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METHODOLOGY

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A critical review of diet-related surveys in England, 1970-2018

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Abstract

Background: Many diet-related surveys have been conducted in England over the past four to five decades. Yet, diet-related ill-health is estimated to cost the NHS £5.8 billion annually. There has been no recent assessment of the diet-related surveys currently available in England. This paper aims to fill this gap in the literature by providing researchers, especially those interested in conducting secondary (quantitative) research on diet, with a detailed overview of the major repeated cross-sectional and longitudinal surveys conducted in England over the last 48 years (1970–2018).

Method: A three-stage review process was used to identify and assess surveys and synthesise the information necessary for achieving the paper's aim. Surveys were identified using the UK Data Service, Cohort and Longitudinal Studies Enhancement Resources (CLOSER), the Medical Research Council (MRC) Cohort Directory and the Consumer Data Research Centre (CDRC) online data repositories/directories. Surveys were summarised to include a brief background, the survey design and methodology used, variables captured, the target population, level of geography covered, the type of dietary assessment method(s) used, primary data users, data accessibility, availability and costs, as well as key survey features and considerations.

Results: The key considerations identified across the various surveys following the review include: the overall survey design and the different dietary assessment method(s) used in each survey; methodological changes and general inconsistencies in the type and quantity of diet-related questions posed across and within surveys over time; and differences in the level of geography and target groups captured.

Conclusion: It is highly unlikely that any survey dataset will meet all the needs of researchers. Nevertheless, researchers are encouraged to make good use of the secondary data currently available, in order to conduct the research necessary for the creation of more evidence-based diet-related policies and interventions in England. The review process used in this paper is one that can be easily replicated and one which future studies can use to update and expand upon to assist researchers in identifying the survey(s) most aligned to their research questions.

Keywords: Diet and nutrition, Researchers, Secondary data, Repeated cross-sectional and longitudinal surveys, Key features, Considerations, Diet-related surveys, Dietary assessment methods, England

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Background

Sub-optimal diet continues to be the most significant contributor to the global burden of disease, accounting for more deaths and disease than physical inactivity, alcohol consumption and smoking combined [4, 8, 10, 14]. Despite a proliferation of interventions which span decades, diet-related ill-health has been estimated to cost the National Health Service (NHS) approximately £5.8 billion annually [21]. In response to this situation, the World Health Organisation (WHO) has urged researchers to make “effective, proper and good use” of the secondary data currently available, in order to conduct the research necessary for the creation of more evidence-based diet-related policies and interventions [27]. Diet-related surveys continue to be the major source of information used by researchers and policy-makers to assess dietary patterns, monitor trends over time, evaluate the success/failure of interventions and identify potential inequalities. Although the availability of diet-related survey data is limited in many European countries, England boasts several Government sponsored/endorsed repeated cross-sectional and longitudinal surveys. Surveys such as the National Diet and Nutrition Survey (NDNS), the Health Survey for England (HSE), Understanding Society, and many others, can be easily accessed online from national data repositories such as the UK Data Service, usually at little or no cost. The relative ease with which secondary data can be accessed in England at present means that now, more than ever, researchers are able to explore diet-related topics of interest and forgo what would have been an otherwise time-consuming and costly primary data collection process. Though beneficial, the analysis of secondary data still requires that researchers clearly define their research questions, critically assess diet-related surveys currently available from the outset and identify the survey(s) which best suits their unique research needs, before any data are analysed [3]. Although initially time-consuming, this type of detailed preliminary assessment is essential, as it saves time in the long run and helps to ensure the overall success of diet-related studies undertaken.

Several studies have noted general challenges and practical considerations which researchers often face when analysing diet-related data [1, 12, 13, 16, 26]. Examples of these include: the unavailability of consistent, nationally representative diet-related data, different dietary assessment methods used in surveys and the tendency for surveys to capture data on single food groups/nutrients (such as fruits and vegetables) as opposed to a variety of foods. Ripplin et al. [20] previously assessed the current status of nationally representative surveys in Europe. However, the authors of that study only focused on the 53 countries in the WHO European

region and not England specifically. Overall, very few studies have outlined and discussed diet-related surveys conducted in England, their characteristics, possible benefits and some of the practical and unique considerations researchers should note when trying to decide the survey dataset(s) most aligned to their research question(s).

This paper is not a systematic review but, rather, a secondary data review which aims to fill a gap in the literature by providing researchers, especially those interested in conducting secondary (quantitative) research on diet and with limited time and resources, with a detailed overview and summary of the strengths and weaknesses of the major repeated cross-sectional and longitudinal surveys conducted in England over the last 48 years (1970–2018). Surveys identified and discussed in this review should not be interpreted as being capable of meeting all the needs of researchers involved/interested in diet-related research. Instead, this review will provide a brief background on some of the major diet-related repeated cross-sectional and longitudinal surveys conducted in England over the past four decades, the survey design and methodology used, variables captured, the target population, level of geography covered, the type of dietary assessment method(s) used, primary users of the data and information related to data accessibility, availability and costs. Additionally, key survey features which could benefit some researchers in answering their particular research question(s) will be highlighted, as well as some practical considerations which should be acknowledged before selecting and analysing data. To the best of our knowledge, this is the first paper to provide this type of detailed information on a current snapshot of major repeated cross-sectional and longitudinal diet-related surveys in England. This information could serve as a template or a quick guide which researchers can refer to as a starting point to identify existing diet-related surveys, assess potential survey benefits/issues and the possible impact (positive or negative) this could have on their research. This information will enable researchers to develop separate work-around strategies (where necessary) to suit their unique research needs and will save them time and resources than if it were necessary to compile this information from scratch.

Methods

Preliminary meetings were held with all members of the paper’s Review Team (MC, DS, JB, GM and CV) to discuss the scope, eligibility criteria and analytic strategy of this review. The decision was to include repeated cross-sectional and longitudinal surveys, where quantitative information on diets in England was collected over the 1970–2018 period. A three-stage review process was

138 used to identify, assess and synthesise the information
 139 necessary for achieving this paper’s aim (Fig. 1).
 140 Stage one of the review process (Fig. 1), involved the
 141 identification of all major repeated cross-sectional and
 142 longitudinal health, diet-related surveys, conducted in
 143 England over the period from January 1970 to December
 144 2018. This assessment period (48 years) was thought to
 145 be an adequate time span in which a sufficient number
 146 of longstanding and current survey datasets (especially
 147 longitudinal surveys) could be captured. Surveys were
 148 identified using the four major online directories cur-
 149 rently available and used by researchers in the UK,
 150 namely: the UK Data Service, the Medical Research
 151 Council (MRC) Cohort Directory, Cohort and Longitu-
 152 dinal Studies Enhancement Resources (CLOSER) and
 153 the Consumer Data Research Centre’s (CDRC) online
 154 directory. These four online directories were selected be-
 155 cause they provided a comprehensive list of all surveys
 156 conducted within the UK over time, a summary of the
 157 survey design, variables captured within datasets, links

158 to survey documentation and where relevant, the institu- 158
 159 tions (academic and research) ultimately responsible for 159
 160 managing and disseminating data. 160
 161 The search strategy used to identify initial survey re- 161
 162 sults varied, based on how each of the four databases 162
 163 were inherently structured. For the UK Data Service and 163
 164 the CDRC databases, an exact keyword search for 164
 165 “Health behaviour”; “Food consumption;” “Diet con- 165
 166 sumption”; “Dietary consumption”; “Diet and nutrition”; 166
 167 “Eating habits” and “Diet” was conducted. This was done 167
 168 to ensure that a wide variety of surveys, especially those 168
 169 not directly associated with diet, but which captured 169
 170 aspects of diet-related behaviours, would have been 170
 171 initially identified. The MRC Cohort Directory presented 171
 172 a full list of all major cohort (longitudinal) studies 172
 173 conducted in the UK, from which diet-related surveys 173
 174 relevant to this review were identified using the data- 174
 175 base’s pre-defined “Dietary Habits” topic filter option. 175
 176 CLOSER was strictly focused on eight longitudinal sur- 176
 177 veys (the Hertfordshire Cohort Study, 1946 and 1970 177

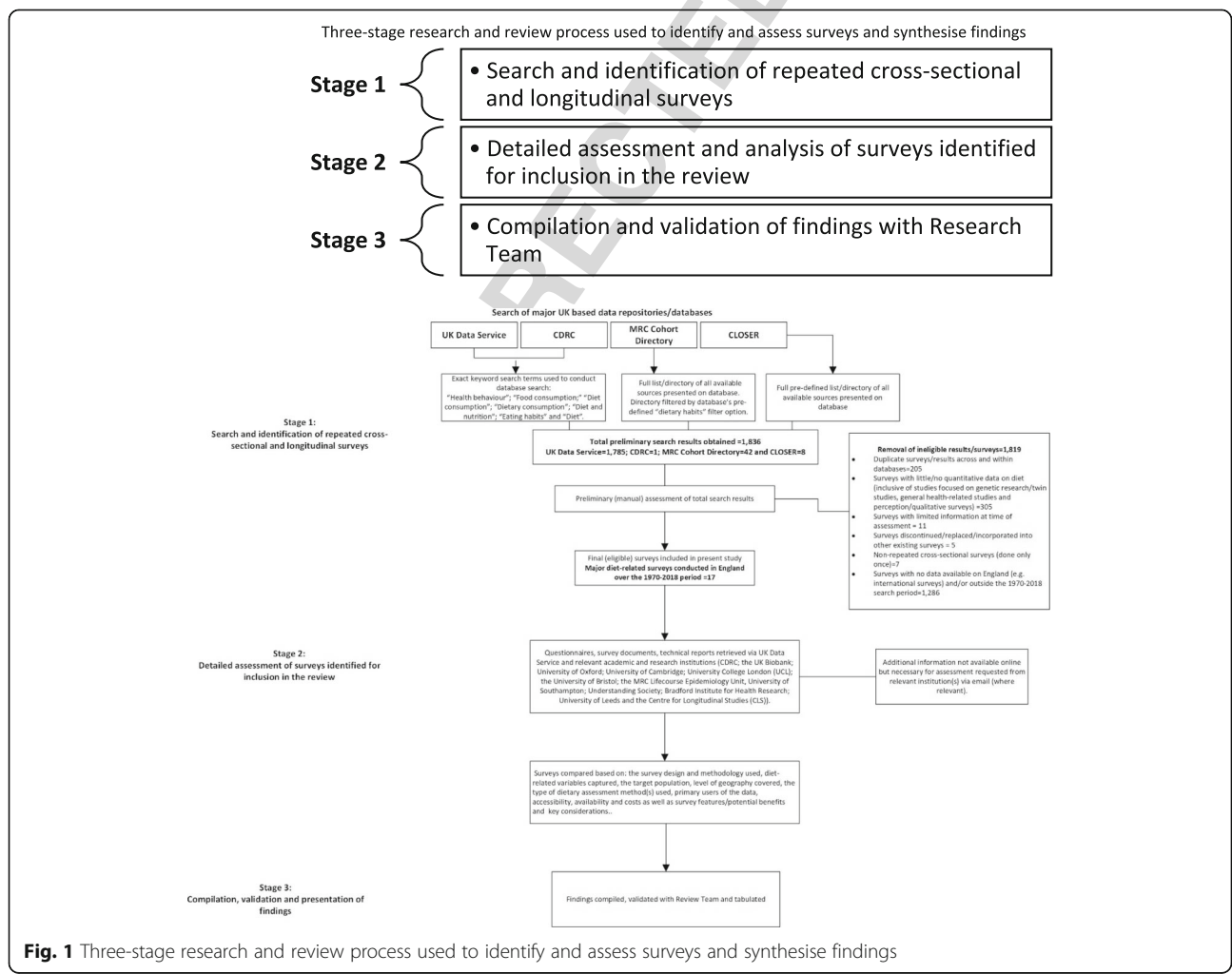


Fig. 1 Three-stage research and review process used to identify and assess surveys and synthesise findings

178 British Cohort Study, 1958 Child Development Study,
179 Avon Longitudinal Study of Parents and Children,
180 Southampton Women's Survey, Understanding Society
181 and Millennium Cohort Study) which captured persons
182 born throughout the 20th and 21st centuries. All eight
183 affiliated surveys were listed in the "Our Studies" section
184 of the CLOSER database, which meant there was no
185 need to filter or conduct any keyword searches. In total,
186 1836 preliminary results were obtained across the four
187 databases, of which 97% (1785 results) were from the
188 UK Data Service.

189 Preliminary search results obtained were manually
190 assessed by the Review Team (MC, DS, JB, GM and CV)
191 to filter out duplicates (205 of the 1836 total preliminary
192 results) and surveys which did not meet the paper's
193 eligibility criteria (1614 out of the 1836 total preliminary
194 results). Ineligible surveys included: discontinued
195 surveys, non-repeated cross-sectional surveys conducted
196 only once, surveys which although diet-related, had no
197 data for England (e.g. international studies or studies fo-
198 cused on a particular UK constituent country such as
199 Scotland only), surveys which fell outside the 1970–2018
200 search period, surveys which had little or no quantitative
201 diet-related data (e.g. qualitative/perception studies,
202 gene/twin studies, general health studies with no diet-
203 related data) and surveys which could not have been
204 properly assessed due to limited documentation at the
205 time of assessment. The removal of duplicate and ineli-
206 gible surveys (1819 results omitted), reduced the results
207 from 1836 to 17 surveys eligible for inclusion in the
208 current review (Fig. 1).

209 In Stage two of the review process, questionnaires,
210 documents and technical reports for the 17 eligible
211 surveys were retrieved online from the UK Data
212 Service and the official website of the responsible
213 academic and research institutions. Academic and re-
214 search institutions included: the CDRC; UK Biobank;
215 University of Oxford; University of Cambridge;
216 University College London (UCL); University of
217 Bristol; the MRC Lifecourse Epidemiology Unit, Uni-
218 versity of Southampton; Understanding Society; the
219 Bradford Institute for Health Research; University of
220 Leeds and the Centre for Longitudinal Studies (CLS).
221 Where necessary, follow-up emails were sent directly
222 to the UK Data Service and institutions to collect
223 additional information not available on official web-
224 sites. Documents (inclusive of questionnaires used
225 across survey waves/periods) received either from
226 websites or via email were thoroughly reviewed in
227 order to identify: the survey design and methodology
228 used, diet-related questions/variables captured, the
229 target population, level of geography covered, the type
230 of dietary assessment method(s) used, primary users
231 of the data, accessibility, availability and data costs, as

well as the key survey features/potential benefits and
key considerations for each survey.

Finally, Stage three involved the compilation of
findings, which were cross-validated with all members of
the Review Team (MC, DS, JB, GM and CV) and
tabulated (see Table 1) in order to capture the detailed
information on all 17 surveys in an easy to understand
and user-friendly manner.

Results

Overall, 17 surveys (5 repeated cross-sectional and 12
longitudinal) were identified and deemed relevant for in-
clusion within this paper (Table 1). The five repeated
cross-sectional surveys were the Living Cost and Food
Survey (LCFS), Active Lives Survey (ALS), National Diet
and Nutrition Survey (NDNS), Health Survey for
England (HSE) and Food and You, all of which were
accessible via the UK Data Service (Table 1). The Centre
for Longitudinal Studies (CLS) and Understanding Soci-
ety were the primary institutions responsible for collect-
ing, managing and disseminating data related to the
British Cohort Study 1970 (BCS70), Millennium Cohort
Study (MCS) and Understanding Society, respectively.
However, these were also the only longitudinal surveys
which were accessible through the UK Data Service. The
nine remaining longitudinal surveys assessed (the South-
ampton Women's Survey (SWS), Born in Bradford (BiB),
Avon Longitudinal Survey of Parents and Children
(ALSPAC), UK Women's Cohort Study (UKWCS),
European Prospective Investigation into Cancer and
Nutrition (EPIC Norfolk/Oxford), UK Biobank,
Whitehall II, British Regional Heart Study (BRHS) and
British Women's Heart and Health Study (BWHHS))
were primarily accessible through the respective
academic and research institutions listed in Table 1.
Table 1 provides a detailed summary of each of the 17
surveys reviewed, inclusive of their key features/potential
benefits and some key considerations which researchers
should note, if or when using any of the following
surveys to conduct secondary data analysis.

The HSE remains the primary source of information
used by the English Government to monitor and assess
changes in the overall health and lifestyle of children (0–
15 years) and adults (16 years and over) living in
England. Although a sports and recreation survey, the
ALS captured annual fruit and vegetable consumption
for over 198,000 persons (aged 14 years and over) living
in England. The NDNS, on the other hand, is currently
the only annual, nationally representative survey which
provides detailed information on all foods and beverages
consumed by persons 18 months of age and older. Food
and You was the only repeated cross-sectional survey
which was not conducted annually, but every 2 y (bi-
annually).

Table 1 Summary/review of 17 major repeated cross-sectional and longitudinal surveys conducted in England over the January, 1970 to December, 2018 period		
Repeated cross-sectional surveys		
	Living Cost and Food Survey (LCFS)	Actives Lives Survey (ALS)
t1.5	Survey Background	The LCFS (formerly known as the Expenditure and Food Survey (EFS) prior to 2008) is the UK's premier household expenditure survey, which captures information on the spending patterns and cost of living across the UK.
t1.6	Survey Design and Methodology	Annual repeated cross-sectional survey. Sample selected using multi-stage stratified random sampling with clustering. Household addresses with small user postcodes are randomly selected from the Royal Mail's postcode address file (PAF). Face-to face interviews (individual and household questionnaires administered) and 2-week self-reported expenditure diaries completed by all members of the household, aged 16 years and over. Simplified expenditure diaries are completed by children 7 to 15 years old.
t1.8	Target population and level of geography covered	Families/households within the UK (England, Scotland, Northern Ireland and Wales). Data for England are available at the national and Government Office Region (GOR) level. Local authority level data can be made available upon request and approval by the UK Data Service.
t1.11	Type of dietary assessment used	Household food expenditure data captured in the Family Food Module of the survey are used as a proxy measure for food consumption.
t1.13	Primary users of diet-related data	Academics/Researchers and several Governmental Departments. The Family Food Module of the LCFS is primarily used by the Department for Environment Food and Rural Affairs (Defra) to monitor food consumption and to produce the annual Family Food Report (a report which provides estimates of nutrient content and statistics on household food purchases by food type).
t1.15	Data Accessibility/Availability	Data accessible through the UK Data Service. Data currently available for the 2008–2017/18 period.
t1.17	Types of variables captured	Socio-demographic information (age, sex, occupation, education), GOR, local authority level geography, data garnered from 2-week expenditure diary (expenditure on energy, bills, utilities and food).
t1.19	Cost to access	Not applicable
t1.20	Key features/potential benefits	1. Nationally representative annual survey with relatively large sample size (approximately 5000 households each year) 2. Two (2) week expenditure diaries (completed by each member of the household 16 years and over) detailing purchased quantities of food and drink are used to estimate food consumption in England. 3. Possible to make comparisons between low and high-income households.
t1.22	Key considerations	1. The survey only captures self-reported fruit and vegetable consumption over a single 24-h period. 2. Difficult to compare data prior to 2015 as a different survey methodology was used for the previous Active People Survey.
t1.23	National Diet and Nutrition Survey (NDNS)	Health Survey for England (HSE)
t1.24	Survey Background	The NDNS was originally established in 1992 as a series of four separate cross-sectional surveys, capturing information on: children ages 1 ½ -4 ½ years (1992–1993), young people 4–18 years old (1997), adults 19–64 years old (2000–2001)

Table 1 Summary/review of 17 major repeated cross-sectional and longitudinal surveys conducted in England over the January, 1970 to December, 2018 period (Continued)

t1.25	Repeated cross-sectional surveys	and persons 65 years and over (1994–1995). In 2008, the new NDNS Rolling Programme (RP) was introduced as a nationally representative repeated cross-sectional survey which captures information on the type and quantity of foods and beverages consumed by 1000 persons (500 adults and 500 children) annually in the UK.	
t1.25	Survey Design and Methodology	Annual repeated cross-sectional survey. Multi-stage stratified random sample. Face-to face interviews conducted with respondents to capture food preparation, smoking and drinking habits. Self-completed 4-day food diaries are completed by persons 12 years and older and parents and/or carers are asked to complete food diaries for children 11 years and younger. Anthropometric measurements and blood and urine samples collected via nurse interview.	Annual repeated cross-sectional survey. Multi-stage stratified random sample. Face-to face interviews, self-completed questionnaires and a follow-up nurse visit carried out to collect anthropometric measurements and blood samples.
t1.26			
t1.27	Target population and level of geography covered	Individuals 1 ½ years and older, residing in private households in the UK. Data for England are available at the national and Government Office Region (GOR) level.	Adults (defined as persons 16 years and older) and children (0–15 years old) living in private households in England. Data available at the national, Government Office Region (GOR) and Strategic Health Authorities level. Local authority level data only available upon request and approval by NatCen Social Research at a cost.
t1.28			
t1.29			
t1.30	Type of dietary assessment used	Four (4) day food diary	Food frequency questionnaire (FFQ) used prior to 2009. Single 24-h screener/brief/shortened instrument (fruit and vegetable only) used since 2009.
t1.31			
t1.32	Primary users of diet-related data	Academics/Researchers, policymakers, UK Health Departments, Scientific Advisory Committee on Nutrition's (SACN), Food Standards Agency (FSA) and several Governmental Departments.	Academics/Researchers, policymakers, the Department of Health & Social Care, Public Health England (PHE), NHS England, other NHS bodies, Local Authorities, charities and voluntary organisations. Data used to track the national achievement of the 5-A-Day, fruit and vegetable target.
t1.33			
t1.34	Data Accessibility/ Availability	Data for the NDNS RP are accessible through the UK Data Service. Data currently available for the 2008–2016/17 period (survey wave 1–9).	Data are accessible through the UK Data Service. Data currently available for the 1991–2017 period.
t1.35			
t1.36	Types of variables captured	Socio-demographic information (age, sex, occupation, education), GOR and all foods and beverages consumed over a 4-day period.	Socio-demographic information (age, sex, occupation, education), GOR, general health, height and weight measurements and fruit and vegetable consumption.
t1.37			
t1.38	Cost to access	Not applicable	No cost to access GOR level data but lower level geography (e.g. local authority level) can be accessed at a minimum cost of £1000.
t1.39	Key features/potential benefits	1. Availability of annual food consumption data at the national level and 2. Detailed information available on all foods and beverages actually consumed by individuals over a 4-day period using the food diary method.	1. Nationally representative annual survey with large sample size of approximately 10,000 individuals (8000 adults and 2000 children). 2. Data captured could be used to explore relationships between diet (specifically fruit and vegetable consumption), obesity and associated chronic diseases.
t1.40			
t1.41	Key considerations	1. Relatively small annual sample size compared to larger cohort studies which employ methods which are less tedious than the food diary method. 2. Difficult to compare data prior to 2008 with NDNS RP data, as a different survey methodology was used previously. This makes it difficult for comparisons to be made across the survey waves and for changes in diet to be assessed over time.	1. Significant changes (e.g. the complete omission of the fruit and vegetable module in the 2012 survey wave) have been made to the type of diet questions asked, which makes it difficult for comparisons to be made across the survey waves and for changes in diet to be assessed over time.
t1.42	Food and You Survey		
t1.43	Survey Background	Food and You is a random probability survey commissioned by the Food Standards Agency (FSA) every 2 y. The survey captures information on public attitudes and self-reported knowledge as it relates to food safety, production and other food-related issues.	
t1.44	Survey Design and Methodology	Bi-annual repeated cross-sectional survey. Multi-stage stratified random sample. Face-to face interviews conducted with adults, defined as persons aged 16 years and over.	
t1.45			
t1.46	Target population and level of	Adults (16 and over) residing in private households the UK.	
t1.47		Data for England are available at the national and	

Table 1 Summary/review of 17 major repeated cross-sectional and longitudinal surveys conducted in England over the January, 1970 to December, 2018 period (Continued)

t1.50	Repeated cross-sectional surveys	
t1.48	geography covered	Government Office Region (GOR) level.
t1.49		
t1.50	Type of dietary assessment used	Food frequency questionnaire (FFQ) conducted at each wave of the survey
t1.51		
t1.52	Primary users of diet-related data	Academics/Researchers, policymakers and several Governmental Departments, particularly the Food Standards Agency (FSA)
t1.53		
t1.54	Data Accessibility/ Availability	Data are accessible through the UK Data Service. Data currently available for the five survey waves completed to date: 2010, 2012, 2014, 2016 and 2018.
t1.55		
t1.56	Types of variables captured	Socio-demographic information (age, sex, occupation, education, household income), GOR, frequency of consumption of foods such as beef, poultry, burgers, ready meals, dairy, fruits and vegetables.
t1.57		
t1.58	Cost to access	Not applicable
t1.59	Key features/ potential benefits	1. Nationally representative survey with sample size of about 3000–3500 individuals every 2 years 2. Besides data collected via FFQs, the survey also captures respondents' knowledge of current dietary recommendations and perceptions of what constitutes a healthy and balanced diet.
t1.60		
t1.61	Key considerations	1. Changes made to diet-related questions asked over the years, makes it difficult for comparisons to be made across the survey waves and for changes in diet to be assessed over time.
t1.62	Longitudinal surveys	
t1.63	Southampton Women's Survey (SWS)	Born in Bradford (BIB)
t1.64	Survey Background	The SWS was established between 1998 and 2002 with the primary aim of measuring non-pregnant women aged 20–34 years living in Southampton (England) and to follow-up members of the cohort who subsequently became pregnant. The study's major aim was to examine the effect of diet and lifestyle factors on the health of mothers and their children throughout the lifecourse.
t1.65	Survey Design and Methodology	Longitudinal Birth Cohort study. Pre-pregnancy home visits were made to 12,583 non-pregnant women (who were 20–34 years old during the 1998–2002 period) who resided in Southampton, England and surrounding areas. Pre-pregnancy food diaries were completed by participants and face-to-face interviews and blood samples were taken by a research nurse. Follow-up nurse visits were made to 3158 women who became pregnant and delivered a live born child; blood samples taken, and follow-up interviews conducted. Participants were asked to keep a food diary during early and late pregnancy. Follow-up surveys were conducted when children were 6 and 12 months and 3, 6–7, 8–9 and 11–13 years old.
t1.66		BIB is a study which tracks the health of over 13,500 children (and their parents) born at the Bradford Royal Infirmary between March 2007 and December 2008. The study tracks the health of these children from pregnancy throughout childhood and into adulthood.
t1.67	Target population and level of geography covered	Longitudinal Birth Cohort study. Women who planned to be give birth during the 2007–2011 period were recruited and baseline data on socio-economic status, ethnicity and family trees, diet, physical and mental health were collected from 12,453 women at 26–28 weeks of pregnancy. Baseline data were also collected from 3448 partners of recruited mothers. Follow-up self-administered questionnaires were completed by partners at 6 and 12 months. Follow-up home visits were made with 2 sub-groups within the cohort when children were 6, 12, 18 months and 2, 3 and 4 years old to collect information on growth trajectories, risk factors for childhood obesity and exposures to asthma and atopy. Follow-up waves are heavily dependent on the level of funding available.
t1.68		Pregnant women (26–28 weeks) who delivered babies at the Bradford (North England) Royal Infirmary, fathers of the children and the children born to recruited mothers. Geographical area captured: Bradford (North of England)
t1.69		
t1.70	Type of dietary assessment used	Interviewer administered FFQ and 24-h recall conducted at each survey wave, food diaries completed by mothers at pre-pregnancy, early pregnancy and when children were 3 years old and 24-h diet recalls administered when children were 6 months old.
t1.71		Food frequency questionnaire (FFQ) at each wave of the survey.
t1.72	Primary users of diet-	Academics/Researchers, Local Authority.
		Academics/Researchers, Local Authority, National Health

Table 1 Summary/review of 17 major repeated cross-sectional and longitudinal surveys conducted in England over the January, 1970 to December, 2018 period (*Continued*)

t1.74	Repeated cross-sectional surveys	
t1.73	related data	Service (NHS).
t1.74	Data Accessibility/ Availability	Data accessible through the MRC Lifecourse Epidemiology Unit, University of Southampton. Data available for women before pregnancy (1998–2002) and during early and late pregnancy. Data for children are available for 6 and 12 months, 3, 6–7, 8–9 and 11–13 years old.
t1.75		Data (and details regarding survey data currently available) accessible through the Bradford Institute for Health Research.
t1.76	Types of variables captured	Socio-demographic information (age, sex, occupation, employment, education), general diet, dietary changes and a 100-point FFQ asking the frequency of consumption in the last 3 months of fruits, vegetables, potatoes, rice, soft drinks, dairy, bread and a host of other foods across the various food groups.
t1.77		Socio-demographic information (age, sex, occupation, employment, education) and a more than 100-point FFQ asking the frequency of consumption in the last 2–3 months of fruits, vegetables and a host of other foods across the various food groups.
t1.78	Cost to access	Not applicable
t1.79	Key features/ potential benefits	1. Food consumption data available for a wide variety of foods. 2. Cohort study data can be used to track changes over time. 3. Availability of pre- and post-pregnancy data.
t1.80		1. Food consumption data available for a wide variety of foods 2. Cohort study data can be used to track changes over time. 3. Bradford has a large ethnic community and so the study captures ethnic minority groups which are usually underrepresented
t1.81	Key considerations	1. Study not representative of English population; only focuses on Southampton (South of England). 2. The study only focuses on women and their children over time. 3. Complete data on children are not available for the entire cohort at each age of follow-up.
t1.82		1. Study not representative of English population; only focuses on Bradford (North of England) 2. Changes made to diet-related questions across the survey waves may make it difficult to make comparisons over time. 3. Follow-up waves are heavily dependent on the level of funding available.
t1.83	Survey Background	Understanding Society Understanding Society is an annual large-scale, multi-topic longitudinal cohort study established to understand social and economic changes in the UK at the individual and household level.
t1.84	Survey Design and Methodology	British Cohort Study 1970 (BCS70) The BCS70 is a large national longitudinal birth cohort study which tracks over 17,000 persons born in England, Scotland and Wales in a single week in 1970. The study has gathered information related to the health, social, economic and educational development of participants.
t1.85		Longitudinal Birth Cohort study. All children born in England, Scotland and Wales in 1970 were recruited and eight follow-up surveys have been conducted to date. Follow-up interviews were done when children were 5, 10, 16, 26, 30, 34, and 42 years of age (in 2012). Although data are not currently available, a follow-up survey was conducted at age 46 (in 2016) and information is currently being processed. In the 2004 study (age 34) cohort members were given a basic skills (numeracy and literacy) assessment test and a self-completion questionnaire to complete.
t1.86	Target population and level of geography covered	Individuals living within over 40,000 households in the UK. Data for England are available at the national and Government Office Region (GOR) level. Local authority level, Westminster Parliamentary Constituencies, Local Education Authorities and Travel to Work Areas are available upon request and approval by the UK Data Service under its Special License Agreement.
t1.87		Children born in England, Scotland and Wales in a single week in 1970.
t1.88		
t1.89	Type of dietary assessment used	Short food frequency screener/brief instrument which primarily captured fruit and vegetable consumption.
t1.90		4-day food diary and a 24-h diet recall included in 1986 wave of survey. Online diet diary also included in the 2016 wave, when respondents were 46 years old.
t1.91	Primary users of diet-related data	Academics/Researchers.
t1.92		Academics/Researchers.
t1.93	Data Accessibility/ Availability	Data accessible through the UK Data Service. Data currently available for the 2009–2018 period (survey wave 1–9)
t1.94		Data accessible through the UK Data Service. Data currently available for the 1975–2016-18 survey period.
t1.95	Types of variables captured	Socio-demographic information (age, sex, education, family, social life), self-reported health, type of milk, bread usually consumed, daily and weekly consumption of fruits and vegetables.
t1.96		Socio-demographic information (age, sex, occupation, education). Consumption of fruits, vegetables, meat, dairy, soup, potatoes, biscuits, crisps, fizzy drinks, sweets and ice-cream consumed over a 24-h period. All foods consumed over a 4-day period in 1986 (paper-based food diary) and in

Table 1 Summary/review of 17 major repeated cross-sectional and longitudinal surveys conducted in England over the January, 1970 to December, 2018 period (Continued)

t1.97	Repeated cross-sectional surveys		2016 (online food diary) when respondents were 46 years old.
t1.97	Cost to access	Not applicable	Not applicable
t1.98	Key features/	1. Large sample size, nationally representative and	1. Large sample size and nationally representative 2. Cohort
t1.99	potential benefits	conducted annually. 2. Cohort study data can be used to track changes over time.	study data can be used to track changes over time. 3. Detailed information on all foods consumed by participants over several days were captured in food diaries conducted in the 1986 and 2016 wave of the survey.
t1.100	Key considerations	1. Very few diet-related questions included in the study (fruit and vegetable consumption, dairy, bread). Questions posed in the main questionnaire primarily focused on the type of bread and milk consumed and portions of fruits and vegetables consumed in a typical week. 2. Differences in the number and types of diet-related questions asked across survey waves could make it difficult for comparisons to be made over time.	1. Food diary data for the 1986 and 2016 wave are being cleaned and the expected date of release is undetermined. 2. Changes made to diet-related questions across survey waves could make it difficult for comparisons to be made over time.
t1.101		Avon Longitudinal Study of Parents and Children (ALSPAC)	UK Women's Cohort Study (UKWCS)
t1.102	Survey Background	ALSPAC also known as the Children of the 90s Study, is a study which tracks the health and well-being of 14,400 families living within the Bristol area.	The UKWCS is a large-scale cohort study which explores the relationship between diet (including foods, nutrients and supplements) and health outcomes such as cancer, cardiovascular disease and obesity amongst over 35,000 middle aged women in the UK.
t1.103	Survey Design and	Longitudinal Birth Cohort study. Study posters were disseminated, and local community midwives discussed the study with women with expected deliveries between April 1991 and December 1992. Persons who contacted the study team were included in the study. Baseline data were captured during pregnancy and follow-up assessments carried out when children were 4 weeks to 24 years of age. Self-completed postal questionnaires were completed by mothers, children and teachers (of children) and clinical assessment visits were carried out at different stages of the study.	Longitudinal Cohort study. Direct mail questionnaires were sent by the World Cancer Research Fund to persons, particularly women, living in England, Scotland and Wales, listed on direct mailing lists. Female survey responders aged 35–69, who self-identified as vegetarian or non-red meat eaters were included in the study. Baseline data were collected during the 1995–1998 period and follow up (known as phase 2 of the study) was done during the 1999–2002 period. Several sub-studies have been carried out over the years. For instance, an iron status sub-study in 2000–2002, a snacking study in 2006 and a pilot study to test a web-based 24-h dietary assessment tool in 2014.
t1.104	Methodology		
t1.105	Target population	All women pregnant during 1990–1992, who resided in Bristol/Avon Health Authority and surrounding areas, their partners and all children born out of these pregnancies. Geographical area captured: Bristol and surrounding areas (South West of England)	Middle aged women (aged 35–69 at recruitment) living in England, Scotland and Wales, who self-reported as being vegetarian or non-red meat eaters. Geographical area captured: England, Scotland and Wales and English regions. Regions included in the study's data set can be easily converted to Government Office Region (GOR) categories
t1.106	and level of		
t1.107	geography covered		
t1.108	Type of dietary	Food frequency questionnaires (FFQs). Food diaries were completed by parents when children were 7, 10 and 13 years of age.	Food frequency questionnaire (FFQ); a 4-day food diary (completed during the follow up study in 1999–2002) and a 24-h web-based diet recall assessment pilot in 2014.
t1.109	assessment used		
t1.110	Primary users of diet-	Academics/Researchers.	Academics/Researchers.
t1.111	related data		
t1.112	Data Accessibility/	Data (and details regarding survey data currently available) accessible through the University of Bristol	Data (and details regarding survey data currently available) accessible through the Consumer Data Research Centre
t1.113	Availability		
t1.114	Types of variables	Socio-demographic information (age, sex, occupation, employment, education), consumption of fruits, vegetables and a host of other foods which vary across the survey waves.	Socio-demographic information (age, sex, occupation, education), food consumption data captured from FFQs and food diaries conducted at different survey waves.
t1.115	captured		
t1.116	Cost to access	Minimum cost of £2715 to access	Not applicable
t1.117	Key features/	1. Large sample size. 2. Cohort study data can be used to track changes over time.	1. Large sample size. 2. Cohort study data could be used to track changes over time.
t1.118	potential benefits		3. Availability of food diary data provides detailed information on all foods consumed by participants.
t1.119	Key considerations	1. Costly to access. 2. Study not representative of English	1. Food diaries completed in phase 2 of the study (1999–

Table 1 Summary/review of 17 major repeated cross-sectional and longitudinal surveys conducted in England over the January, 1970 to December, 2018 period (Continued)

t1.120 Repeated cross-sectional surveys		
	population; only focuses on Bristol and surrounding areas (South West of England). 3. Changes made to diet-related questions across survey waves could make it difficult for comparisons to be made over time	2002) and diaries completed during the 2014 online pilot study were still being processed at the time of this assessment. As such, these data are not available, and the date of release is undetermined 2. Study not representative of the English population. Participants were mostly vegetarian, middle aged, middle class, white women who volunteered to be a part of the study during the late 1990s 3. Changes made to diet-related questions across the survey waves may make it difficult to make comparisons over time.
t1.120	Whitehall II Study	Millennium Cohort Study (MCS)
t1.121	Survey Background	
	The Whitehall II study is a cohort study conducted to assess the causes of social inequalities in health in England.	The MCS is a large national longitudinal birth cohort study which tracks 19,000 children born in the UK during 2000–2001, from childhood into adulthood.
t1.122	Survey Design and Methodology	
t1.123	Longitudinal Cohort study. A cohort of 10,308 middle-aged persons (3413 females and 6895 males, aged 35–55 years old) who worked in the London offices of 20 Whitehall departments in 1985–1988 were included in the study. During the 2015–2016 period, research clinics were established in London, Bristol, Birmingham and Liverpool to allow persons (especially retired persons) now living within these and surrounding areas to be a part of the study and reduce the level of attrition. Members of the cohort were invited to attend a clinic research screening every 5 years and a postal survey sent to participants between clinic phases. Overall, data has been collected over 12 waves, from 1985 to 1988 to 2015–2016	Longitudinal Birth Cohort study. Multi-stage stratified random sample. The sample consisted of all children born (live births) over 12 months (from 1 September 2000 in England and Wales and for 59 weeks from 22 November 2000 in Scotland and Northern Ireland). Six surveys have been conducted to date, capturing information when children were 9 months and 3, 5, 7, 11 and 14 years of age (in 2015). Although data are currently unavailable, the 7th wave was conducted in 2018 captures children at age 18. A combination of data collection methods has been used. These include face-to-face interviews, self-completed questionnaires; psychological measurements, observation; time use diaries and physical measurements.
t1.124	Target population and level of geography covered	
t1.125	Middle-aged persons who worked in the London offices of 20 Whitehall departments in 1985–1988.	Children born in the UK (England, Scotland, Northern Ireland and Wales) during 2000–2001. Data for England are available at the national and Government Office Region (GOR).
t1.126		
t1.127	Type of dietary assessment used	
t1.128	Food frequency questionnaire (FFQ)	Food frequency questionnaire (FFQ)
t1.129	Primary users of diet-related data	
t1.130	Academics/Researchers.	Academics/Researchers.
t1.131	Data Accessibility/Availability	
t1.132	Data accessible through the University College London. Data available for waves 1–12 (1986–2016)	Data accessible through the UK Data Service. Data currently available for the 2001–2015 survey period.
t1.133	Types of variables captured	
t1.134	Socio-demographic information (age, sex, occupation, employment, retirement, education, income), self-reported health and frequency of consumption in the last 12 months of fruits, vegetables, meat, fish, soups, sauces, spreads, eggs, dairy products, fats, bread, pasta, potato, rice, sweets and snacks were consumed.	Socio-demographic information (age, sex, occupation, employment, education of parents), consumption of fruits and vegetables and other foods such as bread, milk, sugary drinks and fast foods.
t1.135	Cost to access	
t1.136	Not applicable	Not applicable
t1.137	Key features/potential benefits	
t1.138	1. Food consumption data available for a wide variety of foods. 2. Fairly large sample size across the 12 waves (10,308 in 1985–1988 to 5632 in 2015–2016). 3. Cohort study data can be used to track changes over time.	1. Large sample size and nationally representative. 2. Cohort study data can be used to track changes over time. 3. Children were asked to state their consumption of fruits and vegetables and other foods such as bread, sugary drinks and fast food at age 14.
t1.138	Key considerations	
	1. Study not representative of English population. Study focused on middle-aged civil servants. 2. Changes made to diet-related questions across the survey waves may make it difficult to make comparisons over time. 3. Based on the current age-group of participants, the study is now primarily focused on issues surrounding population ageing.	1. Cohort members are still very young, which currently limits the assessment of diet by age/over lifecourse. 2. Changes made to diet-related questions across survey waves could make it difficult for comparisons to be made over time.
t1.139	European Prospective Investigation into Cancer and Nutrition (EPIC Norfolk/Oxford)	UK Biobank
t1.140	Survey Background	
	EPIC is a large cohort study which aims to examine diet as a risk factor for cancer and other chronic diseases amongst over 80,000 middle aged persons in the UK.	The UK Biobank is a large-scale longitudinal study which follows 500,000 middle-aged persons across the UK to investigate the association between diet and a range of diseases such as cancer, heart disease, stroke, diabetes and dementia.

Table 1 Summary/review of 17 major repeated cross-sectional and longitudinal surveys conducted in England over the January, 1970 to December, 2018 period (Continued)

t1.141	Repeated cross-sectional surveys		
t1.142	Survey Design and Methodology	Longitudinal Cohort study. EPIC Oxford: 65,000 persons from the general population were recruited between 1993 and 1999 via EPIC nurses in GP practices in Greater Manchester, Oxfordshire and Buckinghamshire, England. Postal questionnaires were also sent to members of the Vegetarian Society of the UK and Vegan Society, and study information distributed through health magazines and shops, to capture persons located across the entire UK. Follow-up surveys were conducted 5, 10 and 15 years later. EPIC Norfolk: Invitations were sent to all 40–79-year olds on collaborating GP listings. Over 30,000 persons within Norwich and surrounding areas (East of England) were recruited over the 1993–1997 period. Participants were followed up at 18 months, 3, 13 and 20 years after recruitment. A combination of data collection methods was used for both studies (nurse interview to collect anthropometric measurements and blood samples, self-completed questionnaires (on physical activity) and record linkages via hospital diagnoses, death certification and cancer registration	Longitudinal Cohort study. Population-based registers such as those held by the National Health Service (NHS) were used as a sampling frame to identify persons living within proximity to study assessment centres. Each assessment centre aimed to recruit as many persons within the target population. Baseline data (for the 2006–2010 period) were collected at assessment centres, where self-reported baseline questionnaires were used to collect health and lifestyle-related data and interviews conducted to collect physical measurements and biological samples. A follow up survey was conducted in 2011–2012.
t1.144	Target population and level of geography covered	EPIC Oxford: Men and women 35 years and over (at recruitment) who lived in Greater Manchester, Oxfordshire and Buckinghamshire in England and vegetarians /vegans located across the UK. EPIC Norfolk: Men and women aged 40–79 (at recruitment) who lived in Norwich and surrounding towns and rural areas.	Middle-aged males and females (persons aged 40–69 during the 2006–2010 period) who lived within a 10-mile radius of 35 study centres strategically located across England, Wales and Scotland.
t1.147	Type of dietary assessment used	Food frequency questionnaire (FFQ) and a 7-day food diary (completed at recruitment and at the 2nd wave of the study)	Food frequency questionnaire (FFQ) with foods related to increased cancer risk conducted at baseline. Web-based 24-h recall repeated on four occasions over a 16-month period.
t1.149	Primary users of diet-related data	Academics/Researchers.	Academics/Researchers.
t1.151	Data Accessibility/ Availability	The EPIC Oxford study is accessible through the University of Oxford and EPIC Norfolk through the University of Cambridge. Details on current data availability accessible from both institutions.	Data accessible through the UK Biobank. Data available (at the time of assessment) for the 2006–2010 (baseline) and 2011–2012 period.
t1.153	Types of variables captured	Socio-demographic information (age, sex, occupation, education), food consumption data captured from FFQs and food diaries conducted at different survey waves.	Socio-demographic information (age, sex, employment) and fruits, vegetables, meat, dairy and a host of other foods consumed (total of over 200 foods) over a 24-h period.
t1.155	Cost to access	Not applicable	Minimum £2000 to cover application and data access cost. Possibly reduced cost of £500 for research students (subject to review and approval).
t1.156	Key features/potential benefits	1. Large sample size. 2. Cohort study data can be used to track changes over time. 3. Availability of food diary data (at recruitment and wave 2) which provides detailed information on foods consumed by participants.	1. Large sample size. 2. Cohort study data can be used to track changes over time. 3. Detailed information on foods consumed by participants over repeated days (repeated 24-h diet recalls).
t1.158	Key considerations	1. Study not representative of English population. Focused on middle-aged persons living in Norwich, Greater Manchester, Oxfordshire and Buckinghamshire who were in some instances selected via purposive sampling. 2. 50% of participants were vegetarians/vegans. 3. Changes made to diet-related questions across the survey waves may make it difficult to make comparisons over time	1. Study not representative of English population. Focused on middle-aged persons from less-deprived areas (based on the target population). 2. The baseline survey captured some aspects of diet consumption but was not as comprehensive as the 2011–2012 survey wave. 3. Differences in the number and types of diet-related questions asked across survey waves could make it difficult for comparisons to be made over time. 4. Relatively high cost to access data. 5. Lengthy application process and possible lag time for approval.
t1.159		British Regional Heart Study (BRHS)	British Women's Heart and Health Study (BWHHS)
t1.160	Survey Background	The BRHS is a cohort study, established in 1978–1980, which explores the factors associated with heart disease, hypertension and stroke amongst 7735 middle-aged men (40–59 years at recruitment) recruited from General Practices (GPs) in 24 towns in England, Scotland and Wales.	The BWHHS is a cohort study, established in 1999 as a complement to the BRHS. The study follows 4286 women, aged 60 years and over (at recruitment) from 24 General Practices (GPs), in 23 towns in England, Scotland and Wales
t1.161	Survey Design and Methodology	Longitudinal Cohort study. Almost 8000 middle-aged men who were selected at random from one GP in each of the	Longitudinal Cohort study. Almost 8000 middle-aged women were randomly selected from 24 GPs, in 23 towns from 1999

Table 1 Summary/review of 17 major repeated cross-sectional and longitudinal surveys conducted in England over the January, 1970 to December, 2018 period (Continued)

t1.163 Repeated cross-sectional surveys		
	24 towns, were examined over the 1978–1980 period. Self-completed health and lifestyle questionnaires and clinical assessments/examinations (inclusive of anthropometric measurements) completed at baseline (1978–80). Follow-up self-completed questionnaires were completed in 1985,1992, 1996,1998–2000, 2003,2005,2007,2010–12, 2014,2015, 2016, 2017 and 2018. A review of GP records (including all hospital and clinic correspondence) was also conducted bi-annually. A clinical re-examination was done in the 1998–2000 wave. Participants were also given a self-completed activity survey questionnaire and asked to wear an activity monitor and keep a 3-day activity diary in 2010, 2011, 2012, 2013, 2015 and 2017.	to 2000. Self-completed health and lifestyle questionnaires, and nurse administered interviews and medical examinations were completed at baseline (1999–2000). A review of GP records (including all hospital and clinic correspondence) was completed at baseline and in 2002, 2004, 2007, 2011–12 and 2016–17. Self-completed health and lifestyle questionnaires were completed in 2003, 2007 and 2010–2011. Participants were also given a self-completed activity survey questionnaire and asked to wear an activity monitor/belt and keep a 3-day activity diary in 2010–2011.
t1.163 Target population and level of geography covered	Middle-aged men aged 40–59 years (at recruitment) who resided in 24 towns across England, Scotland and Wales.	Middle-aged women aged 60 years and over (at recruitment) from 23 towns across England, Scotland and Wales.
t1.164 Type of dietary assessment used	Food frequency questionnaire (FFQ)	Food frequency questionnaire (FFQ)
t1.165 Primary users of diet-related data	Academics/Researchers.	Academics/Researchers.
t1.166 Data Accessibility/Availability	Data accessible through University College London	Data accessible through University College London
t1.167 Types of variables captured	Socio-demographic information (age, sex), health status, consumption of fruits and vegetables, fish, meat, bread and a host of other foods which vary across the survey waves.	Socio-demographic information (age, sex), consumption of fruits, vegetables, cheese, milk, red meat and other foods which vary across the survey waves.
t1.174 Cost to access	Unknown (Information inaccessible at time of assessment).	Unknown (Information inaccessible at time of assessment).
t1.175 Key features/potential benefits	1. Cohort study data can be used to track changes over time. 2. Data captured could be used to explore relationships between diet, cardiovascular disease and associated chronic diseases.	1. Cohort study data can be used to track changes over time. 2. Data captured could be used to explore relationships between diet, cardiovascular disease and associated chronic diseases.
t1.177 Key considerations	1. Study not representative English population. Study only captures middle-aged men from 24 towns across sections of Scotland, England and Wales. 2. Differences in the number and types of diet-related questions asked across survey waves could make it difficult for comparisons to be made over time. 3. Based on the current age-group of participants, the study is now primarily focused on issues surrounding population ageing.	1. Study not representative English population. Study only captures middle-aged women from 23 towns across sections of Scotland, England and Wales. 2. Differences in the number and types of diet-related questions asked across survey waves could make it difficult for comparisons to be made over time.

285 Of the 12 longitudinal surveys assessed, five (SWS,
286 BiB, BCS70, ALSPAC and MCS) were birth cohort
287 surveys which followed the same group of individuals
288 from birth through to adulthood (Table 1). With the
289 exception of Understanding Society, the remainder of
290 the longitudinal surveys reviewed (UKWCS, EPIC, UK
291 Biobank, BRHS, BWHHS and Whitehall II) were primar-
292 ily focused on exploring the relationship between diet
293 and health outcomes such as cancer and heart disease,
294 amongst middle- aged persons (aged 35 years and over
295 at the time of recruitment). Understanding Society was
296 the only large-scale, multi-topic longitudinal study,
297 which followed individuals across all age groups (child-
298 ren and adults), living in over 40,000 households in the
299 UK, on an annual basis. As such, one of its key features
300 was its large annual sample size and its national
301 representativeness.

In terms of dietary assessment methods used, the Food
and You, BiB, BRHS, BWHHS, MCS and Whitehall II
used Food Frequency Questionnaires (FFQs) solely,
whereas the SWS, ALSPAC, UKWCS and EPIC used a
combination of methods (inclusive of FFQs, across
different survey waves). A key feature of the LCFS was
the availability of two-week expenditure diaries which
captured purchased quantities of food and drink. How-
ever, it should be noted that the survey does not capture
foods actually consumed by individuals, but rather
household food purchasing and expenditure. Under-
standing Society primarily captured the frequency of
fruit and vegetable consumption using a brief dietary in-
strument. Besides their large annual sample sizes, the
HSE and ALS captured the consumption of fruits and
vegetables using a single 24-h shortened dietary instru-
ment/screener. The NDNS' consistent use of the food

319 diary assessment method across the survey waves was a
320 feature which set it apart from the remainder of the
321 surveys which used FFQ, shortened dietary screener
322 instruments, 24-h diet recalls or a combination of these
323 methods across the different survey waves. The use of
324 this method meant that the survey provided detailed
325 information, including nutrient content and portion size,
326 on all foods and beverages actually consumed by individ-
327 uals, over a four-day period.

328 Besides methodological changes to the NDNS, and
329 LCFS noteworthy changes to the type and number of
330 diet-related questions asked across the survey waves
331 were observed for 13 of the 17 surveys reviewed
332 (HSE, Food and You, BIB, Understanding Society,
333 BCS70, ALSPAC, UKWCS, MCS, EPIC, UK Biobank,
334 Whitehall II, BRHS and BWHHS).

335 Of all the surveys reviewed, nine (SWS, BiB, ALSP
336 AC, UKWCS, Whitehall II, EPIC, UK Biobank, BRHS
337 and BWHHS) were not representative of the general
338 English population, all of which were longitudinal
339 surveys. BiB focused on Bradford in the North of
340 England, whereas SWS and ALSPAC were limited to
341 Southampton and Bristol in South East and South
342 West England, respectively. Besides the study's focus
343 on middle-aged persons, EPIC Norfolk/Oxford was
344 also limited in terms of its focus on the geographical
345 areas of Norwich, Greater Manchester, Oxfordshire
346 and Buckinghamshire. Data captured in BRHS and
347 BWHHS were not representative of the English
348 population and were limited to middle-aged males
349 and females from only 24 and 23 towns (respectively)
350 across Scotland, Wales and England. Although the
351 UK Biobank followed 500,000 persons across the UK,
352 the survey was focused on middle-aged persons.
353 Overall, BCS70, MCS and Understanding Society were
354 the only longitudinal surveys reviewed which were
355 nationally representative.

356 Discussion

357 The primary aim of this paper was to provide re-
358 searchers, especially those interested in conducting
359 secondary data analysis, with a detailed overview of
360 17 major diet-related repeated cross-sectional and
361 longitudinal surveys conducted in England over the
362 past 48 years (1970–2018). Following this review,
363 three broad thematic areas were identified. These in-
364 cluded: the overall survey design and the different
365 dietary assessment method(s) used in each survey;
366 methodological changes and general inconsistencies in
367 the type and quantity of diet-related questions posed
368 across and within surveys over time; and differences
369 in the level of geography and target groups captured
370 across the surveys.

Survey design and dietary assessment methods used 371

372 Repeated cross-sectional surveys such as the NDNS,
373 HSE, ALS, LCFS and Food and You, are inherently
374 designed to provide researchers with a snapshot of diet
375 and related behaviours for a particular group of individ-
376 uals (sample), at a particular point in time. With the
377 exception of Food and You (conducted bi-annually), the
378 remaining repeated cross-sectional surveys were con-
379 ducted annually. Longitudinal surveys (such as SWS,
380 BiB, Understanding Society, BCS70, ALSPAC, UKWCS,
381 Whitehall II, MCS, EPIC, UK Biobank, BRHS and
382 BWHHS) however, are primarily designed to follow the
383 same group of individuals over an extended period of
384 time or across the lifecourse (in the case of birth cohort
385 studies such the SWS, BiB, BCS70, ALSPAC and MCS).
386 It is possible to pool data from individual survey waves/
387 years for repeated-cross-sectional surveys. This could
388 help to increase the overall sample size (where deemed
389 necessary) and could be a means of exploring possible
390 differences in diet and related behaviours across survey
391 waves. However, because repeated cross-sectional
392 surveys capture a different group of individuals at each
393 survey wave, they may be more appropriate for
394 researchers interested in assessing current diet-related
395 behaviours, than those interested in tracking possible
396 changes amongst the same group of individuals over
397 time.

398 Aside from survey design, it was known that the diet-
399 ary assessment method(s) used in all 17 surveys would
400 have inherent strengths and weaknesses, depending on
401 the context in which they are used. Unlike previous
402 studies [18, 19, 22], providing a detailed description of
403 the pros and cons of the different dietary assessment
404 methods used in surveys was not within the scope of this
405 review. Nevertheless, similar to those studies, this review
406 found that the type of dietary assessment method(s)
407 used in surveys is another area researchers should
408 closely consider, especially when trying to decide the
409 secondary data sources(s) most aligned to their research
410 questions. For instance, the LCFS captures data on the
411 amount (quantity) of food and drink purchased by
412 households, via 2 week/14-day expenditure diaries
413 (found in the survey's Family Food Module). This type
414 of information is particularly useful for persons inter-
415 ested in exploring household-level shopping and eating
416 habits, household-level socio-economic variations in diet
417 [5] or evaluating population level food purchasing-
418 focused interventions [2]. Researchers in the Department
419 for Environment, Food and Rural Affairs (DEFRA) rely
420 on LCFS data to calculate cost of living indices and to
421 produce the Government's annual Family Food Report,
422 which provides estimates of nutrient content and statis-
423 tics on household food purchases by food type. Although
424 beneficial in these circumstances, because the LCFS is

425 an expenditure survey, its design and focus are not the
426 diet of individuals. Whilst it is possible to use expend-
427 iture data (as captured in the LCFS) to estimate the
428 quantity of food consumed and the nutrient intake of in-
429 dividuals within households (proxy measure), this is
430 mostly done in low resource settings, specifically in
431 countries which have limited diet-related data other than
432 that captured in household expenditure surveys [7].
433 Given that the LCFS is not the only source of diet-
434 related data in England, researchers interested in explor-
435 ing the actual consumption of individuals and potential
436 demographic and socio-economic differences (e.g. age,
437 sex, educational attainment) in diet in England (using re-
438 peated cross-sectional survey data), should consider
439 more appropriate surveys such as the NDNS or others,
440 which have data on the actual diet of individuals.

441 The NDNS' consistent use of the food diary assess-
442 ment method across the nine survey waves (nine waves
443 were completed at the time of this review/assessment)
444 meant that the survey captured detailed information on
445 all foods and beverages actually consumed by individ-
446 uals, over a four-day period. A key feature of the food
447 diary method is that recording of data is done at the
448 time of consumption, which helps to reduce recall bias
449 or the reliance on memory and improves the quality and
450 accuracy of data collected [22]. Respondents are trained
451 to estimate and record amounts consumed using house-
452 hold measures (e.g. one tablespoon of baked beans) and
453 photographs included in the survey. This type of data
454 could be useful to researchers interested in fully explor-
455 ing the overall diet, nutrients or portion sizes (not only
456 single food groups such as fruits and vegetables) of
457 individuals living in England and possible socio-
458 demographic differences. However, the food diary
459 method, although beneficial, requires significant finan-
460 cial, physical and human resources to implement, espe-
461 cially on an annual basis, and requires that survey
462 participants be literate and committed to completing the
463 entire process [7, 22]. As a result, individuals with low
464 levels of literacy and those from lower socio-economic
465 groups may be under-represented.

466 Another key consideration is that the NDNS currently
467 targets 1000 persons (500 adults and 500 children) an-
468 nually, across the entire UK (England, Scotland, North-
469 ern Ireland and Wales). Although customary for surveys
470 which use the food diary method, the survey's relatively
471 low annual sample size could be seen as a limitation.
472 Nevertheless, the pooling of data across the survey waves
473 is one means of increasing the overall sample size and a
474 possible workaround for researchers desirous of investi-
475 gating diet across the survey waves. Similar to the
476 NDNS, a key feature of the BCS70 was the availability of
477 food diary data for the 1986 and 2016 survey wave. The
478 use of this method meant that diet-related information

479 captured was detailed and as a longitudinal survey, inter- 479
480 ested researchers could possibly assess differences or 480
481 changes in the diet of cohort members over time. How- 481
482 ever, researchers keen on accessing BCS70 food diary 482
483 data should note that data for both the 1986 and 2016 483
484 waves were being processed at the time of assessment 484
485 and the expected date of release is yet to be determined. 485

486 The traditional 24-h diet recall method captures all 486
487 foods and beverages consumed the preceding day, 487
488 ideally, over multiple or repeated assessment periods. 488
489 Dietary screeners or shortened instruments, however, 489
490 only assess one or two nutrients/food groups, such as 490
491 fruits and vegetables or calcium/dairy products [7, 19]. 491
492 The UK Biobank was the only survey in which 24-h diet 492
493 recalls were conducted on four separate occasions over a 493
494 10-day and 16-month period, respectively. Conversely, 494
495 respondents in the HSE and ALS were asked to recall 495
496 their consumption of fruits and vegetables, over a single 496
497 24-h period. This meant that a brief dietary assessment 497
498 instrument (screener) was used in both surveys, and not 498
499 the traditional 24-h diet recall method as initially as- 499
500 sumed. The traditional 24-h diet recall method is benefi- 500
501 cial in that it provides more precise estimates of 501
502 nutrients/food and estimates which are more representa- 502
503 tive of usual dietary consumption. Given that this 503
504 method captures all foods and beverages consumed over 504
505 repeated assessment periods, it may be useful to re- 505
506 searchers interested in exploring total diet, rather than 506
507 just key food groups such as fruit and vegetables. The 507
508 fruit and vegetable screener used in the HSE and ALS 508
509 may be more beneficial to researchers interested in 509
510 assessing current adherence to the national "5-A-Day" 510
511 (fruit and vegetable) dietary target or those interested in 511
512 exploring the association between fruit and vegetable 512
513 consumption, physical activity and related health out- 513
514 comes/chronic diseases. However, because the HSE and 514
515 ALS only captured consumption over a single 24-h 515
516 period, researchers should also bear in mind that day-to- 516
517 day variations in consumption cannot be accounted for. 517

518 FFQs often require that respondents indicate how 518
519 much and/or how often (e.g. daily, weekly) they con- 519
520 sume a set of listed foods over a specific period (e.g. over 520
521 a week, the last 12 months). Unlike the food diary and 521
522 24-h diet recall method, surveys which used FFQs are 522
523 beneficial as they are usually less burdensome and are 523
524 able to assess the usual diet of individuals over a long- 524
525 term period, with the added benefit of larger sample 525
526 sizes [23]. However, because some FFQs are comprised 526
527 of a short, pre-selected list of foods, (sometimes referred 527
528 to as dietary screeners) many aspects of diet are not 528
529 measured, which may make them prone to systematic 529
530 errors and not be entirely reflective of diet consumption 530
531 at the population level [9]. For instance, in Under- 531
532 standing Society, respondents were primarily asked about the 532

533 number of days in a week they eat fruits and vegetables
 534 and the number of portions consumed on those days.
 535 Although this captures some elements of diet, the
 536 survey's emphasis on fruits and vegetables may make it
 537 inappropriate for researchers more interested in explor-
 538 ing diet in its entirety.

539 **Methodological changes and changes to survey questions** 540 **over time**

541 As expected, more than a half of the surveys reviewed
 542 either had changes made to the type and number of
 543 questions asked and the level of detailed captured over
 544 time or the survey design/methodology used. For in-
 545 stance, the NDNS, established in 1992, initially consisted
 546 of four separate cross-sectional surveys which captured
 547 data for individuals from specific age groups (e.g. per-
 548 sons aged 19–64 years in 2000–2001), 18 months and
 549 older, across the 1992–2001 period. However, with the
 550 introduction of the rolling programme (the NDNS RP)
 551 in 2008, the survey changed from a series of ad-hoc age-
 552 group specific surveys, to an annual repeated cross-
 553 sectional survey for all age groups. As a result, data
 554 captured prior to 2008 may not be easily compared with
 555 NDNS RP data, which could affect researchers interested
 556 in assessing food consumption in England, especially by
 557 age. Besides methodological changes, as expected there
 558 were notable changes to the type and number of diet-
 559 related questions posed across the survey waves. How-
 560 ever, the most noteworthy were those made to the HSE
 561 across the survey waves. Prior to 2009, the HSE had a
 562 “Fruit and Vegetable Consumption” module in addition
 563 to an “Eating Habits” module, which captured the fre-
 564 quency of consumption for at least 12 food items via a
 565 FFQ. Food categories included: cheese, red and white
 566 meat, fried food, sweets, fizzy drinks, among others.
 567 However, since 2009, the HSE only captures data on
 568 fruit and vegetable consumption, as it is currently the
 569 primary survey used by Public Health England to moni-
 570 tor the Government's national “5-A-Day” target [17].
 571 Although the survey is currently focused on fruit and
 572 vegetable consumption, it should be noted that the
 573 “Fruit and Vegetable Consumption” module was com-
 574 pletely omitted from the survey in 2012, for all age
 575 groups and was omitted in 2014 for persons 16 years
 576 and older. These changes could possibly affect re-
 577 searchers interested in monitoring fruit and vegetable
 578 consumption specifically for the 2012 and 2014 survey
 579 period, as well as persons interested in merging and
 580 analysing data across several survey waves, inclusive of
 581 the 2012 and 2014 waves.

582 The rapid and ever-evolving field of nutrition science
 583 could possibly explain some of the changes observed in
 584 the surveys reviewed over the paper's 1970–2018 review
 585 period. However, it should also be acknowledged that

586 survey content, questions asked over time and the meth- 586
 587 odology used is ultimately based on the overall purpose 587
 588 and intended use of the survey, and the priorities, inter- 588
 589 ests and needs of survey administrators/Governmental 589
 590 Departments/primary stakeholders, rather than the re- 590
 591 search interests of researchers/users of secondary data. 591
 592 For instance, although surveys such as the HSE capture 592
 593 some aspects of diet, researchers should recall that the 593
 594 survey's main purpose or focus is not on diet, but on 594
 595 capturing the overall health status of the population and 595
 596 associated risk factors. Also, changes to the type of sur- 596
 597 vey questions asked and the level of detail captured over 597
 598 time, is heavily dependent on the financial, physical and 598
 599 human resources available. Whilst funders and data col- 599
 600 lectors are cognisant of some of the general interests 600
 601 and data needs of secondary data users, they are also 601
 602 faced with the tremendous challenge of balancing the 602
 603 needs of primary stakeholders and reducing survey costs 603
 604 and participant burden [15]. Researchers therefore need 604
 605 to be aware and constantly keep abreast of survey 605
 606 changes (such as those highlighted in this paper) and 606
 607 their potential impact (positive or negative) on research 607
 608 and devise workaround strategies needed to meet their 608
 609 unique research needs, as far as possible. 609

610 **Geographical areas and groups targeted across the** 611 **surveys**

612 Another major consideration which researchers should 612
 613 acknowledge is the different geographical areas/regions 613
 614 and target groups captured across the surveys. All re- 614
 615 peated cross-sectional surveys reviewed were nationally 615
 616 representative and the BCS70, MCS and Understanding 616
 617 Society were the only nationally representative longitu- 617
 618 dinal studies reviewed. SWS, BiB and ALSPAC could be 618
 619 beneficial for researchers interested in tracking changes 619
 620 in the diet-related behaviours of cohort members from 620
 621 birth through to adulthood. However, it should be noted 621
 622 that these surveys were only focused on certain regions 622
 623 of England, (specifically Southampton, Bradford and 623
 624 Bristol/Avon Health Authority and surrounding areas, 624
 625 respectively), of interest to the respective survey admin- 625
 626 istrators/academic institutions. Similarly, the UKWCS, 626
 627 Whitehall II, EPIC, BRHS, BWHHS and UK Biobank 627
 628 were not representative of the English population, as 628
 629 they targeted certain groups within the population, such 629
 630 as women, middle-aged persons, middle-class persons, 630
 631 vegetarians or members of the Civil Service. Groups 631
 632 which although of possible interest to some researchers, 632
 633 were specifically aligned to the interests and needs of the 633
 634 administrators/academic institutions responsible for 634
 635 these surveys. 635

636 In terms of the repeated cross-sectional surveys 636
 637 reviewed, a key feature of the ALS was its annual sample 637
 638 size of over 198,000 individuals and data at the local 638

639 authority level. The ALS was the only repeated cross-
640 sectional survey reviewed in which data below the
641 Government Office Region (GOR) level was readily
642 available in survey datasets. The ALS could be especially
643 beneficial to researchers (e.g. public health geographers)
644 interested in exploring diet (fruit and vegetable
645 consumption) and possible variations at the national, re-
646 gional and sub-regional/local authority level. However,
647 persons interested in accessing data below the regional
648 (GOR) level should note that this information is not in-
649 cluded in the general End User License for the HSE,
650 NDNS, LCFS or Food and You survey datasets. This
651 type of information needs to be specially requested and
652 approved, and in some instances (in case of the HSE), at
653 an additional cost, to cover data processing and adminis-
654 tration fees. Based on the General Data Protection Regu-
655 lation (GDPR) and other disclosure guidelines, the UK
656 Data Service has instituted strict measures regarding
657 access to sensitive data (e.g. lower-level/sub-regional
658 geographical data), which could be used to reveal the
659 identity of participants [17]. These are other consider-
660 ations researchers need to acknowledge when trying to
661 decide the survey(s) best aligned to their unique research
662 questions/interests.

663 **Strengths and weaknesses of this review**

664 The research presented involved a detailed process to
665 provide researchers, especially those interested in con-
666 ducting secondary data analysis, with an overview (incli-
667 sive of key features and practical considerations) of 17
668 major diet-related repeated cross-sectional and longitu-
669 dinal surveys conducted in England over the past 48
670 years (1970–2018). A major strength is that the findings
671 presented in this paper should save researchers inter-
672 ested in diet-related research, time and well-needed re-
673 sources in compiling this type of information from
674 scratch. This structure is one that may be easily repli-
675 cated as a follow-up as resources change, providing a
676 clear template for the evaluation of available sources for
677 secondary data analysis of population diet in England.
678 This review did not discuss new and emerging
679 technology-based dietary assessment methods (e.g. web-
680 based and mobile device applications or the use of “big
681 data”), which is a limitation. However, such methods are
682 still not clearly defined and not comprehensively cap-
683 tured in repositories or widely available for re-use [24,
684 25]. Also, the surveys reviewed may not be exhaustive of
685 all diet-related surveys conducted in England over the
686 1970–2018 period. The paper’s focus on longitudinal
687 and repeated cross-sectional surveys meant that surveys
688 conducted only once were not included within this re-
689 view. Therefore, cross-sectional surveys such as the
690 Low-income Diet and Nutrition Survey (LIDNS) and
691 What about Youth (WAY), conducted in 2003–2005

and 2014–2015 (respectively) were not assessed. The de-
692 tailed description of the pros and cons of the different
693 dietary assessment methods used in surveys was not
694 within the scope of this review. As a result, the review’s
695 failure to discuss the availability of biomarker data in
696 surveys such as the NDNS and the usefulness of this
697 kind of information for validating self-reported dietary
698 data, was another limitation. 699

The review process used in this paper was time con-
700 suming but was a task which assisted the paper’s Review
701 Team (MC, DS, JB, GM and CV) in identifying the sur-
702 veys most appropriate for their individual research pro-
703 jects. During this process, the need for a review of the
704 current status of diet-related surveys conducted in
705 England over time was identified, particularly if benefits
706 and the practical considerations to using surveys datasets
707 could be incorporated as part of a review. Although the
708 survey documentation required to conduct the review
709 was readily available online from the UK Data Service,
710 CLOSER, CDRC and the MRC Cohort Directory, to the
711 best of our knowledge, no resource exists which provides
712 a comprehensive list and background on the major re-
713 peated cross-sectional and longitudinal surveys in
714 England. Although Rippin et al. [20] previously assessed
715 the current status of nationally representative surveys in
716 Europe, it focused on the 53 countries in the WHO
717 European region and not England specifically. Griffith,
718 O’Connell & Smith [11] noted some benefits and possi-
719 ble limitations of diet-related surveys in England. How-
720 ever, unlike this review, their assessment was limited to
721 only three data sources: the NDNS, LCFS and Kantar
722 Worldpanel. Coleman [6] comprehensively summarised
723 16 longitudinal surveys conducted in England, over the
724 2005–2015 period. However, Coleman’s report was not
725 focused on diet-related behaviours because it was
726 intended to provide the Department of Education with
727 the information necessary to plan interventions and
728 meet the educational needs of children and young per-
729 sons under age 19. This review has helped to fill this gap
730 in the literature. Overall, the findings presented indicate
731 that although several diet-related surveys have been
732 conducted over the years, each with their own unique
733 benefits/features, there are still several practical consid-
734 erations which researchers should note when consider-
735 ing the survey(s) best suited to their research interests. 736

737 **Conclusion**

738 Diet-related surveys continue to be the major source of
739 information used by researchers and policymakers to as-
740 sess dietary patterns, monitor trends over time, evaluate
741 the success/failure of interventions and identify potential
742 inequalities. It is highly unlikely that any survey con-
743 ducted will meet all the needs of researchers. Addition-
744 ally, data-related challenges faced by researchers will

745 inevitably vary based on the nature of the research ques-
 746 tion(s). Regardless, it is still vital that researchers clearly
 747 define their research question(s), critically analyse the
 748 secondary survey data available (as done in this paper),
 749 gain a full understanding of the unique survey character-
 750 istics and note key considerations, before delving into
 751 data sets. In some instances this may mean that initial
 752 research questions may have to be modified or refined,
 753 where data of interest may be limited, unavailable, in-
 754 consistently captured across survey waves, captured/de-
 755 fined in a manner not befitting to research questions or
 756 perhaps too costly to access based on financial con-
 757 straints. Although not ideal, this is one possible strategy
 758 which may help to save time and money and could help
 759 researchers to make the best use of the data currently
 760 available.

761 Enhanced communication and engagement between
 762 data collectors, data users (existing and new/emerging),
 763 data repositories, funding agencies and policy makers
 764 could help to ensure that the data being collected is ap-
 765 propriate and cost-effective to inform policy and inter-
 766 vention development. However, researchers using
 767 secondary data must acknowledge that change is inevit-
 768 able and that the type of dietary assessment used, the
 769 type of questions included and the level of detail cap-
 770 tured in surveys over time, ultimately depends on the
 771 priorities and interests of primary stakeholders, the over-
 772 all purpose and intended use of the survey, and the fi-
 773 nancial, physical and human resources available. With
 774 the increasing prevalence of sub-optimal diet and as re-
 775 search budgets continue to tighten, funding agencies,
 776 governments and research institutions are constantly
 777 having to consider new, cost-effective and creative
 778 methods (e.g. big data and digital technology) of main-
 779 taining existing repeated cross-sectional and cohort
 780 studies, retaining survey participants and overcoming
 781 geographical constraints. In light of these challenges, re-
 782 searchers therefore need be cognisant of these practical
 783 considerations, and as far as possible, make every effort
 784 to make “effective, proper and good use” of the second-
 785 ary data currently available, in order to conduct the re-
 786 search necessary for the creation of more evidence-
 787 based diet-related policies and interventions in England.

788 Abbreviations

789 ALS: Active Lives Survey; ALSPAC: Avon Longitudinal Study of Parents and
 790 Children; BCS70: British Cohort Study 1970; BiB: Born in Bradford;
 791 BRHS: British Regional Heart Study; BWHHS: British Women’s Heart and
 792 Health Study; CDRC: Cohort Directory and the Consumer Data Research
 793 Centre; CLOSER: Cohort and Longitudinal Studies Enhancement Resources;
 794 CLS: Centre for Longitudinal Studies; CV: Christina Vogel; DEFRA: Department
 795 for Environment, Food and Rural Affairs; DS: Dianna Smith; EFS: Expenditure
 796 and Food Survey; EPIC: European Prospective Investigation into Cancer and
 797 Nutrition; FFQ: Food frequency questionnaire; FSA: Food Standards Agency;
 798 GDPR: General Data Protection Regulation; GM: Graham Moon;
 799 GOR: Government Office Region; GP: General Practitioner; HSE: Health Survey
 800 for England; JB: Janis Baird; LCFS: Living Cost and Food Survey; LIDNS: Low-

income Diet and Nutrition Survey; MC: Monique Campbell; MCS: Millennium
 Cohort Study; MRC: Medical Research Council; NDNS: National Diet and
 Nutrition Survey; NHS: National Health Service; PHE: Public Health England;
 RP: Rolling Programme; SWS: Southampton Women’s Survey; UCL: University
 College London; UK: United Kingdom; UKWCS: UK Women’s Cohort Study;
 WAY: What about Youth; WHO: World Health Organisation

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Authors’ contributions

MC conceived and designed the study, acquired the survey documentation
 and completed the review. DS, GM, JB and CV refined the review design and
 assisted with interpretation of results. MC drafted the manuscript; all authors
 revised and approved the final version

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The authors declare no conflict of interest.

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Q1	Author names: Please confirm if the author names are presented accurately (given names/initials, family name). Author 1: Given name: Monique Family name: Campbell Author 2: Given name: Dianna Family name: Smith Author 3: Given name: Janis Family name: Baird Author 4: Given name: Christina Family name: Vogel Author 5: Given name: Emeritus Given name: Graham Family name: Moon	
Q2	Please check if the affiliations are presented correctly.	
Q3	Figure 1 contain poor quality text. Please provide replacement figure file. Otherwise, please confirm if we can retain the current presentation.	