobin

Month	Target value (g/L)[1]	Assayed value (g/L)	Analytical performance score[2]
January 2016	112	113	
	106	108	31.0
February	120	122	
	121	123	38.4
March	76	77	
	100	101	36.3
April	112	113	
	109	110	30.8
May	113	113	
	185	186	19.6
June	106	108	
	112	114	19.5
July	68	68	
	145	147	26.8
August	106	107	
	140	142	40.0
September	129	130	
	184	188	33.9
October	116	116	
	116	116	29.0
November	76	77	
	141	142	21.7
December	180	182	
	115	117	20.7
January 2017	112	112	
	90	90	20.5
February	113	112	
	115	114	20.7
March	75	73	
	125	125	20.0

1 Reference values.
2 An analytical Performance Score >100 is deemed to be unsatisfactory. Details of how this is calculated are provided in Section 9.4.1.

Table A41: HSE 2016: external quality assessment results for platelets

Month	Target value ($x10^9$/L)[1]	Assayed value ($x10^9$/L)	Analytical performance score[2]
January 2016	214	207	
	86	85	11.1
February	20	23	
	222	215	26.6
March	163	160	
	437	444	27.2
April	48	49	
	247	248	25.1
May	952	974	
	215	200	16.2
June	347	373	
	227	241	13.7
July	88	93	
	861	891	24.1
August	124	129	
	152	163	35.6
September	156	152	
	177	182	28.9
October	11	12	
	222	230	29.7
November	115	120	
	841	866	24.1
December	220	228	
	230	236	22.1
January 2017	216	227	
	112	115	16.8
February	22	23	
	228	234	16.2
March	196	186	
	858	885	17.4

1 Reference values.
2 An analytical Performance Score >100 is deemed to be unsatisfactory. Details of how this is calculated are provided in Section 9.4.1.

Table A42: HSE 2016: external quality assessment results for urinary sodium

Month	Target value (mmol/L)[1,2]	Assayed value (mmol/L)	WEQAS SDI[3]
January 2016	53	54	0.50
	48	48	0.16
	62	64	0.58
February	110	110	-0.05
	79	77	-0.72
	53	50	-1.09
March	36	36	-0.05
	80	80	0.11
	74	74	0.13
April	142	143	0.31
	36	37	0.36
	77	79	0.68
May	54	55	0.43
	96	98	0.59
	33	35	0.93
June	70	69	-0.38
	105	106	0.43
	84	86	0.56
July	77	77	-0.01
	49	48	-0.43
	37	34	-1.15
August	28	28	0.22
	66	68	0.57
	149	150	0.27
September	87	88	0.27
	41	41	0.11
	112	117	1.41
October	169	174	1.07
	51	53	0.72
	68	69	0.39
November	115	115	-0.03
	68	68	-0.06
	38	37	-0.33
December	73	72	-0.32
	71	70	-0.45
	36	34	-1.05
January 2017	36	35	-0.53
	79	82	1.00
	71	72	0.38
February	133	134	0.23
	96	98	0.53
	20	20	0.04
March	60	61	0.25
	138	139	0.22
	134	135	0.37

1 Reference values.
2 Method-specific mean used for each month, as no reference value was given for each sample
3 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.

Table A43: HSE 2016: external quality assessment results for urinary potassium

Month	Target value (mmol/L)[1,2]	Assayed value (mmol/L)[3]	WEQAS SDI[4,5]
January 2016	34	34	-0.05
	43	42	-0.42
	41	42	0.53
February	76	80	1.36
	41	43	1.22
	34	35	0.91
March	48	49	0.66
	73	76	1.21
	52	54	1.22
April	92	96	0.87
	48	46	-1.06
	37	37	0.25
May	30	32	1.42
	81	82	0.45
	44	45	0.65
June	23	23	0.24
	110	>100	NNR[5]
	34	35	0.84
July	35	35	0.21
	19	19	0.06
	36	37	0.84
August	40	40	0.26
	51	52	0.83
	85	82	-0.83
September	46	47	0.81
	29	30	0.66
	71	74	1.18
October	32	33	0.55
	20	20	0.42
	72	73	0.43
November	50	52	0.95
	72	74	0.83
	33	34	0.79
December	28	29	1.18
	46	48	1.47
	40	42	1.46
January 2017	40	40	-0.07
	21	22	0.64
	46	45	-0.46
February	39	40	0.56
	25	25	-0.07
	33	33	0.44
March	39	40	0.56
	76	78	0.86
	39	40	0.63

1 Reference values.
2 Method-specific mean used for each month, as no reference value was given for each sample.
3 The method used is linear up to 100mmol/l only, therefore any results above 100mmol/l are inaccurate and reported as >100.
4 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.
5 NNR: Non Numerical Results, meaning an SDI could not be calculated.

Table A44: HSE 2016: external quality assessment results for urinary creatinine

Month	Target value (mmol/L)[1,2]	Assayed value (mmol/L)	WEQAS SDI[3]
January 2016	6.2	6.5	0.79
	7.6	8.0	0.92
	8.1	8.6	0.97
February	7.5	7.6	0.29
	8.2	8.2	0.03
	6.3	6.3	0.12
March	4.1	4.1	-0.09
	6.0	6.1	0.24
	8.3	8.3	-0.05
April	12.4	12.2	-0.32
	4.1	4.1	-0.07
	5.5	5.4	-0.21
May	4.6	4.7	0.24
	6.6	6.6	-0.06
	4.6	4.6	0.03
June	6.3	6.4	0.17
	4.9	5.0	0.19
	7.6	7.6	0.07
July	7.5	7.6	0.29
	3.4	3.5	0.39
	4.4	4.6	0.63
August	5.4	5.5	0.32
	3.9	4.0	0.27
	10.8	11.0	0.32
September	11.2	10.9	-0.41
	3.5	3.5	-0.02
	8.0	7.8	-0.36
October	16.3	16.3	0.00
	6.6	6.6	0.08
	10.6	10.7	0.21
November	4.8	4.9	0.28
	10.6	10.7	0.11
	4.1	4.1	0.11
December	8.3	8.4	0.26
	6.1	6.2	0.18
	4.5	4.6	0.36
January 2017	4.5	4.7	0.65
	4.6	4.7	0.30
	6.1	6.3	0.52
February	10.3	10.5	0.41
	6.8	6.9	0.33
	3.9	4.0	0.57
March	6.3	6.5	0.66
	12.9	13.2	0.43
	10.3	10.6	0.46

1 Reference values.
2 Method-specific mean used for each month, as no reference value was given for each sample
3 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.

Table A45: HSE 2016: external quality assessment results for urinary albumin

Month	Target value (mg/l)[1,2]	Assayed value (mg/l)[3]	WEQAS SDI[4,5]
January 2016	3	<4	NNR[5]
	4	4	0.04
	4	<4	NNR[5]
February	863	820	-0.50
	419	425	0.13
	3	<4	NNR[5]
March	2	<4	NNR[5]
	225	217	-0.31
	509	515	0.12
April	246	222	-0.90
	3	<4	NNR[5]
	627	601	-0.40
May	242	235	-0.28
	556	558	0.03
	3	<4	NNR[5]
June	3	<4	NNR[5]
	548	538	-0.17
	523	529	0.12
July	3	<4	NNR[5]
	6	6	-0.18
	3	<4	NNR[5]
August	2	<4	NNR[5]
	570	570	0.00
	237	230	-0.26
September	398	426	0.67
	2	<4	NNR[5]
	384	383	-0.01
October	822	821	-0.01
	1	<4	NNR[5]
	186	176	-0.47
November	554	549	-0.09
	187	177	-0.46
	2	<4	NNR[5]
December	3	<4	NNR[5]
	550	548	-0.04
	261	263	0.08
January 2017	262	263	0.03
	2	<4	NNR[5]
	551	546	-0.09
February	3	<4	NNR[5]
	337	327	-0.27
	312	308	-0.11
March	547	506	-0.73
	289	266	-0.74
	3	<4	NNR[5]

1 Reference values.
2 Method-specific mean used for each month, as no reference value was given for each sample
3 The method used is sensitive down to 4mg/l only, therefore any results below 4mg/l are inaccurate and reported as <4.
4 Standard Deviation Index (SDI) of the Welsh External Quality Assessment Schemes (WEQAS). The SDI is an index of total error, including components of inaccuracy and imprecision. A score between -1 and 1 SDI is good, between 1 and 2 or between -1 and -2 SDI is acceptable.
5 NNR: Non Numerical Results, meaning an SDI could not be calculated

Appendix B: Glossary

This glossary explains terms used in the HSE 2016 reports.

Acute sickness

A condition or illness that reduces a participant's ability to carry out day-to-day activities.

Age standardisation

Age standardisation has been used in order to enable different groups to be compared after adjusting for the effects of any differences in their age distributions.

When different sub-groups are compared in respect of a variable on which age has an important influence, any differences in age distributions between these sub-groups are likely to affect the observed differences in the proportions of interest.

Age standardisation was carried out for adults aged 16 and over, using the direct standardisation method. The standard population to which the age distribution of sub-groups was adjusted was the mid-year 2015 population estimates for England. All age standardisation has been undertaken separately within each sex.

Age standardisation was carried out using the age groups 16 to 24, 25 to 34, 35 to 44, 45 to 54, 55 to 64, 65 to 74 and 75 and over.

Most tables present age-standardised data. For region analysis, both observed and standardised data are provided, so that those who need results for a single region can look at the observed estimates. However, for any comparisons across regions, the age-standardised estimates are recommended, and these are the results commented on in the report.

Alanine aminotransferase (ALT)

A marker of early-stage liver disease, measured from non-fasting blood samples. The reference range for normal was 0-40 IU/L for men and women. Raised levels were defined for this report as more than 1.5 times the upper limit of normal, and levels of ALT over 60 IU/L (1.5 x 40 IU/L) were considered abnormal.

Anthropometric measurements

See **Body mass index (BMI), Waist circumference**.

Albumin

This is excreted in urine and is used to measure kidney function. See also **Albuminuria, Creatinine, Urine analytes.**

Albuminuria

The presence of albumin in the urine was assessed using the albumin:creatinine ratio (ACR), which correlates well with 24 hour urinary albumin excretion. Non-sex-specific thresholds were used, in accordance with NICE guidelines. Up to 3mg/mmol is considered normal. Abnormal levels are split into two groups. Micro-albuminuria is defined as small, though raised, excretion of albumin (3mg/mmol to 30mg/mmol). Macro-albuminuria is defined as more than 30mg/mmol. This differs from the previous HSE report in 2010, when sex-specific references were used to define normal and micro-albuminuria. See also **Albumin**, **Creatinine**, **Urine analytes**.

Reference: NICE Clinical Guidance [CG182] . *Chronic kidney disease in adults: assessment and management.* Nice, 2015 https://www.nice.org.uk/guidance/cg182/chapter/1-recommendations

Arithmetic mean

See **Mean**.

Aspartate aminotransferase (AST)

A marker of early-stage liver disease, measured from non-fasting blood samples. The reference range for normal was 0-40 IU/L for men and women. Raised levels were defined for this report as more than 1.5 times the upper limit of normal, and levels of AST over 60 IU/L (1.5 x 40 IU/L) were considered abnormal.

Blood analytes

Analysis of non fasting blood samples. See **Aspartate aminotransferase (AST)**, **Alanine aminotransferase (ALT)**, **Creatinine**, **Cystatin C**, **Cholesterol (total and HDL)**, **Glycated haemoglobin (HbA_{1C})**.

Blood pressure

Systolic (SBP) and diastolic (DBP) blood pressure was measured in participants aged 5 and over using a standard method (see Appendix B for measurement protocol). In adults, hypertension is defined in this survey as SBP at least 140mmHg or DBP at least 90mmHg, or on medication prescribed to control hypertension. See also **Diastolic blood pressure, Systolic blood pressure**.

Body mass index (BMI)

Weight in kilograms divided by the square of height in metres.

Adults (aged 16 and over) can be classified into the following BMI groups:

BMI (kg/m^2)	*Description*
Less than 18.5	Underweight

18.5 to less than 25	Normal
25 to less than 30	Overweight
30 or more	Obese
40 or more	Morbidly obese

In children, although the BMI calculation method is the same, there are no fixed BMI cut-off points defining overweight and obesity. Instead, overweight and obesity may be defined using several other methods, including age and sex specific BMI cut-off points or BMI centile cut-offs based on reference populations. In this report, overweight and obesity prevalence for children have been estimated using the 85th and 95th BMI centiles of the 1990 UK reference curves as cut-offs respectively for overweight and obesity.

Centile

Centiles are values of a distribution that divide it into 100 equal parts. For example, the 20th centile is the value of a distribution where 20% of the cases have values at or below the 20th centile and 80% have values above it. The 50th centile is the median. See also **Quintile, Tertile.**

Cholesterol (total and HDL)

Measured in non-fasting blood samples. Cholesterol is a fat-like substance (lipid) that is present in cell membranes and is a precursor of bile acids and steroid hormones. Cholesterol is essential for the body in small amounts. It is made in the liver and some is obtained from the diet. Serum total cholesterol concentration is positively associated with the risk of coronary heart disease (CHD). In the 2011 HSE report, the most recent to examine blood analytes, the definition of raised total cholesterol used the NICE guidance ‘audit level’ of 5.0 mmol/L or above. For those at high risk of cardiovascular disease (CVD), or those with established CVD, the target of less than 4.0mmol/L was also examined.

In a normal individual, high density lipoprotein (HDL) constitutes approximately 20-30% of serum total cholesterol. HDL cholesterol carries cholesterol away from the arteries back to the liver and is considered to be beneficial or ‘good’ cholesterol. Studies have demonstrated a strong direct relationship between coronary heart disease and low HDL cholesterol. In the 2011 HSE report HDL cholesterol was defined as low at a level of less than 1.0 mmol/L.

Confidence interval

All such survey estimates are subject to some degree of error. The confidence interval (CI) is calculated from the sampling error, which is a measure of how such a survey estimate would vary if it were calculated for many different samples. If the survey was repeated many times, such a 95% CI would contain the true value 95% of the time. A CI includes information about the uncertainty associated with an estimate.

For example the survey estimate might be 24% with a 95% confidence interval of (22% to 26%). 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.

Confidence intervals are quoted for key statistics within this report and are also shown in more detail in the Excel tables accompanying the Methods report. 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 hence the more precise the estimate.

See also **P-value, Statistical significance.**

Cotinine

Cotinine is a metabolite of nicotine. It is one of several biological markers that are indicators of smoking. In this survey, it was measured in saliva. It has a half-life in the body of between 16 and 20 hours, which means that it will detect regular smoking (or other tobacco use such as chewing) but may not detect occasional use if the last occasion was several days ago. Anyone with a salivary cotinine level of 15 nanograms per millilitre or more is highly likely to be a tobacco user; more recently a threshold of 12 nanograms per millilitre has been taken as indicative of personal tobacco use; survey participants who report that they do not smoke are described as cotinine-validated non-smokers if their salivary cotinine levels are below this threshold. See also **Half-life.**

Creatinine

This is excreted in urine and is used to measure kidney function. See also **Cystatin C, Estimated glomerular filtration rate (eGFR), Urine analytes.**

Cystatin C

This is excreted in urine and is used to measure kidney function. See also **Creatinine, Estimated glomerular filtration rate (eGFR), Urine analytes.**

Diastolic blood pressure

When measuring blood pressure, the diastolic arterial pressure is the lowest pressure at the resting phase of the cardiac cycle. See also **Blood pressure, Systolic blood pressure.**

Estimated glomerular filtration rate (eGFR)

An eGFR can be calculated using either serum creatinine or cystatin C (referred to as $eGFR_{creat}$ and $eGFR_{cys}$ respectively). $eGFR_{creat}$ is generally used as the measure to assess renal function, however under certain conditions, it is recommended to use $eGFR_{cys}$.

The Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation was used to calculate the eGFR. This equation is considered more accurate than the Modification of Diet in Renal Diseases (MDRD) equation, which may over-diagnose chronic kidney disease. The MDRD equation was used in the previous kidney disease and renal function chapters using HSE 2009-2010 data, as it was being used widely at the time. The results for HSE 2016 are therefore not directly comparable with those in the HSE 2009 or 2010 reports.

References: NICE Clinical Guidance [CG182] . *Chronic kidney disease in adults: assessment and management.* Nice, 2015 https://www.nice.org.uk/guidance/cg182/chapter/1-recommendations

Björk, J, Grubb, A, Larsson, A et al. *Accuracy of GFR estimating equations combining standardized cystatin C and creatinine assays: a cross-sectional study in Sweden.* Clin Chem Lab Med 2015;**53**:403-14.

Equivalised household income

Income has been included in the Health Survey for England (HSE) series since 1997. Making precise estimates of household income, as is done for example in the Family Resources Survey, requires far more interview time than was available in the HSE. Household income was thus established by means of a card (see Documents at http://digital.nhs.uk/pubs/hse2016) on which banded incomes were presented. Information was obtained from the household reference person (HRP) or their partner. Initially they were asked to state their own (HRP and partner) aggregate gross income, and were then asked to estimate the total household income including that of any other persons in the household. Household income can be used as an analysis variable, but there is interest in using measures of equivalised income that adjust income to take account of the number of persons in the household. Methods of doing this vary in detail: the starting point is usually an exact estimate of net income, rather than the banded estimate of gross income obtained in the HSE. The method used in the present report was as follows. It utilises the widely used McClemens scoring system, described below.

A score was allocated to each household member, and these were added together to produce an overall household McClemens score. Household members were given scores as follows:

First adult (HRP)	0.61
Spouse/partner of HRP	0.39
Other second adult	0.46
Third adult	0.42
Subsequent adults	0.36
Dependant aged 0 to 1	0.09
Dependant aged 2 to 4	0.18
Dependant aged 5 to 7	0.21
Dependant aged 8 to 10	0.23
Dependant aged 11 to 12	0.25

Dependant aged 13 to 15	0.27
Dependant aged 16+	0.36

The equivalised income was derived as the annual household income divided by the McClemens score. This equivalised annual household income was attributed to all members of the household, including children.

Households were ranked by equivalised income, and quintiles q1 to q5 were identified. Because income was obtained in banded form, there were clumps of households with the same income spanning the quintiles. It was decided not to split clumps but to define the quintiles as 'households with equivalised income up to q1', 'over q1 up to q2' etc.

All individuals in each household were allocated to the equivalised household income quintile to which their household had been allocated. Insofar as the mean number of persons per household may vary between quintiles, the numbers in the quintiles will be unequal. Inequalities in numbers are also introduced by the clumping referred to above, and by the fact that in any sub-group analysed the proportionate distribution across quintiles will differ from that of the total sample.

Reference: McClemens D. *Equivalence scales for children*. Journal of Public Economics 1977;8:191-210

General Health Questionnaire (GHQ-12)

The General Health Questionnaire (GHQ-12) is a scale designed to detect possible psychiatric morbidity in the general population, and was administered to participants aged 13 and over. The questionnaire concentrates on the broader components of psychological morbidity and consists of twelve items measuring general levels of happiness; depression and anxiety; sleep disturbance; and ability to cope over the last few weeks. The twelve items are rated on a four-point response scale, where a score of 0 is given to responses such as that the symptom is present 'not at all' or 'no more than usual' and a score of 1 is given to responses such as 'rather more than usual' or 'much more than usual'. A GHQ-12 score of 4 or more is referred to as a 'high GHQ-12 score', indicating probable psychological disturbance or mental ill health.

Reference: Goldberg D, Williams PA. *User's Guide to the General Health Questionnaire.* NFER-NELSON, 1988.

Glycated haemoglobin (HbA_{1C})

Measured from non fasting blood samples. The percentage of glycated haemoglobin is the percentage of haemoglobin in the circulation to which glucose is bound. Glycated haemoglobin (HbA_{1c}) concentration is an indicator of average blood glucose concentration over the previous three months and is therefore used to assess glycaemic control in people with diabetes. It is used as a diagnostic or screening tool for diabetes. Diabetic patients with elevated glycated haemoglobin are at increased risk of microvascular events (complications from diseased small blood vessels, such as eye and kidney problems) and macrovascular events (complications from diseased arteries, such as coronary heart disease including angina, heart attacks and heart failure). In the 2011 HSE report, the most recent where blood analytes were examined, raised glycated haemoglobin was taken as 48mmol/mol (6.5%) or above.

Half-life

Half-life is the time taken for the concentration or amount of a substance in the body to reduce by half. See **Cotinine**.

High blood pressure

See **Blood pressure**.

Household

A household is defined as one person or a group of people (not necessarily related) living at the same address who share cooking facilities AND share a living room or sitting room or dining area.

Household Reference Person

The household reference person (HRP) is defined as the householder (a person in whose name the property is owned or rented); if there is more than one such person in a household, it is defined as the person with the highest income. If there is more than one householder with equal income, then the household reference person is the oldest.

Hypertension

See **Blood pressure**.

Income

See **Equivalised household income**.

Index of Multiple Deprivation

The Index of Multiple Deprivation 2015 combines a number of indicators, chosen to cover a range of economic, social and housing issues, into a single deprivation score for each small area in England. This allows each area to be ranked relative to others according to their level of deprivation. Seven distinct domains have been identified in the English Indices of Deprivation:

- Income Deprivation
- Employment Deprivation
- Health Deprivation and Disability
- Education, Skills and Training Deprivation
- Barriers to Housing and Services
- Living Environment Deprivation

- Crime.

Individual domains can be used in isolation as measures of each specific form of deprivation, as well as using the single overall Index of Multiple Deprivation (IMD).

The Index is used widely to analyse patterns of deprivation, identify areas that would benefit from special initiatives or programmes and as a tool to determine eligibility for specific funding streams. In HSE reports quintiles of IMD are used to give an area-level measure of socio-economic status, as opposed to household-level measures such as equivalised household income.

Reference: Department for Communities and Local Government. *The English Indices of Deprivation 2015.* London, 2015. https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015

Limiting longstanding illness

See **Longstanding illness**.

Lipids

Fats in blood, such as cholesterol.

Longstanding illness

Longstanding illness is defined as ‘any physical or mental health condition or illness lasting or expected to last 12 months or more’. This definition changed in 2012; in previous years the question referred to ‘an illness, disability or infirmity… that has troubled you over a period of time or that is likely to affect you over a period of time’. This change was to bring the HSE questions in line with harmonised disability questions for social surveys. The harmonised standards are designed to be consistent with a conceptual framework of disability, taking account of the needs of national and European administrations for data continuity and the definitions and guidelines contained in UK and EU legislation, including the Equality Act and the EU-SILC (EU-Statistics on Income and Living Conditions) regulation.

Longstanding illnesses were coded into categories defined in the International Classification of Diseases (ICD 10), but it should be noted that the ICD is used mostly to classify conditions according to the cause, whereas HSE classifies according to the reported symptoms.

A longstanding illness is defined as limiting if the participant reports that it reduces their ability to carry out day-to-day activities.

Mean

Means in this report are arithmetic means (the sum of the values for cases divided by the number of cases) unless stated otherwise. See also **Standard error of the mean.**

Median

The value of a distribution which divides it into two equal parts such that half the cases have values below the median and half the cases have values above the median. See also **Centile**.

Morbid obesity

See **Body mass index**.

NS-SEC

The National Statistics Socio-economic Classification (NS-SEC) was introduced from April 2001, and replaced Social Class based on occupation and Socio-economic Groups (SEG). NS-SEC is a social classification system that attempts to classify groups on the basis of employment relations, based on characteristics such as career prospects, autonomy, mode of payment and period of notice. Full details can be found in 'The National Statistics Socio-economic Classification User Manual 2002', ONS 2002.

There are fourteen operational categories representing different groups of occupations and a further three 'residual' categories that are excluded when the classification is collapsed into its analytical classes: full-time students, those whose occupation is not stated or inadequately described, and those who are not classifiable for some other reason. The classification excludes those who have never worked and the long term unemployed, in addition to the groups mentioned above.

In 2016, NS-SEC has been used to calculate non-response weights for individuals (see Section 7 of this volume).

Obesity

See **Body mass index**.

ONS well-being measures

As part of its programme to measure national well-being, the Office for National Statistics (ONS) developed four questions, which have been used on surveys since 2011. One of these was used in the 2016 HSE questionnaire:

- Overall, how satisfied are you with your life nowadays?

Each of the ONS questions are scored on a scale where 0 indicates 'not at all' and 10 indicates 'completely'. As a result, higher scores for the first three measures indicate more positive responses, whereas for the measure of anxiety, a higher score indicates greater anxiety.

These questions have been validated for use with adults and children and in a variety of modes.

Reference: ONS. *Personal well-being user guidance.* ONS, 2016. https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/methodologies/personalwellbeingsurveyuserguide

Overweight

See **Body mass index**.

Percentile

An alternative term for **Centile**.

Physical activity

In 2016, information on adults' physical activity was collected by self-report.

Aerobic activity was classified into three categories: meets recommendations, some activity, and low activity. For adults aged between 19 and 65, these categories are defined as follows:

Meets aerobic / MVPA guidelines	Reported 150 minutes per week of moderate physical activity (MPA), or 75 minutes per week of vigorous physical activity (VPA), or an equivalent combination of the two.
Some activity	Reported 60-149 minutes per week of MPA, or 30-74 minutes/week of VPA, or an equivalent combination of these.
Low activity	Reported 30-59 minutes per week of MPA, 15-29 minutes/week of VPA, or an equivalent combination of these.
Inactive	Reported less than 30 minutes per week of MPA, less than 15 minutes per week of VPA, or an equivalent combination of these.

Sports and exercises were grouped into light, moderate or vigorous intensity categories based on the MET (metabolic equivalent) intensity. MET is a unit used to estimate the intensity of physical activity. It is based on the amount of oxygen consumed during physical activity. The baseline energy used by the body at rest in one minute is defined as 1 MET. Thus an activity with a MET value of 1.5 uses 50% more energy than baseline energy expenditure. MET levels can be linked to specific activities in various settings. Moderate physical activity (MPA) includes activities with estimated intensity levels of 3 to 6 METs; vigorous physical activities (VPA) are those with estimated intensity levels of 6 METs or higher.

Examples of moderate physical activity include brisk walking, athletics, cricket, netball, cycling, aerobics or swimming. Vigorous activity includes for example football, hockey

or wheelchair basketball; or activities such as cycling or swimming if they make the individual breathless or sweaty.

Reference: Sports and exercise activities – intensity classification, based on Ainsworth BE, Haskell WL, Herrmann SD, et al. 2011 *Compendium of Physical Activities: a second update of codes and MET values*. Med Sci Sports Exerc 2011;**43**:1575-1581.

P-value

A p -value is the probability of the observed result occurring due to chance alone. A p-value of less than 5% is conventionally taken to indicate a statistically significant result ($p<0.05$). It should be noted that the p-value is dependent on the sample size, so that with large samples differences or associations which are very small may still be statistically significant. Results should therefore be assessed for their importance on the magnitude of the differences or associations as well as on the p-value itself. See also **Confidence interval**, **Statistical significance**.

Quintile

A quintile is a statistical value of a data set that represents one fifth of a given population. Quintiles are used to create cut-off points to divide a distribution into five equal parts, i.e. the first quintile represents the lowest fifth of the data (0 to 20%), the next quintile represents 21% to 40% etc. See also **Centile, Tertile**.

Region

The regions used by the HSE since 2013 are based on the nine former Government Office Regions: North East, North West, Yorkshire and the Humber, East Midlands, West Midlands, East of England, London, South East and South West. This definition was also used as the regional base for sampling and weighting in HSE 2009. Between 2010 and 2013, the HSE used Strategic Health Authorities for sampling, weighting and reporting. These were co-terminus with the Government Office Regions, except that the South East was split into South Central and South East Coast. Following the abolition of SHAs from April 2012, the sampling from 2013 onwards is based on the former GORs, now referred to as ‘regions’.

Significance

See **Statistical significance**.

Standard error of the mean

The standard error (SE) is a measure of the degree of sampling error associated with a mean. It quantifies the degree to which a mean is likely to vary over repeated samples of the same size: the larger the sample, the smaller the standard error for a given measure. See **Mean**.

Standardisation

In this report, standardisation refers to standardisation (or 'adjustment') by age. See **Age standardisation**.

Statistical significance

The statistical significance of an estimate is based on the probability of its occurring due to chance alone. Within this report, estimates are assumed to be statistically significant if they have a p-value of less than 0.05 or less, that is a probability of occurring by chance below 5%. Statistical significance does not imply substantive importance; differences that are statistically significant are not necessarily meaningful or relevant. See also **Confidence interval**, **P-value**.

Systolic blood pressure

When measuring blood pressure, the systolic arterial pressure is defined as the peak pressure in the arteries, which occurs near the beginning of the cardiac cycle. See also **Blood pressure**, **Diastolic blood pressure**.

Tertile

A tertile is a statistical value of a data set that represents one third of a given population. Tertiles are used to create cut-off points to divide a distribution into three equal parts, i.e. the first tertile represents the lowest third of the data (0 to 33%), the middle tertile represents 34% to 67% etc. See also **Centile**, **Quintile**.

Unit of alcohol

Alcohol consumption is reported in terms of units of alcohol; one unit of alcohol is 10ml by volume of pure alcohol. Participants are asked about the alcoholic drinks they have had, and these are converted to units. This conversion was revised in 2006 and 2007; see the 2007 report, Volume 1 Chapter 7, for full details of the revised method and the conversion of drinks to units. (www.hscic.gov.uk/pubs/hse07healthylifestyles).

Urine analytes

Analysis of spot urine samples. See **Albumin**, **Creatinine**.

Waist circumference

Waist circumference is a measure of deposition of abdominal fat i.e. central obesity. A raised waist circumference has been taken to be greater than 102cm in men and greater than 88cm in women. According to NICE guidelines, for men, waist circumference of less than 94cm is defined as 'low' waist measurement, between 94cm and 102cm is 'high' and more than 102cm is 'very high'. For women, waist

circumference of less than 80cm is defined as ‘low’ waist measurement, between 80cm and 88cm is ‘high’ and more than 88cm is ‘very high’. These waist circumference categories, in combination with BMI, have been used to identify categories of health risk.

References: Molarius A, Seidell JC. *Selection of anthropometric indicators for classification of abdominal fatness - a critical review.* Int J Obes 1998; 22:719-727

National Institute of Health and Clinical Excellence. *Obesity: the prevention, identification, assessment and management of overweight and obesity in adults and children.* www.nice.org.uk/nicemedia/pdf/cg43niceguideline.pdf

Warwick-Edinburgh Mental Well-being Scale (WEMWBS)

The Warwick-Edinburgh Mental Well-being Scale (WEMWBS) was developed by researchers at the Universities of Warwick and Edinburgh, with funding provided by NHS Health Scotland, to enable the measurement of mental well-being of adults in the UK. WEMWBS is a 14 item scale of mental well-being covering subjective well-being and psychological functioning, in which all items are worded positively and address aspects of positive mental health. The scale is scored by summing responses to each item answered on a 1 to 5 Likert scale. The minimum scale score is 14 and the maximum is 70. WEMWBS has been validated for use in the UK with those aged 16 and over. Validation involved both student and general population samples, and focus groups.

Appendix C: Acknowledgements

We wish to thank, first of all, all those who welcomed interviewers and nurses into their homes and gave up their time to be interviewed. We should also like to acknowledge the commitment and professionalism of the interviewers and nurses who worked on the survey throughout the year, on whom the survey's success depends.

We should like to thank all those colleagues who contributed to the survey. In particular we would like to thank:

- the authors and contributors to this report: Laura Brown, Anne Conolly, Kate Earl, Sue Faulding, Alison Moody, Sarah Morris, Linda Ng Fat, Paul Roderick, Charlotte Saunders, Shaun Scholes, Annemijn Sondaal
- Laura Brown, Suzanne Hill and Si Ning Yeoh for preparing and managing the data
- the programmers, Sandra Beeson, and Sven Sjodin
- other research colleagues, including Sally Bridges, Alina Carabat, Rachel Craig, Emma Fenn, Victoria Hawkins, David Hussey, Hollie Jones, Klaudia Lubian, Franziska Marcheselli and Varunie Yaxley
- Field staff, especially Chris Bryan, Sue Roche, Josephine Taylor and the Field Area Managers.

We should also like to express our thanks to Linda Wilson, Julie Fletcher, Julie Day and the staff at the Department of Blood Sciences at the Royal Victoria Infirmary, Newcastle University Hospitals Trust; to Mira Doig and the staff at ABS Laboratories, Welwyn Garden City, for their helpfulness and efficiency, and to Barbara Carter-Szatynska for administrative support to the survey.

Last, but certainly not least, we wish to express our appreciation of the work of many staff at NHS Digital (formerly the Health and Social Care Information Centre) at all stages of the project, and in particular the contributions made by Vicky Cooper, Robert Dobson, Adam Langdon, Clare McConnell, Alison Neave, Helen Nunn, Paul Niblett, Johann Piper, Gemma Ramsey and Steve Webster.

Elizabeth Fuller, Jennifer Mindell and Gillian Prior, editors.

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ISBN 978-1-78734-099-2

This publication may be requested
in large print or other formats.

**Published by NHS Digital, part of the
Government Statistical Service**