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Piloting and producing a map of Millennium Cohort Study Data usage

Where are data underutilised and where is granularity lost?

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Executive Summary

Findings

- This study sets out to examine where MCS data are underutilised. To fit within the remit of the study, we hone in on ten priority question areas (Strengths and Difficulties Questionnaire, Child Social Behaviour Questionnaire, Diet, BMI, Immunisations, School Dis/like, Self-reported Friendships, Self-reported feelings, Screen Time, Hobbies)

- In total we found 481 unique studies that were using MCS data and undertaking primary analysis.

- Data that are collected through a recognised scale with defined thresholds or cut-off points for identifying constructs of interest and/or data that can provide a unique insight into a policy-relevant issue, are those most widely used in the MCS data.

- Strengths and Difficulties Questionnaire data embody these principles and are the most widely utilised of our ten areas, having featured as a focus in 121 studies.

- Data that were collected from the child's own reports (e.g. friendships and feelings) have seldom been utilised in comparison to data collected through parental reports (e.g. SDQ). Collection of data from multiple informants did not always correlate with higher levels of usage. Child self-reported data will become more important as the MCS children grow older, but it is unclear why these data are rarely used at age 7, although the nature of the scales and measures used is likely to be a factor. Future studies among children may also use these results to carefully consider the types of questions that are asked to younger children and their suitability for that developmental stage.

- Data on immunisations at age 3 and 5 did not feature in a great number of publications. However, those using MCS data were highly cited. One of the unique strengths of the MCS data is that they were able to directly reflect and address the research needs of policy-makers in terms of understanding antecedents of MMR uptake. Crucially, MCS data were able to provide a unique insight into uptake of single vaccines as well as combined vaccines; these data were not readily available elsewhere.

- Imposing thresholds on data was found to be problematic in some cases, for example for BMI, where a number of different thresholds for overweight and obesity were in use. The use of different thresholds can lead to substantial differences in the results obtained. Some users failed to report which definition was used, impeding the comparison of results.

Further ideas for good practice around the use of and reporting of MCS data

- **Encouraging notification of publication:** Currently CLS traces MCS publications through inviting users to notify the centre of publications and through additional web searching. Emphasising the importance of notifying CLS of publications using MCS data at the stage of accessing data may boost the number of studies that are traced.

• **Further development of a community of users (requires further funding/investment):** Establishing a searchable database of MCS users on the CLS website could help to further foster the community of users. The database could hold a short entry with users' contact details, topic areas of interest and key variables of interest. This would allow MCS users to develop links with others with similar interests, and potentially foster collaborations between users and across institutions. This database could also be used as the basis of future work in contacting users for consultations for future sweeps and other forms of user engagement. Participation in such a database would be voluntary although it could be encouraged when users obtain the data.

• **Recording publications with study level meta-data (requires further funding/investment):** Enhancing the functionality of the CLS library could allow for the recording of a greater number of fields on publications and a more efficient means of searching the library. Users notifying CLS of new publications could be invited to complete a template of meta-data about their publication including, for example, abstract, keywords, key variables used in the analysis, and other study-level meta-data. This enhanced functionality would assist in future exercises aimed at tracing MCS usage and would also be beneficial to future researchers to identify where data has been used previously and where they are underutilised. This would support the further development of a community of users.

• **Publishing the case for variables:** Most variables/measures included in MCS surveys go through a process of consultation which involves a written case being made by the research team/users for their inclusion. We recommend that a record of this process is published for new variables to allow users to understand why variables have been suggested (and included). For example in the case of hobbies data, which are not widely used, publishing this information would allow users to understand the rationale underlying new questions and may stimulate further use of the data.

• **Nominating variable champions:** Each variable that is included in MCS surveys is included usually after a written case has been made. 'Variable champions' could be nominated to provide some support or engage with in discussion around the use of those variables. In some cases this could include policy-makers and practitioners, which would foster links between academic users and other stakeholders.

• **Making MCS studies more identifiable:** Further guidance or emphasis of the importance of naming of MCS in publications' titles/abstracts/keywords may facilitate other reviews of data usage in future, and may give additional prominence to the study in the literature.

• **Principles of good practice in data analysis:** Although MCS data users are required to adhere to good practice, in terms of data security and to ensure that the confidentiality of respondents is preserved (among other elements), there is no part in the End User Licence (EUL) that explicitly covers other aspects of the ethical treatment of data. For example, Social Research Association (SRA) Ethical Guidelines state that researchers 'must conduct their work responsibly and in light of the moral and legal order of the society in which they practice' and must also 'not engage or collude in selecting methods designed to produce misleading results, or in

misrepresenting findings by commission or omission' [187, p18]. It would be expected that researchers using MCS data would be already adherent to the ethical guidelines set out by an association such as the SRA. A suggestion could be for the EUL for MCS data to include a reminder for users around the expectation that the data will be analysed appropriately and not in a way as to purposely misrepresent the results.

Specific recommendations around data and future research

• **Methodological development:** We recommend further exploration in terms of how a systematic approach to discovering, mapping and synthesising literature could be integrated with the further analysis of MCS data. An example might be the investigation of the relationship between BMI and behavioural outcomes. A systematic review could be conducted of studies using MCS data on BMI and child behaviour to synthesise the conceptual frameworks and to help design a model to be tested in the data, with covariates selected based on the results and/or recommendations of previous studies. This synthesised model (based on the synthesis of theory and previous results) could then be tested on MCS data, blending both the systematic review approach and new analysis of the data.

• **Further investigation of the Child Social Behaviour Questionnaire (CBQ):** We recommend that funding be sought for a project that would aim to investigate the measurement properties of the CBQ using MCS data. This could enhance further use of these variables.

• **Voice of the child studies:** Related to the earlier recommendation around publishing the written case for including variables in MCS, we recommend that this should start with those variables collected through child self-report at age 7. This could provide a basis for a programme of further analysis of variables that reflect the voice of the child. This perspective has been a concern among policy-makers and voluntary sector practitioners for a number of years [188] and there is substantial potential for MCS to make further contributions in this area.

• **BMI measures:** As described earlier, we recommend that variables that are deposited with flags for whether the child is obese/overweight are clearly marked according to the thresholds used for categorising overweight/obesity. Furthermore, users should be encouraged to explicitly report the thresholds used. Further work is currently underway to understand the implications of using different thresholds around overweight/obesity in MCS data.

1. Introduction and Background

1.1 The Millennium Cohort Study

The UK Millennium Cohort Study (MCS) is a longitudinal interdisciplinary study following the lives of 19,000 children born in the UK in 2000/1. The study recruited families of children born in randomly selected electoral wards, disproportionally stratified to boost representation of children from disadvantaged and ethnic minority families; further booster data sweeps have resulted in additional data being collected for Scottish and Welsh children. Information has been collected at 9 months, 3, 5, 7 and 11 years, with the next sweep of data collection underway among study members who are aged 14 years. Initially, over 19,000 households were recruited into the study; by age 7 the number of participating families had dropped to 13,800 and at age 11, fewer than 13,300 interviews were conducted. A wide range of data have been collected from children, parents and guardians, the partners of parents/guardians, older siblings and teachers, as well as sub-studies that collected data from health visitors; these include self-reported and objectively measured/verified data. In addition, contextual (observational and reported) data have been collected reflecting the children's homes, schools and neighbourhoods, and data linkage projects have enabled the capture of detailed neighbourhood contextual measures and educational outcomes through linkage with National Pupil Database records.

1.2 Procedures for data selection and challenges

Each wave of MCS data collects a wide range of data across a range of domains and from a range of actors in a child's life (named above). For example, the age 11 years questionnaire collected data from parents on the household composition, family context; early education, schooling and childcare; child and family activities and children's behaviour; parenting activities; children's health; parent's health; employment, income and education; housing and local area; parental mental well-being; relationship; attitudes and values; and socio-demographic data. These data can be linked to previous sweeps and models of causal inference can be developed. MCS sweeps are primarily designed in consultation with policy-makers and commissioners, researchers and the MCS-user community through a number of activities. These consultation activities have usually included a consultative conference for recent MCS sweeps where new proposals for questions are discussed openly as well as the usability of questions that were fielded in previous sweep(s). In the run-up to a consultative conference, theme leaders are selected to solicit comments and information from the wider policy and research community. As each included question incurs a substantial cost in fieldwork, new questions are openly scrutinised by the survey team, as well as in public forums, and tested in pilot surveys. After publication of the data, descriptive reports are generated showcasing the analytical potential of different survey modules/themes; and additions can be made to deposited data (for example data linkages and derived variables) at different points. Attempts are made by MCS team to collect information on all publications using MCS data and users are invited to notify the survey team on any publication using the data. These sources are published on the CLS bibliography (see http://www.cls.ioe.ac.uk/Bibliography). In June 2015, the bibliography held approximately 440 sources that were described as using MCS.

Up to the present time, the analysis of existing patterns of data usage have involved cursory analysis of the literature as well as being based on the input of experts through consultation activities or independently through assorted means. No other evaluation activities are undertaken after data are collected and publicly deposited to assess the usage and usefulness of different forms of collected data. Potentially, this can result in some research areas/questions having comparatively low impact, but nevertheless being consistently collected across sweeps without challenge. All questions are included in the MCS survey at substantial cost, making maximising the use of their data all the more important. In addition, any subsequent analysis that occurs as a result of uncovering underutilised data could uncover significant findings for policy and research.

Furthermore, the way in which data are used has also not been assessed fully; for example, information on children's diets are collected to a high level of detail (e.g. identifying whether children eat 'fish on Fridays' for religious reasons) but low sample sizes may mean that such specific information is rarely used by MCS users, or is instead collapsed to form larger aggregations due to sample size constraints. Of particular concern are (i) those data that have been collected repeatedly across sweeps but where they have not been widely used and (ii) those data that are collected with high degrees of granularity but which are rarely used in disaggregate form.

1.3 Objectives

The objectives of this work are to (i) identify where potentially under-explored areas of data may lie for MCS users; (ii) to inform the design of future sweeps of the MCS and other child cohort studies by highlighting where data are rarely used; (iii) to inform the design of future sweeps/studies by highlighting examples where detailed response categories are rarely used.

Mapping out the totality of MCS data usage would be an undertaking beyond the scope of the current project, and in conjunction with the MCS study team, priority areas of research were identified based on specific topic areas, questions or scales. These topic areas were intended to represent data known by the investigators to be well used in studies, as well as representative of data that are thought to be underutilised.

This therefore means that the current study is not a systematic map of how all MCS data are used, but is more focussed on core sets of questions/modules.

1.4 Existing reviews and challenges

This type of review has not been undertaken with reference to a particular survey in the past and this represents a pilot systematic mapping exercise, rather than a systematic review. The distinction between a systematic review and the mapping exercise described here being that this mapping exercise is inclusive with regards to study quality and study design, and that a tightly bound research question is not driving the current study. One known systematic review of MCS data ([1]) exists which examined the impact of the involvement of fathers on the mental health outcomes of children, mothers and fathers themselves. This type of study is distinct from the findings described here through the included studies being bound by a common research question and use of a common dataset, as opposed to being bound by common usage of specific variables.

There are several challenges of the approach adopted here which are outlined in the limitations. Briefly, the main challenge in the current study is in terms of establishing that data are underutilised (establishing that they are not used) as opposed to remaining unpublished. As with most research that is ultimately dependent on the secondary analysis of published research, establishing that the published literature is representative of the totality of scientific enquiry is a challenge, and publication bias describes the case where studies remain unpublished (particularly in peer-reviewed literature) due to the significance of their findings, their focus, their perceived novelty, or other reasons. A comprehensive search strategy and encompassing inclusion criteria can go some way to limiting such bias, through ensuring that studies that are published in lower impact journals, as working papers or in theses are included. However, publication bias remains a caveat of the results presented, and statistical methods of exploring the presence of publication bias are inappropriate to this mapping exercise. Identification of whether data are used is also a challenge, particularly in studies using data such as the MCS where variables of interest may be included alongside a battery of other variables, and we describe our strategy for identifying relevant studies in the methods section.

2. Methods

2.1 Choice of topics

Reviewing the full scope of how data were used from the Millennium Cohort Study was beyond the scope of this pilot mapping project. Instead, ten question areas were selected intended to be representative of question areas hypothesised to be well used in the literature, as well as question areas hypothesised to be rarely used. The intention was to contrast how different question areas are used in practice, to identify where data are underutilised and to identify the perceived strengths and weaknesses of MCS data as reported by authors (see Box 1).

2.2 Identifying studies – piloting and implementing the search criteria

Two approaches were considered in identifying studies. The first approach involved developing separate search strategies for each of the ten areas in focus and implementing these across different sources. Broadly this search strategy would consist of three parts (descriptors for the data, descriptors for the question area, additional detail around the questions/question area). The second approach involved implementing a single search of the literature for studies using terms for 'MCS' data, and then two rounds of screening to identify relevant studies across the ten areas of interest among these studies. Because we were concerned that subject specific searches may not capture the heterogeneity in terminology used to describe question areas across disciplines, we conducted further testing based on the second approach. Adopting this second approach meant that although the search may be simpler to implement, the screening would be more complex as studies would have to be screened across subject areas simultaneously.

We conducted further testing of a search strategy that was based on variants of MCS and one which was implemented across a number of datasets. We were able to compare our results against the CLS bibliography. The CLS bibliography is populated through web searching and through notification by study authors of publications that use CLS data. Specifically, we tested whether a simple search based on 'millennium cohort study' and variants (see Appendix 1) would be sufficient to capture studies or whether a more in-depth search strategy was necessary.

We conducted preliminary searches based on the simpler set of search terms in Appendix 1 and compared these to a snapshot of 60 publications in the CLS bibliography (approximately 15% of records held for CLS publications). Of these 60 studies, fourteen were identified as problematic as they did not appear in our initial set of studies. When we examined these records further we found that six would not meet our inclusion criteria (see later section) as they did not use MCS data directly but instead reported on the results of MCS data published elsewhere (for example [2]). Of the remaining eight studies identified, we found that a search that included the terms in Appendix 1, which looked for their occurrence anywhere in the document (as opposed to title and abstract only) and implemented through Scopus and Science Direct, located seven of these studies. The remaining study was a CLS working paper and was not indexed in these sources; as a result CLS working papers were added as a specific source. This testing was used to justify our approach of implementing a small search across a large number of databases to locate

studies using MCS data, and then to screen the results for inclusion across any one of the chosen subject areas. One deviation from this was in our search for economic literature, where the search on EconLit was expanded to include terms reflecting 'birth cohort' (and UK geography) as well as those in Appendix 1; this did not yield additional results after screening. The following sources were searched at the end of July through to mid-August 2015 (and the sources reflected the diversity in our choice of data; see Box 1):

Source	Description and Implementation	Results
Applied Social Sciences Index and Abstracts	Covering health, social services, psychology, sociology, economics, politics, race relations and education	Search for terms occurring anywhere in the text; 44 results
Australian Education Index	Contains more than 200,000 entries on education	Search for terms occurring anywhere in the text; 1159 results; additional criteria imposed on search (NOT (veteran OR "US military" or PATENT)
Australian Institute of Family Studies catalogue	Social sciences	Search for terms occurring in title, abstract, descriptor, heading word, original title, keyword; 7 results
British Education Index	Index to the contents of significant education journals published in the UK (note as of Aug 2014 merging with EBSCO)	Search for terms occurring anywhere in the text; 25 results
British Nursing Index	Collection of nursing and midwifery journals covering 400 titles	Search for terms occurring anywhere in the text; 1159 results; Additional criteria imposed on search (NOT (veteran OR "US military" or PATENT)
Data Citation Index	Includes content from more than 80 established, curated repositories spanning multiple disciplines	Implemented in 'topic'; 20 results
EconLit	American Economic Association's electronic bibliography	Search for terms occurring anywhere in the text; 22 results; additional searches also conducted
Education Resources Information Centre database	Library of education research and information, sponsored by the Institute of Education Sciences (IES) of the US	Search for terms occurring anywhere in the text; 28 results
EMBASE	Elsevier biomedical database	Search for terms occurring anywhere in the text; 261 results
Euro PubMed Central	30.4 million+ abstracts and 3.3 million+ full text research articles from PubMed and PubMed Central	Search for terms occurring anywhere in the text; 417 results

Source	Description and Implementation	Results
Geobase	Includes Human Geography (and other geographic/environmental sciences)	Search for terms occurring in title, abstract, descriptor, heading word, original title, keyword; 53 results
Google scholar	Multidisciplinary	100 records included for screening
Health Management Information Consortium	A compilation of data from two sources, the Department of Health's Library and Information Services and King's Fund Information and Library Service	Search for terms occurring anywhere in the text; 53 results
International Bibliography of Social Sciences	Abstracts and indexes the international literature in social science and interdisciplinary research from 2,800 journals with 7,000 books added annually	Search for terms occurring anywhere in the text; 57 results
IOE Digital Education Resource Archive (DERA)	A digital archive of documents published electronically by government and other relevant bodies in the areas of education, training, children and families	Search of title only; 7 publications
JSTOR	Multidisciplinary digital library of academic journals, books, and primary sources	Search for terms occurring anywhere in the text; 269 results
Labordoc	Largest collection of knowledge on the world of work	Search for terms occurring in title, abstract; 2 results
PsycInfo	American Psychological Association database of journals in the social and behavioural sciences	Search for terms occurring anywhere in the text; 140 results
PubMed	More than 25 million citations for biomedical literature from MEDLINE, life science journals, and online books	Search for terms occurring anywhere in the text; 290 results
Science direct	Includes scientific, technical, and medical research	Search for terms occurring anywhere in the text; 206 results
Scopus	The largest abstract and citation database of peer-reviewed literature: scientific journals, books and conference proceedings	Search for terms occurring anywhere in the text; 722 results

Source	Description and Implementation	Results
Social Policy and Practice	UK focussed; draws upon five of the UK's leading bibliographic collections of social policy and practice	Search for terms occurring in abstract, title, publication type, heading word, accession number; 185 results
Social Services Abstracts	Abstracts and indexes the international literature in social work, human services, and related areas, including social welfare, social policy, and community development from 1,300 titles	Search for terms occurring anywhere in the text; 12 results
Sociological Abstracts	Abstracts and indexes the international literature in sociology and related disciplines in the social and behavioural sciences from almost 2,000 titles	Search for terms occurring anywhere in the text; 34 results
SPORTDiscus	Sports and sports medicine journals (670 titles)	Search for terms occurring anywhere in the text; 68 results; Additional searches also conducted
TRID	Transportation research database	Search for terms occurring in title, abstract, descriptor, heading word, original title, keyword; 2 results
UK Data Archive	Contains a list of projects using different data sources	List of projects obtained
Zetoc journals	Contains over 29,000 journals and more than 52 million article citations and conference papers through the British Library's electronic table of contents	Search for terms occurring anywhere in the text; 203 results

2.3 Identifying studies – inclusion criteria

All records were inputted into EPPI-Reviewer 4 for further screening (4,329 records). Records were first screened for duplicates, with just under half of records identified as duplicates and excluded (2,056 records). All remaining records were screened on the basis of title and abstract by two reviewers (DK and MK); any disagreements that could not be resolved were to be referred to other team members (although this did not prove to be necessary).

It is worth noting that this mapping exercise is focussed on the 'study' as the unit of interest and not the 'publication'. Therefore, some records that are treated as individual publications on the CLS library are coded as duplicates here; for example, while both publications below are treated as separate entries on the CLS library (as it has a diffident focus), in the present study we would default to the most recent publication (which usually corresponds with the journal publication).

• JACKSON, M, KIERNAN, K and McLANAHAN, S. (2011) Immigrant-Native Differences in Child Health: Does Maternal Education Narrow or Widen the Gap? Working Paper WP10-11. Princeton, NJ: University of Princeton.

• JACKSON, M.I, KIERNAN, K and McLANAHAN, S. (2012) Immigrant–Native Differences in Child Health: Does Maternal Education Narrow or Widen the Gap? Child Development, 83(5), 1501-1509.

All studies using MCS data of interest (see Box 1) were considered to be eligible. These ten areas were prioritised with input from MCS investigators and were selected to represent:

- related topics/scales where usage could be contrasted by the type of scale used (e.g. SDQ and CBQ for dimensions of child behaviour);
- topics where usage could be contrasted in terms of respondent (parent/teacher reports (SDQ; CBQ) vs child report (feelings, school dis/like, friends));
- related topics where usage could be contrasted in terms of whether they are usually specified as outcomes or as antecedents (outcomes (e.g. BMI) and antecedents (e.g. Diet, screen time))
- topics of high policy relevance (arguably all fall within this category, but immunisation was selected as representative here). Those interested in using the immunisation data would also have had substantial opportunities to work with and publish from these data.

This meant that some important areas, and notably cognitive development, were sacrificed in order to conduct a more thorough examination of these constructs. Similarly, there are a large number of questions that provide a snapshot of parental characteristics and broader contextual factors that could have been included, but were too diffuse to be included in the approach here.

Initial title and abstract screening mainly focussed on whether the data being used were MCS data. This included excluding studies using data from a US-based Millennium Cohort Study (a study of military veterans) and the Gateshead Millennium Cohort Study. Full texts of records that were deemed eligible on the basis of title and abstract screening were retrieved and subject to a second round of screening by two reviewers (DK and MK), who read the texts in full to establish eligibility. Both used a list of questions and potential synonyms for the terms used in questions to establish eligibility. We retrieved the full record for 224 publications to examine their relevance at this stage. All records were deemed ineligible if they:

- Did not 'use' MCS data (and either used different data or did not include primary analysis)
- Were a review or systematic review (and did not include primary analysis)
- Were a news item (including news items reported in journals where the full text paper was published elsewhere)
- Were a book review
- [Were a duplicate]
- Did not clearly focus on an area of interest (see Box 1)

Included studies were those that used one of the question areas in Box 1 as a main dependent or independent variable in their analyses. These were defined on the basis of the scope of the study as outlined in the aims/objectives or research questions. Where studies did not clearly specify a clear independent variable of interest in the aims/objectives – for example the study explored which of a range of factors predicted a specific outcome of interest – then we examined whether there was a focus on the question areas of interest in the literature review or conceptual framework. In particular, we aimed to exclude studies where the question area in scope here was being used only as a background control variable; this was often made apparent in studies when full parameter estimates in statistical models were not published, made available, or discussed in the write up. Studies could be included as being relevant across multiple areas of interest.

2.4 Data extraction and synthesis

Information was extracted on the following characteristics of studies:

- Country of lead author
- Institution of lead author
- Study sweep of data used
- Other data sources analysed in study
- Which questions used in analysis (which measures were fielded from which respondent at which sweep)
- Aims/objectives of study
- Which analytical methods used in analysis; additional study design notes
- Whether measures were used as outcome variable or main predictor of interest (see text above for definition)
- Conclusions/results
- Strengths of the data/measures
- Difficulties reported in using data/measures and/or study limitations
- Recommendations for future research/data collection
- Journal discipline
- Citations of study (based on Google Scholar)

Data extraction forms were piloted first before being completed for each study. Where a reviewer was unable to populate a particular field, the advice of a second reviewer was sought. The data were synthesised and presented according to themes separately for the ten measures/topics of interest. These themes were developed from pre-defined categories and new categories that emerged from the data. These categories were compared and contrasted and studies were then grouped into a coherent framework according to key themes that emerged, for example around how and why data were selected and used, the strengths and weaknesses of using particular sets of measures in particular ways, and the recommendations that were made for future research.

Box 1: Choice of data

1. Strengths and Difficulties Questionnaire (SDQ)

The Strengths and Difficulties Questionnaire (SDQ) measures children and young people's behaviour, emotions and relationships. It is composed of five domains: (i) emotional symptoms, (ii) conduct problems, (iii) hyperactivity/inattention, (iv) peer problems and (iv) prosocial behaviour. Each question is scored 0 (not at all true), 1 (partly true), or 2 (certainly true), with some question reverse coded. Four domains (i-iv) are summed together to calculate a total difficulties score [3]. The SDQ was selected as a question area that was thought to be well utilised, and the focus here was on understanding whether there were any particular factors surrounding the collection or availability of SDQ data that may facilitate extensive usage.

2. Child Social Behaviour Questionnaire

The Child Social Behaviour Questionnaire (CSBQ) is an extension of the Adaptive Social Behaviour Inventory [4], and has been implemented in different forms across different sweeps of the survey (see later section). The CSBQ is distinguished from other measures, including the SDQ, through including a focus both on pro-social and anti-social behaviours [5]. Three domains are covered in the CSBQ: independence and self-regulation; emotional dysregulation and cooperation [6]. The focus here in particular was on understanding how CSBQ is used in studies compared with well-known alternatives such as the SDQ.

3. Diet

Several questions have been developed and fielded around children's diet and nutrition in the MCS. Data on children's diet are thought to be generally well used in the literature. However, the comprehensive nature of the questions – which include more general fields such as frequency of consuming portions of fruit to more specialist data such as whether children eat fish on Fridays for religious reasons – mean that it is likely that some questions or areas may rarely be used in published studies. Our focus here is on distinguishing which questions are commonly used in sweeps 2, 3 and 4 and which are rarely used.

4. BMI

Along with questions about diet and SDQ data, data collected on children's BMI are thought to feature in several publications using MCS data. However, of particular interest here is the way in which BMI data are used – for example are BMI data used in continuous form or do researchers more commonly use the grouped data measuring whether children are overweight or obese. The grouped data have historically been derived and deposited using International Obesity Task Force thresholds for identifying obesity/overweight among children (based on the gender and age of the child); the UK90 thresholds are an alternative set of 'rules' to categorise children as being obese/overweight.

5. Immunisation

It is hypothesised that immunisation data collected at 9 months has been used in several MCS-based studies. However, the extent to which 'completed' immunisation histories have been used in studies is unknown and the focus here is on establishing the way in

which immunisation information collected at ages 3 and 5 years have been used in studies.

6. Hobbies

Two of the earlier British birth cohort studies (1958 and 1970) have fielded extensive questions on surveys (albeit at later ages), which have been used in different disciplines, for example in examining resilience among young people [7]. Age 7 saw the inclusion of a self-completion module that asked children about their hobbies, and we investigate the use of these data in published studies.

7. Children's feelings

One of the weaknesses of measures such as the SDQ is that it is reliant on the observations of parents/teachers and not a reflection of the child's own perceptions. Through asking about children's feelings at age 7 via a self-completion module, the MCS attempted to capture the child's voice, and we investigate the use of these data in published studies.

8. School dis/like

Several 'objective' and established measures of cognitive development and school readiness are collected in the MCS. Additional questions capturing the child's own perceptions of school may provide additional insight and may be predictive of future indicators of school performance and adjustment. School dis/like has been used in studies examining the outcomes of older children and young people in terms of engagement in risk behaviours [8], and the focus here is on how these data are used to examine the outcomes of younger children in the MCS.

9. Friends

Through asking about children's friendships at age 7 via a self-completion module, the MCS attempted to capture the child's perception of their peer group, and we investigate the use of these data in published studies.

10. Screen time

BMI and diet are issues that are thought to be well used in studies using MCS data. However, another important predictor of BMI is thought to be physical activity and sedentary behaviour. Here the focus is on examining how widely used indicators of sedentary behaviour at ages 3, 5 and 7 are used, and how these data are used in studies.

3. Results

PRISMA Flow Diagram

Identification

Records identified through database searching
Scopus n=722; Econlit n=22; Geobase n=53; Sport Discus n=68; Jstor n=269; Trid n=2; Sociological abstracts n=34; Social policy and practice n=185; AEI n=1141; ASSIA n=44; British Education Index n=25 DERA n=7; EMBASE n=261; ERIC n=28; Europepmc n=417; Google scholar n=85; HMIC n=53; IBSS n=57; Labordoc n=2; PsychInfo n=140 PubMed n=289; Science Direct n=206; Zetoc n=203; Social Services Abstracts n=12; Total n=4,329

Additional records identified through other sources (n = 64)

Screening

Total records (n = 4,934)
Records after duplicates removed (n = 2,348)

Records screened (n = 2,344)

Records excluded on the basis of title and abstract

STUDY NOT ABOUT MCS n=1638;
EXCLUDE - STUDY IS A REVIEW OR SYSTEMATIC REVIEWn=39;
EXCLUDE - NEWS ITEM OF MCS n=162; EXCLUDE - MCS BOOK REVIEW n=7;

STUDY NOT FOCUSSED ON AREA OF INTEREST BUT IS MCS n=258;

Eligibility

Full-text articles assessed for eligibility (n = 460; unique records = 223)

Included

Studies included for f/t screening immunisation (n = 27) Studies analysed (n = 11)

Studies included for f/t screening diet (n = 40) Studies analysed (n=11)

Studies included for f/t screening SDQ (n = 152) Studies analysed (n = 121)

Studies included for f/t screening child behaviour (n = 117) Studies analysed (n = 7)

Studies included for f/t screening hobbies (n = 9) Studies analysed (n = 1)

Studies included for f/t screening school dis/like (n = 5) Studies analysed (n = 2)

Studies included for f/t screening screen time (n = 20) Studies analysed (n = 16)

Studies included for f/t screening 'feelings' (n = 7) Studies analysed (n = 2)

Studies included for f/t screening friends (n = 5) Studies analysed (n = 2)

Studies included for f/t screening BMI (n = 78) Studies analysed (n = 49)

- The initial results of the flow of studies show the number of studies using the ten topics of focus as their prime in/dependent variables.
- The total number of MCS studies identified was 481. This is a similar number of records as found on the CLS Bibliography at the time of the search (481 vs 440); however, the results presented here are likely to represent a greater volume of studies (as opposed to publications) as we do not include duplicates in the form of
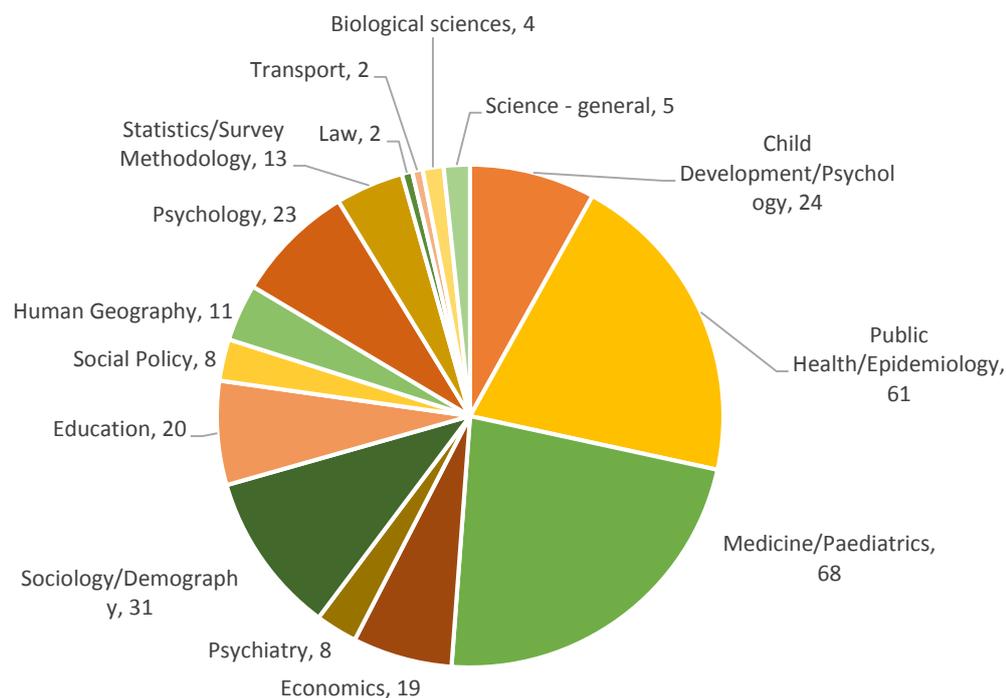
working papers or reports, and do not include reviews, reports or news of other MCS studies that do not include primary analyses of MCS data (including, for example, the review of fatherhood studies discussed earlier [1]).

- We can already begin to see that those measures that have been collected across sweeps – diet, BMI, SDQ and screen time - are comparatively well used. Those measures that have started to be collected at age 7 (and first made available in 2010) have had a lower usage. In the next sections we disaggregate these patterns further.

- We examined where studies were published and found that the majority were published as journal articles (62.2%), over a quarter (28.1%) of studies were published as reports (or report sections in edited volumes), working papers and conference papers; with approximately one-in-twenty studies published as theses (4.2%), or books or book chapters (5.6%).

- MCS data were used across disciplines when we examined the journal discipline[1]. Reflecting the lag between data being made available and the time taken for publication, a number of publications used data from early sweeps and were published in public health/epidemiology journals (20.4%) and medicine/paediatric health journals (22.7%). Around one fifth of publications featured in psychology/psychiatry/child development journals (18.4%) while the data were also used extensively in studies published in educational (6.7%), economic (6.4%) and sociological/demographic journals (10.4%) (see Figure 1 for a full breakdown).

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[1] The categorisation of journal discipline should be considered as an approximation based on the journal title and in some cases the journal description. In a number of cases the journal could be placed in multiple disciplines – for example a publication in the journal Dyslexia could be categorised as either belonging to Education, Psychology or Child Development (in this instance it was coded as belonging to Child Development/Psychology). In most cases however, there was a clearer distinction.

Figure 1: Journal discipline of MCS articles published up to July 2015

Biological sciences, 4
Transport, 2
Science - general, 5
Statistics/Survey Methodology, 13
Law, 2
Child Development/Psychology, 24
Psychology, 23
Public Health/Epidemiology, 61
Human Geography, 11
Social Policy, 8
Education, 20
Medicine/Paediatrics, 68
Sociology/Demography, 31
Psychiatry, 8
Economics, 19

3.1 Strengths and Difficulties Questionnaire

Which questions are available by sweep?

Table 1: Strengths and Difficulties scales (summary) fielded in MCS surveys

	Age 3	Age 5	Age 7
Emotional symptoms (scale; *5)	✓ (PR)	✓ (PR)	✓ (PR) ✓ (TR)
Conduct problems (scale; *5)	✓ (PR)	✓ (PR)	✓ (PR) ✓ (TR)
Hyperactivity/Inattention (scale; *5)	✓ (PR)	✓ (PR)	✓ (PR) ✓ (TR)
Peer problems (scale; *5)	✓ (PR)	✓ (PR)	✓ (PR) ✓ (TR)
Pro-social (scale; *5)	✓ (PR)	✓ (PR)	✓ (PR) ✓ (TR)
Total difficulties (4 scales)	✓ (PR)	✓ (PR)	✓ (PR) ✓ (TR)
Perceived impact	✓ (PR)	✓ (PR)	✓ (PR) ✓ (TR)
Difficulties on areas of life	✓ (PR)	✓ (PR)	✓ (PR) ✓ (TR)

PR: Parental report; CM: Cohort member report; TR: Teacher report

- Over successive sweeps, the focus of Strengths and Difficulties Questionnaire is switching from the parent being the sole respondent to input being collected from teachers[2]. Each scale displayed above is composed of a number of questions which are fielded in full in the sweeps.

How many studies are using SDQ as their main focus
- We found 121 studies that used SDQ measures as the main focus of their study (that included measures taken at waves 2, 3 and 4), either as an outcome variable or a key predictor. This accounted for approximately a quarter of all publications discovered in these analyses.

Where are SDQ data being used?
- We extracted data on the host institution of the first named author[3]. Figure 2 displays the institutions and authors that published three or more publications that met the inclusion criteria. The UCL Institute of Education was the institution for three-in-ten of first named authors (31%), with UCL (12%) and York University (9%) following closely. Two organisations that were not higher education institutions also published three or more studies using SDQ information as the primary focus (Institute of Fiscal Studies and Demos).

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[2] However, teachers have less than complete response, and at 11 were only surveyed in England and Wales (not Northern Ireland)
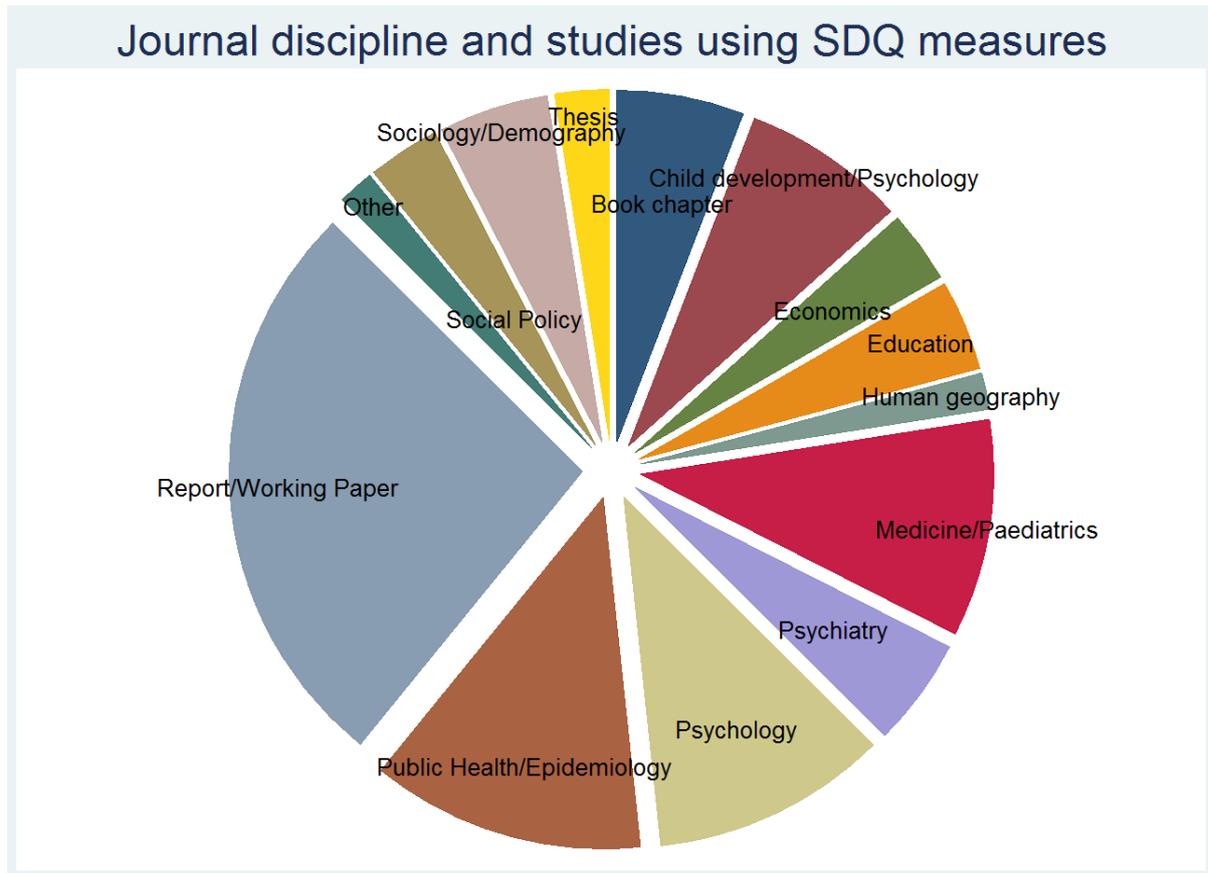[3] For most disciplines, first named author would equate to the lead author. However, in economics and related disciplines, the convention is to list authors alphabetically.

Figure 2: Countries and Institutions – Use of Strengths and Difficulties Questionnaire in the MCS
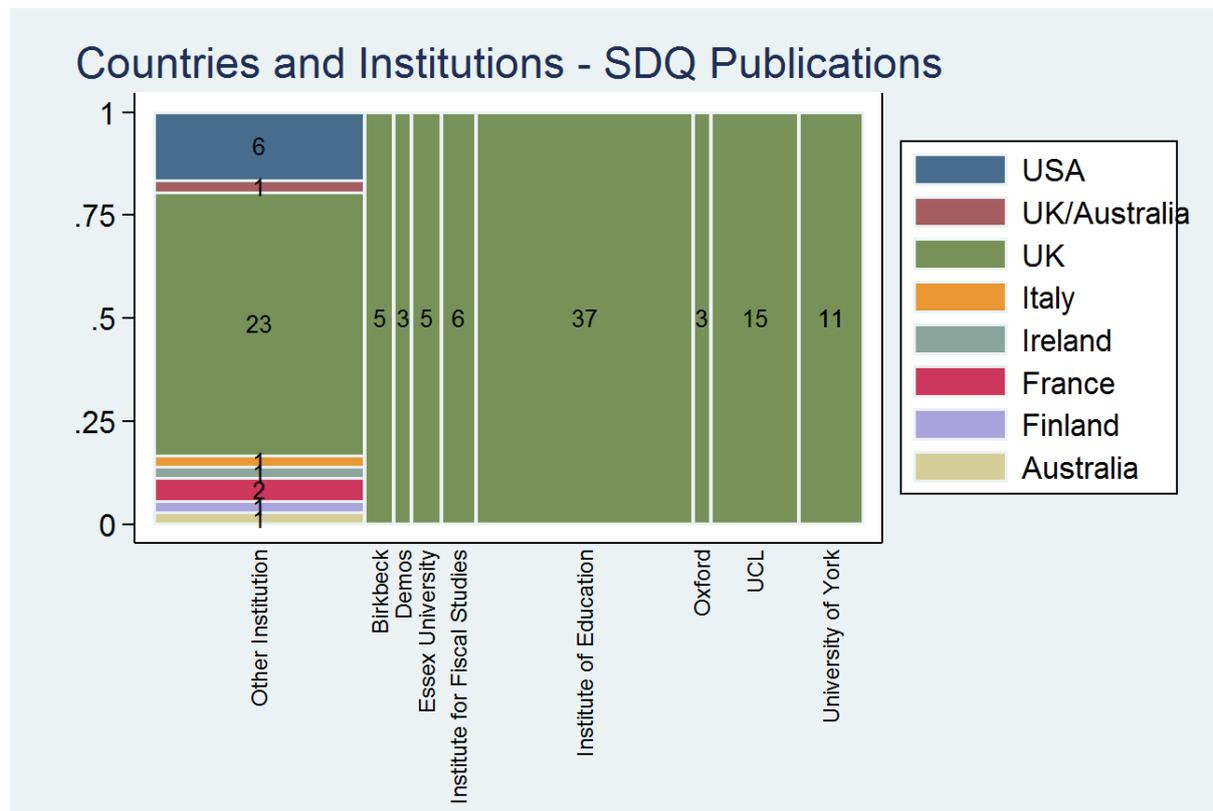
- The majority of publications originated in the UK (89%) followed by the USA (5%). Other countries included Finland, Australia, France, Ireland and Italy.
- Some authors were prolific users of MCS data, with one author alone being named as first author in 12% of studies we discovered.
- Of the thirteen studies conducted by first named authors based outside the UK, five used other sources of data in the study (comparative analyses). In contrast, just nine out of 108 studies with UK-based first authors conducted comparative work with other studies (including other UK-based studies). Nevertheless, the majority of authors based outside the UK using SDQ data rely solely on MCS data to conduct their studies.
- Despite the geographic bias of MCS data and the over-representation of Welsh, Scottish and Northern Irish children, just 8 studies originated from first authors based in Wales (4), Scotland (1) and Northern Ireland (3). However, country specific reports were produced by authors based in England and elsewhere.
- Of the 121 studies, 12% appeared in public health/epidemiology journals, 11% appears in psychology journals and 10% appeared in medical journals. However, over a third (35%) of studies were not found in academic journals but in reports, working papers, theses or book chapters.

Figure 3: Use of Strengths and Difficulties Questionnaire in the MCS by Journal Discipline

Journal discipline and studies using SDQ measures

Thesis
Sociology/Demography
Other
Social Policy
Report/Working Paper
Book chapter
Child development/Psychology
Economics
Education
Human geography
Medicine/Paediatrics
Psychiatry
Psychology
Public Health/Epidemiology

- The absence of publications in Psychology journals is perhaps most stark given the nature of the measure (and that most studies used SDQ as an outcome variable rather than a predictor of other states (see later analysis)). In addition, none of the five institutions with the greatest research capacity in terms of FTE staff working in Psychology and Psychiatry (UCL, Kings College, Edinburgh, Oxford and Cambridge[4]) were represented among first authors publishing in these disciplines and using MCS SDQ data.

Which sweeps and questions are used in the literature?
- We classified each study on the basis of all data used in the study (including SDQ data and other variables) finding that the majority of studies used data from multiple sweeps (74%). The most common research designs involved using data from the first three sweeps of MCS (18% of studies) and sweeps 2-4 (14% of studies), while a further set of studies used data from four sweeps (10%). While the majority of studies used data from multiple sweeps, several studies did not incorporate the repeated measures of SDQ data in longitudinal study designs. Although the methods employed are likely to have been appropriate for the research questions being addressed, there may be further scope for undertaking analyses that take advantage of the repeated measures of SDQ.

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[4] http://results.ref.ac.uk/DownloadSubmissions/ByUoa/4

- All studies used the parental reports of SDQ; just seven studies were coded as using teacher reports of SDQ and in all seven studies these data were used alongside parental reports of SDQ. Teacher and parent reports were used in different ways in these studies. In some studies, the use of teacher reports alongside parent reports aided cross-cohort comparisons with other data (for example [9]); in others examining the congruence between teacher and parent SDQ reports was a specific aim of the study (for example [10]), while in others comparisons between teacher and parental reports aided in qualifying/validating the study findings, for example in a study of irregular bedtimes and reports of behaviour at home and in the classroom [11].
- The SDQ measure is composed of five subscales. A total difficulties measure is calculated based on four subscales (emotional symptoms, conduct problems, hyperactivity/Inattention, and peer problems) and does not usually contain the pro-social scale. The total difficulties measure is derived and deposited with MCS data and all scales are summated and deposited as continuous data. Researchers treated SDQ data as continuous variables, but also frequently imposed recommended thresholds for problematic (normal, borderline or abnormal) behaviour (see www.sdqinfo.com), transforming the data into categorical measures. Some studies exercised caution in applying the recommended thresholds, reflecting analytical (sample size) concerns as well as methodological concerns around a clear definition of caseness (for example [12]).
- We examined descriptions of SDQ analyses and the results to identify how SDQ variables were used in studies. The majority of studies incorporated the parental total difficulties score into their analyses, although overall there was great heterogeneity in the use of SDQ MCS data (see Table 1); two-fifths of studies relied solely on the total difficulties score (39%, 47 studies).

Table 2: Use of SDQ in studies using MCS data

Data used	Number of	(%) studies
Total difficulties only	47	39.2
Total difficulties & 5 separate scales	18	15.0
Total difficulties & other combination	6	5.0
5 scales individually	7	5.8
4 scales individually	4	3.3
Internalising/Externalising scores	9	7.5
Total difficulties, 5 separate scales & other combination	2	1.7
2 scales individually	6	5.0
3 scales individually	4	3.3

Other combination	17	14.2

Information for one study was not obtained

- There was no clear trend between the journal discipline in which the study was published and the combination of SDQ scales used.
- We found only one example where a single question was used as the basis for analysis). This was in the case of a study examining children's subjective well-being and used whether parents viewed their children as 'often unhappy' (an item from the emotional symptoms subscale [6]) as one indicator of children's well-being [13]. We also found other studies that used items from SDQ outside the SDQ scoring framework. For example, Delaney and Doyle (2012 [14]) use items from the hyperactivity/inattention scale in combination with two items from the Child Social Behaviour questionnaire to derive three factors (inhibition, compulsivity, impulsivity) in their examination of socioeconomic differentials of 'time discounting'. Some items from SDQ were also used to construct behaviour scores in the evaluation of Sure Start [15-17].

How are SDQ data used in the literature?
- The majority of studies used SDQ data as a dependent variable of other conditions, states or events experienced in childhood (108 studies, 89%)[5]; eight studies used the data to predict other states while three studies used reciprocal modelling frameworks where it was not clear whether SDQ data were being used as an independent or dependent variable, or where one sub scale was used as a predictor of other subscales.
- The majority of studies used regression or more advanced techniques to analyse SDQ data. Five studies relied on more descriptive analyses ([18-22]), these tended to be included as chapters in the MCS reports of initial findings. SDQ data were used in different forms of regression models (OLS, logistic, Poisson, Probit, Quantile, Fixed effects and Multilevel Random Effects), simpler forms of multivariate analysis (factor analysis, ANOVA), structural and simultaneous equation models and related strategies including growth curve models. Each of these strategies were well represented in the data; other techniques including event history analysis and propensity score matching were also used in a more limited range of studies. The range and complexity of methods used to analyse SDQ data was in contrast with the simpler range of techniques adopted in other subject areas. Furthermore, several studies did adopt a hierarchical framework and exploited the longitudinal nature of SDQ measures in MCS data.

What has using MCS SDQ data uncovered?
A full analysis of the findings from 121 studies is beyond the remit of the current report and while it is not possible to do justice to the large body of literature emanating from these data, some of the selected findings as presented by theme below (not all 121 studies are represented below):

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[5] We include bivariate analyses here where SDQ data were treated as an outcome of a given condition – e.g. living a particular area or living in a particular family configuration.

Circumstances at birth and during pregnancy and SDQ outcomes

- MCS data have been used to establish that light consumption of alcohol during pregnancy was not associated with cognitive defects when MCS children were aged 3, 5 or 7 years [23-25]. The data have also been used to establish a protective association between breastfeeding and lower risk of behavioural problems among children aged 5 years [26]. However, the latter relationship is not consistent to all studies, suggesting that there remains some uncertainty regarding the significance of the relationship between behavioural outcomes and breastfeeding [27, 28]. Other studies also examined circumstances during pregnancy and birth, finding associations between smoking in pregnancy and behavioural problems in childhood [29], and examining associations between whether births were planned and/or their conception assisted [30], and younger age at motherhood [31, 32] and behavioural problems.

- Other circumstances surrounding birth were also found to be significantly predictive of behavioural outcomes, including the month of birth, with children born in August at greater risk of poorer socio-emotional development than children born in September, particularly with respect to hyperactivity and conduct domains [33]; lower birthweight was also found to predict lower levels of socio-emotional adjustment, particularly for girls [34].

Poverty, Discrimination and Deprivation and SDQ scores

- A separate set of studies examined relationships between different aspects of poverty, disadvantage and discrimination. They generally found a significant relationship between increased risk of children's behavioural problems and disadvantageous life circumstances [for example 35, 36-40]. However poverty was not synonymous with behaviour problems, and different studies examined the factors that enabled children to be resilient to disadvantageous socioeconomic circumstances [41], and identified several mediators and moderators [for example 42, 43] with many focussed on parenting [43, 44] and childcare [45]. Some have examined the way in which these factors are clustered among different ethnic groups, finding that socioeconomic factors as well as parenting, childcare, family health and well-being and home learning environment largely explain any apparent ethnic differences [46]. A further study suggested that a difficulty in tackling these risk factors was that they were not clustered, introducing an added layer of complexity to any intervention strategy [47]. A further study also noted the methodological complexity in distinguishing the way in which risk factors accumulated, and highlighted the importance in testing the way in which these were moderated by other proximal and cumulative factors using theory-led analyses [48].

- Similarly, other researchers also uncovered the interrelationships between poverty and other domains, including one well-known study by Kiernan and Huerta which quantified the separate and collective impact of economic deprivation and maternal depression [49]. A further study noted the additional importance of maternal mental health in predicting children's behaviour compared to paternal mental health [50]. Totsika and colleagues' study [51] suggested that the relationship between maternal mental well-being and children's behaviour was not

bidirectional; instead the evidence suggested that lower maternal well-being was associated with higher levels of child behavioural problems across several sweeps.

Families, homes and communities and SDQ scores
- Some studies were focussed on disentangling the effects of neighbourhoods from the impact of schools – finding that both levels of neighbourhood human capital and rurality had a residual impact on some dimensions of SDQ once school and socioeconomic background had been accounted for [52, 53], although other studies (based on different sweeps of data) suggested that family socioeconomic status may explain the association between area risk and broad psychopathology [54].
- Other studies have focussed on specific neighbourhood attributes, such as green spaces, as predictors of behavioural adjustment [55] or the level of neighbourhood social housing [56], as well as examining the role of different factors in moderating the relationship between area characteristics and childhood behaviour, including cognitive ability [57].
- MCS data have been used to examine the impact of residential mobility on behavioural outcomes, with Flouri and colleagues uncovering that movement in early childhood was associated with higher risk of behavioural problems (but not emotional problems after adjustment for confounding variables) [58].
- One study examined the impact of living in Sure Start[6] areas with matched MCS children, finding that children in Sure Start areas had better behaviour scores [15].
- In one study examining the differences in childhood outcomes between children living in England and Scotland, the results were used to question the focus of the extant body of literature investigating geographic disparities in adult health outcomes, which has tended to focus on foetal/birth determinants as opposed to examining inequalities emerging in early childhood [59].
- A body of literature has examined SDQ scores as an outcome of family structure and relationships [60-66]. While the results differ slightly between studies, they tend to suggest that while socio-emotional well-being may be lower in households that do not contain both natural parents in bivariate analyses, the results are substantially attenuated, often to statistical insignificance, by the inclusion of factors reflecting socioeconomic circumstances and other selection effects, as well as relationship quality, and maternal mental health [64].

SDQ scores as predictors of public health and other outcomes
- SDQ data were used to predict other public health issues including lower levels of partaking in (organised) physical activities [67]. However, a different study established that increased hours of screen time (TV, computer games etc.) was associated with higher levels of behavioural problems [68], suggesting that the relationship between screen time/physical activity and SDQ problem behaviour may be bidirectional.
- MCS SDQ data have contributed to the understanding of how children with autism and/or intellectual disability develop compared with other children [19, 51, 69-75]. Russell and colleagues' study for example [72], examines the relationship between

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[6] Sure Start was an area based initiative aimed at giving every child the best start in life through improving childcare, early years education, health and family support among children growing up in the most deprived parts of England.

autism, ADHD and SDQ scores, finding that both autistic children and those with ADHD experienced elevated risks of behavioural difficulties.

- SDQ scores were indicative of other developmental changes in childhood. For example, SDQ scores were found to be predictive of language changes during childhood [76]; similarly children who, when asked about their future career aspirations at age 7, answered with a 'fantasy' occupation (e.g. superhero) were more likely to exhibit hyperactivity, conduct or peer problems [77].

What impact has the analysis MCS SDQ data had?
- Studies that have used MCS SDQ data have been cited a total of 2355 times (correct as of November 2015)[7].

- SDQ data has formed an important component part in at least four theses, two of which were conducted in US universities and one each at the University of York and the UCL Institute of Education.

What are the main strengths and weaknesses of SDQ data in MCS?[8]
Strengths
- There was a good deal of consistency among authors in terms of the strengths identified. Many of the strengths identified by study authors revolved around the size of the datasets [for example 20, 29, 32, 37, 77-79], but more specifically the (national and country) representativeness and breadth of the MCS study which allowed for the adjustment of several known and hypothesised confounders in models [for example 14, 25, 26, 30, 35, 37, 57, 64, 67, 71, 76, 80-85]. The longitudinal nature of the MCS study was also highlighted as a strength in several studies [for example 68, 69, 86]. In many cases, the longitudinal nature of data collection allowed for the examination of how behaviour changed before, during and after specific events or developmental milestones, such as the diagnosis of autism in the case of Dillenburger and colleagues [19].
- Specific strengths of SDQ measures revolved around their repeated collection which enabled the implementation of longitudinal modelling and contributed to the understanding of developmental trajectories [for example 10, 19, 76, 83, 87] and some of the moderators (and mediators) of these trajectories. For example, the repeated nature of SDQ observations was used by Midouhas and colleagues to examine how trajectories of psychopathology were moderated by family-level circumstances among children with autism [71]. Many of these studies specifically implemented modelling techniques that exploited the longitudinal nature of SDQ data.
- Other strengths included that the data were collected from different informants [10, 23, 38, 88], which allowed for a degree of validation between reports, as well as the collection/availability of data across different SDQ domains, which allowed for a deeper understanding of contextual risks of psychopathy [54].

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[7] In the case of some book chapters and report chapters, the citations are based on those for the whole book/report where a citation estimate for individual sections was unavailable.
[8] Note, while the studies named here are coded as explicitly discussing these strengths and weaknesses, these are likely to have been considerations shared among all study authors in their choice of data and others too, besides those named above, may have expressed similar points in less explicit ways.

Weaknesses

- The most frequently cited weakness was a risk of bias and subjectivity (or shared variance in reporting with other measures), brought about by SDQ representing a parental (usually mothers') or occasionally teacher report of behaviour [24, 25, 29, 32, 37, 38, 42, 44, 52, 62, 63, 70, 74, 83, 85, 86, 89-97]. This was sometimes associated specifically by the added risk of bias based on maternal mental health and differential reports of child behaviour [38, 91]. Two additional studies cited the lack of child or objective reports of SDQ as being a disadvantage of the data [44, 90].

- One study reported that the peer problems domain had shown weak internal consistency in the MCS and other data, and this domain was not used in the analyses [91].

- Some studies viewed the fact that SDQ was fielded to children age 3 (as opposed to age 4+) and that the factor structure hadn't been validated for children of this age as being disadvantageous [50, 54, 57], although Flouri and colleagues' study did discuss evidence of how findings from an earlier study partly mitigated this potential weakness [57].

- Other critiques of SDQ were that it potentially lacked sensitivity in detecting behavioural difficulties among ethnic minority children [38] and that it didn't necessarily reflect the intensity of children's behaviour or their responsiveness to contextual effects [10], or that it didn't capture the full range of difficulties faced by some groups of children, notably children with autism [71].

- Some authors named potential limitations that were based on the design of the MCS, for example sample size among particular groups or geographies of children [69, 97-99]; the larger sampling error among estimates for children from ethnic minority children was also viewed as a potential weakness [18, 21]. Other potential limitations in the study design were that the window of time may be too long or too short between sweeps to detect effects [100] or that the limited number of time points (usually between age 3, 5 and 7; the focus of our study) were insufficient to model the full form of trajectories [42, 51, 86].

- Other limitations or weaknesses were generally not necessarily specific to the SDQ data, or to the MCS even, and included that not all potential confounding factors had been included in models or that not all potential selection effects had been accounted for [15, 52, 55, 58, 70, 101] or that missing data, attrition or sample composition impeded the generalisability of the findings to wider populations [42, 48, 53, 85, 102].

What recommendations do researchers make for future research using SDQ data?9

- The following are some of the main themes around the recommendations that are emerging from MCS studies using SDQ data. Some studies' recommendations were aimed more towards policy-making audiences (which were not in focus here) [see examples in 10, 12, 86]. Few recommendations were made on the basis of any specific limitations of the SDQ measure/data itself per se, but were more reflective of general ways of enhancing the robustness of study findings.

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9 Note, while the studies named here are coded as explicitly making these recommendations, these may have been considerations shared among all study authors and others too, besides those named above, may have made similar recommendations in less explicit ways.

Nevertheless, the volume and diversity of research recommendation emanating from the research suggests that despite SDQ variables being one of the most widely used sets of questions profiled here, there remains substantial research potential in existing data that can be enhanced with further waves of data collection.

- The most consistent recommendation made was to enhance the longitudinal aspects of analyses, either through incorporating existing sweeps into the study or incorporating data from future sweeps, and was crystallised by some as examining the long-term impact of experiences or states [21, 32, 36, 38, 45, 59, 67, 73, 76, 77, 79, 101, 103] or examining longitudinal trajectories [38, 103].

- Some researchers recommended testing the generalisability of their findings, through examining for the presence of the same identified relationships in other data [76, 101], or among older children (related to the points specified above [80, 104]); or with specific groups of children and/or among more general populations of children where the study had focussed on a subset of children [26, 48, 54, 69, 80, 90].

- Another frequently occurring recommendation was for future researchers to unpack the underlying mechanisms behind some of the observed associations or to examine alternative mechanisms or pathways [23, 29, 30, 37, 52, 55, 63, 81, 82, 100, 102]. One study specifically mentioned searching for the presence of relationships that may occur in the opposite direction to those identified in the study [81], while another suggested further disaggregation of the associations identified [88].

- A number of studies recommended further research to examine the contribution of potential moderating effects or in identifying potentially modifiable mediating variables [21, 29, 42, 49, 51, 56, 105]. Arguably, such enhancements would aid decision-making/targeting of vulnerable children, and a sub-set of studies recommended further research examining the contribution of specific policies or policy changes in moderating behavioural outcomes [9, 95].

Additional points
- While the data are deposited with pre-constructed variables these generally aren't mentioned in studies.
- Our search for SDQ studies also uncovered one study that had used the data in an unprincipled way through undertaking bivariate analyses and using these to support a prejudicial argument in the paper, while not acknowledging the limitations of such superficial analysis.

3.2 Hobbies

Which questions are available by sweep?
- Information on hobbies and interests was self-reported by cohort members at age 7 and children were asked how much they liked undertaking the activities in Table 3.

Table 3: Self-reported hobbies and interests questions fielded in MCS surveys

	Age 3	Age 5	Age 7
Listening to or playing music			✓ (CM)
Watching television, videos or DVDs			✓ (CM)
Drawing, painting or making things			✓ (CM)
Using a computer or playing games like X-Box or Playstation			✓ (CM)
Playing sports and games outside			✓ (CM)
Playing sports and games inside			✓ (CM)

CM = Cohort Member Report

- After searching, we found that only the descriptive report for that sweep included data on hobbies and interests as a main focus of interest [106]. This report found several trends by child characteristics in terms of the hobbies children preferred. For example, gender appeared to consistently pattern the way in which children reported partaking in hobbies, with girls more likely than boys to report liking drawing, painting and making things as well as listening to and playing music, and boys more likely to report liking watching television, playing computer games and playing sports inside and outside. Other differences by region, child's ethnicity, parental education and household income were also reported, although gender appeared to be the most consistent predictor of hobbies/interests preferences (based on bivariate analyses).
- It should be remembered that the caveat to the findings above is that our concern here is on identifying studies that used these data as a main focus of the study. Other studies have used the questions above, although not necessarily as the main focus. For example, Harris and colleagues examine how sight loss impaired participation in hobbies and interests at age 7 (specifically drawing and painting) in their study for the Royal London Society for Blind People and Royal National Institute of Blind People. This study is not included here as hobbies are among 60 indicators included to examine how children with sight loss experience life differently [107]. Other examples are also likely to exist, and furthermore the full utility of the data collected may only become apparent at a later date. However, some of the expected uses of these data, and particularly those questions that represent (other) indicators of screen time don't appear to feature in the literature around sedentary behaviour, physical activity and impacts on BMI; instead authors appear to favour more objective indicators for frequency of behaviour found in parental reports.

3.3 Self-reported friends and friendships at age 7

Table 4: Self-completed friends questions fielded in MCS surveys

	Age 3	Age 5	Age 7
How many friends do you have?			✓ (CM)
Are your friends mostly boys, mostly girls or a mixture of boys and girls?			✓ (CM)
Do you have any best friends?			✓ (CM)
How much do you like playing with your friends?			✓ (CM)

CM = Cohort Member Report

- We were primarily interested in the use of data collected through cohort members' self-reports of the number of friends, the strength of friendships, gender mixing and how much children like to socialise with their friends (see Table 4). Similar questions are fielded at age 11 (see [108]). Further data were collected through parental and teacher ratings of peer relationships collected through the Strength and Difficulties Questionnaire, although these were not included here.
- We initially identified five studies as being potentially focussed on the questions identified above. However, three of these were excluded as they either did not use data from the sweep of interest, did not use the data of interest, or in the case of a report on child development in Wales, friendships were not the focus of the study [99].
- The remaining two studies were the descriptive report for the sweep [109] and a report on child well-being [13]. The first report examined how patterns of friendships varied by a number of child and family characteristics. It found that friendship patterns varied by gender, region of residence, ethnicity and family characteristics such as parental education and household income. For example girls were more likely to report having lots of friends, as were children living in Wales and Northern Ireland compared to their peers in Scotland and England. Girls were more likely than boys to report having mixed gender friendships (47% vs 35%), while Pakistani and Bangladeshi children were less than half as likely to report mixed gender friendships as White and Black children (18% vs 43% and 45% respectively).
- Chanfreau and colleagues' examined the role of friendships as a key predictor of MCS child well-being using multivariate logistic regression models, finding that children who had only some or not many friends were around half as likely to report being happy as those with lots of friends [13].
- Neither of the included studies described any specific strengths or difficulties in using data on friendships.

3.4 BMI

Which questions are available by sweep?

- Information on BMI was collected from children at all sweeps after the first sweep based on height and weight data.

How many studies are using BMI as their main focus?

- We found 49 studies that used BMI measures as the main focus of their study (that included measures taken at sweeps 2, 3 and 4), either as an outcome variable or a key predictor. This accounted for a tenth of all publications discovered in this exercise and after SDQ, BMI was the most frequently used set of data within our ten areas of focus.
- Some studies were excluded as they focussed on BMI at age 11 [110] or were excluded as they focussed just on height, weight [111], or in three cases, waist circumference or other measures of adiposity [112-114]. Included studies were those that used height and weight data to calculate BMI or used BMI to calculate whether children could be classified as obese or overweight.

Where are BMI data being used?

- Of the 49 included studies, 44 were conducted with a first author based in a UK university[10]; 4 were conducted in the USA and a further study in Finland.
- Almost half of studies were conducted with first named authors based in UCL (excluding the Institute of Education: 22 studies); authors based at the UCL Institute of Education and Birkbeck accounted for 6 studies and 4 studies respectively, while authors based at Princeton, Swansea and Leeds University accounted for 2 studies each, and studies were also conducted in a further twelve institutions.
- Studies focussed on BMI were almost exclusively published in journals categorised as Public Health/Epidemiology (18 studies) and Medicine (11 studies). Around a quarter of studies appeared in reports, book chapters and theses. All publications with first named authors based in the UCL Institute of Education were in the form of book chapters or reports (see Figure 4). Studies focussed on BMI were rarely published in journals that were not focussed on Medicine or Public Health/Epidemiology; exceptions included Child Development/Psychology (2 studies) and Social Policy journals (1 study).

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[10] For most disciplines, first named author would equate to the lead author. However, in economics and related disciplines, the convention is to list authors alphabetically.

Figure 4: Disciplines and Institutions – Use of BMI data in the MCS
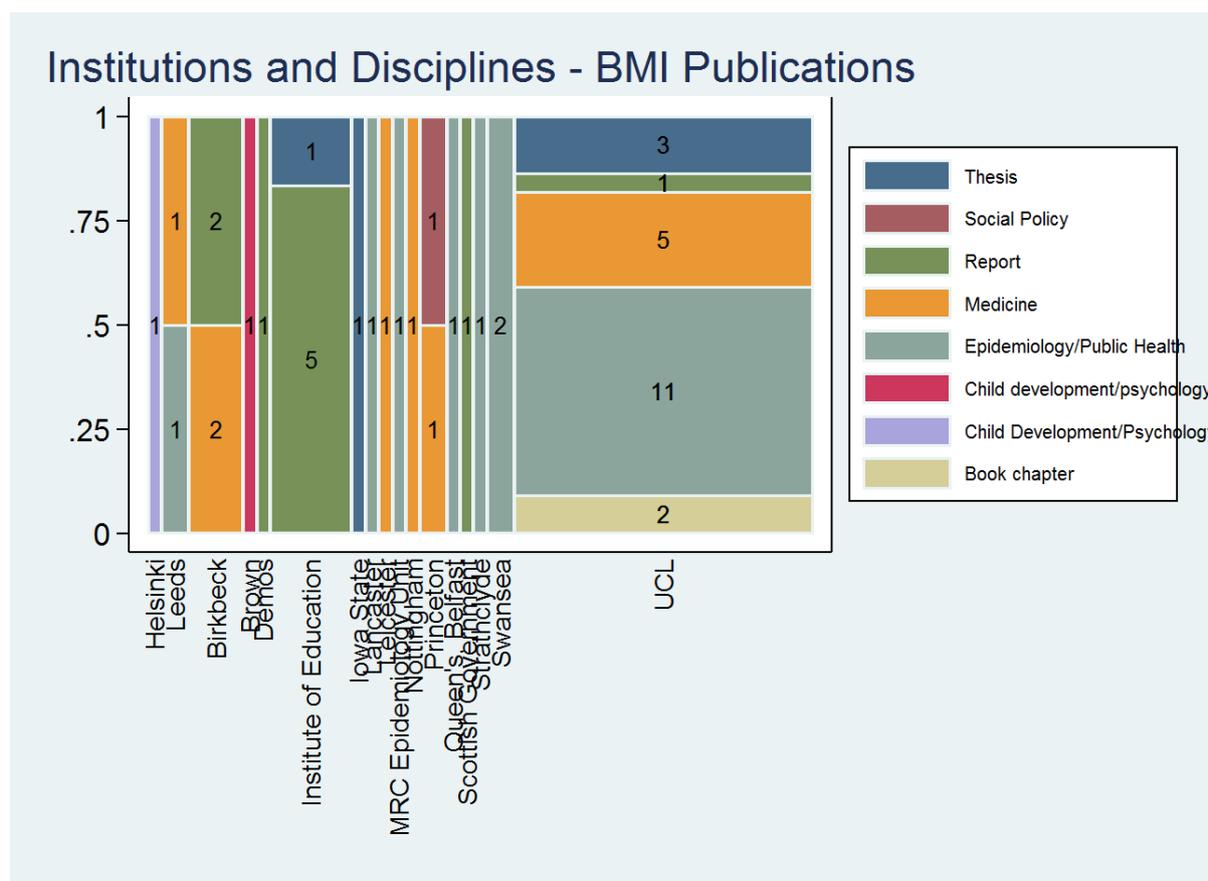
Which sweeps and questions are used in the literature?
- The majority of studies used data from multiple sweeps (35 studies). Of those using data from a single sweep, the majority were published as reports or other grey literature (9 out of 14 studies).
- BMI is calculated in a standard way and has been measured consistently in the sweeps of interest (ages 3-7). However, thresholds for calculating whether children are overweight or obese differ. Four different sets of thresholds are in existence: the British 1990 growth reference (UK90) thresholds, International Obesity Task Force (IOTF), World Health Organization Child Growth Standard thresholds (WHO) and 2007 thresholds (WHO 2007), and United States Centers for Disease Control and prevention 2000 growth reference (CDC) [115]. One study did not examine children's risk of becoming obese or overweight per se, and examined BMI solely as a continuous variable [116].
- The UK90 thresholds are now the recommended standard for identifying obese and overweight children in England by the National Obesity Observatory, although these are recommended for children aged 4 years and over [115]. In contrast, MCS data have been deposited with obesity flags based on IOTF thresholds (ages 3, 5 and 7 years). Comparisons between studies using different thresholds are discouraged. Different thresholds possess different strengths and weaknesses [117]; for example while UK90 thresholds can be used to classify the height and weight centile of children unlike the IOTF, the IOTF thresholds are recommended for international comparisons as they are based on children from a number of ethnic groups.

Figure 5: Thresholds used to identify obese and overweight children in the MCS

Thresholds used to identify obesity/overweight
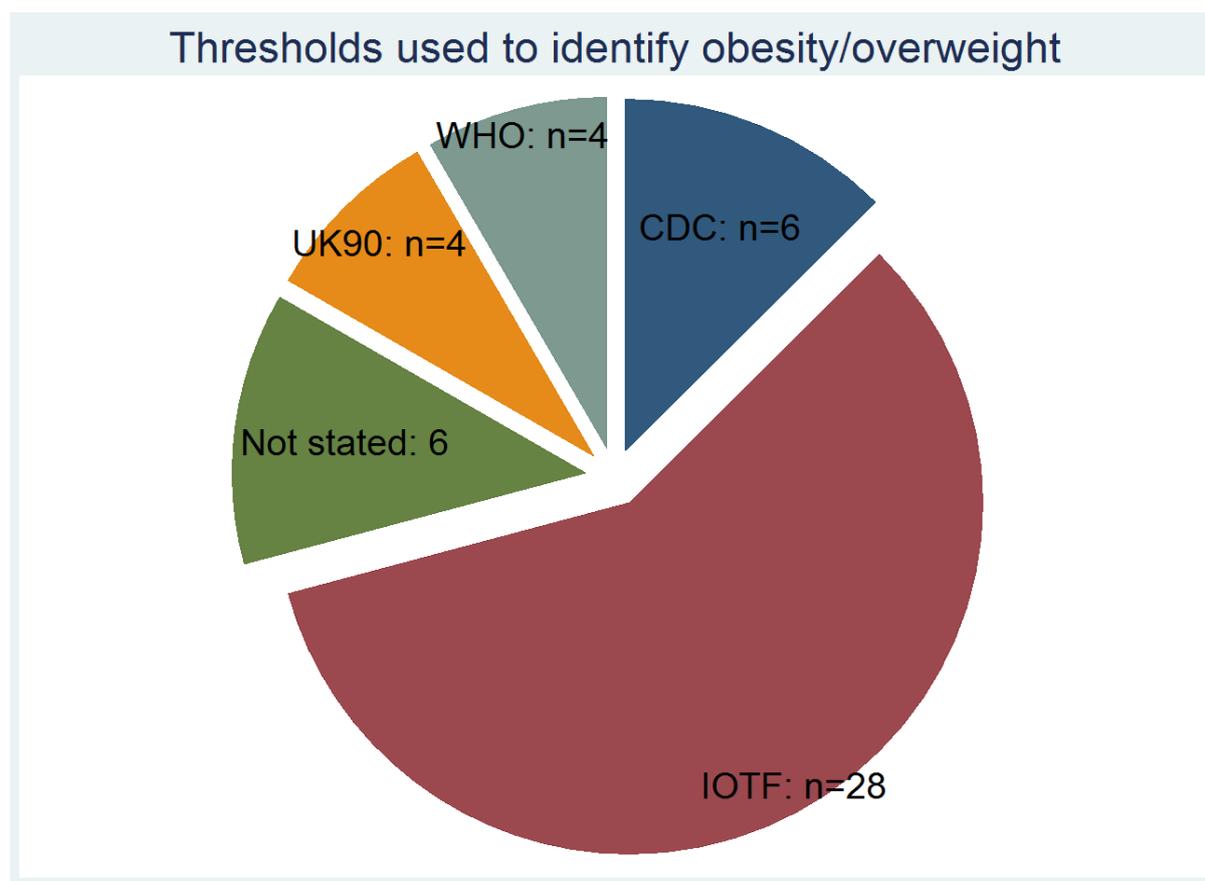
- As might be expected, the majority of studies used thresholds based on IOTF thresholds (28 studies). What is perhaps more surprising is that a greater number of study authors selected CDC thresholds than UK90 thresholds (6 compared to 4 studies).
- Six studies compared MCS data with international data [105, 118-122] and these used IOTF thresholds and CDC thresholds. However, three out of the six studies using CDC thresholds, and all of those using WHO thresholds, compared MCS data with other UK data or solely used MCS data in their analyses [16, 17, 123-126], and the reasons for choosing these thresholds is unclear.
- Using different thresholds may have a substantial impact on the number of children identified as overweight or obese in studies and could change the overall conclusions. Perhaps of most concern is the small number of studies where the threshold used was not declared (6 studies in total). It is unclear whether these studies used the derived variables made available with the data. Nevertheless, guidance on the need to report the thresholds used when using derived variable may be beneficial, particularly when attempting to compare results across studies. This may be particularly relevant given that in the analyses published in the latest age 11 descriptive report (not included here), the UK90 thresholds were used [127].

How are BMI data used in the literature?
- Over nine-in-ten studies that used BMI data as a main variable of interest used BMI as a dependent variable (45 studies). Just four studies used BMI as a main predictor

of interest – for example as a predictor of cognition [128], as a predictor of medicine use [129], as a predictor of social and emotional problems [81], and as a predictor of walking to school and participation in organised activities [130][11]. While high BMI and being categorised as obese or overweight is identified as being associated with 'significant medium and long-term health risks' [131], understanding how children's obesity/overweight impacts upon other domains of development appears to have been less of a priority in much of the published MCS literature.

- We explored the most complex techniques reported in the included studies. In half of studies (25 studies), logistic regression was the basis of the analysis, which extended in a number of cases to more complex specifications in hierarchical models. A further three studies reported using Poisson Regression, two used Probit regression, and one used negative binomial regression to model (thresholds) of BMI. Just seven studies were identified where BMI was modelled continuously (as well as in categorically using thresholds for overweight/obesity), including two studies using growth curve analysis [118, 123]; one study did not impose thresholds for overweight/obesity [116]. The high numbers of studies that only utilise BMI data in categorical analyses reinforces the need to report which thresholds are used in the data, as well as potentially for greater guidance, or signposting to guidance, to be issued by the study depositors around the relative merits and drawbacks of using different threshold values.

- Five studies included here relied solely on descriptive methods (e.g. cross-tabulations). Nevertheless, three of these studies had over twenty citations demonstrating the far-reaching impact that studies using MCS BMI data can have.

What has using MCS BMI data uncovered?

Demographic predictors of overweight/obesity

- Children's ethnicity was found to be a predictor of being obese or overweight in several studies [82, 105, 120-122, 132-137]. Specific groups named as being at increased risk of excess adiposity often included Bangladeshi children, Asian children more broadly, and black children. One study highlighted that this may be due to differential growth patterns, with several groups starting out thinner as babies but gaining weight faster as they grew to infanthood [122]. Some questioned the validity of the measures for comparison across ethnic groups, suggesting that other measures of adiposity may be more useful [134].

- Family structure was only moderately associated with excess height and weight in some studies [124], while disaggregated results were not presented in a further study that examined the presence of a father in childhood [93] and the risk of overweight/obesity. Similarly, the evidence around age of mother at first birth was mixed [125, 132], and there was little evidence that conception through assisted reproductive technology increased the risk of obesity/overweight in childhood [126].

- Higher parental BMI was also found to be positively associated with their children's BMI in a number of studies including [135, 138].

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[11] In this study, BMI was used as one of a number of predictors, although this study remained in focus as BMI contributed to the theoretical framework and estimates were produced separately.

Poverty, socioeconomic circumstances and discrimination and associations with BMI

- Indicators of low socioeconomic status are identified as increasing the risk of overweight/obesity in several of the included studies [118, 119, 132, 134, 136, 137, 139, 140]. Not all indicators of poverty are associated with increased risk of obesity/overweight indicating that different mechanisms underlie associations between different indicators [134]; similarly, the relationship between low socioeconomic status and increased risk of obesity is higher among some groups, for example children living in Scotland [141]. Higher levels of maternal education are found to be associated with a decreased risk of obesity/overweight, and this pattern in the MCS has been contrasted with the converse found in some international studies (China) [118]. In another international comparative study, maternal occupation categories in the USA are found to be protective against obesity/overweight but the same effect was not found in the UK [119].
- One study examined the impact of maternal experiences of racial discrimination on their children's health, finding indicative (although statistically insignificant) associations between experience of prejudice and higher likelihood of overweight/obesity [35].

Families and care, homes and communities, and associations with BMI

- Within the UK, children growing up in Wales and Northern Ireland are found to be at elevated risk of overweight/obesity in a number of studies [133, 134, 136, 137, 142]. Within England, one study found that children growing up in Sure Start Areas were less likely to be overweight/obese at age 5 than similar children growing up in similarly deprived areas that were not/did not have Sure Start area[17]; similar results were observed at age 7 [16]. However, two separate studies found little evidence of neighbourhood associations on the risk of overweight/obesity [116, 143].
- In terms of obesogenic environments and lifestyles, children who regularly ate breakfast were less likely to be overweight/obese [136, 141, 144]. Earlier in the lifecourse, children who were breastfed were also less likely to be overweight/obese in later childhood [133, 145]. Parental smoking was associated with increased risk of overweight/obesity [82, 133, 139, 145], particularly maternal smoking in pregnancy [139].
- Two studies found similar results with regards to informal care, identifying that grandparental care was associated with higher risks of children being overweight or obese [146, 147], with one observing the strongest effect among affluent families [146].

Predicting BMI and its outcomes

- Cross-cohort comparisons between MCS children and children in older cohorts suggest that children are growing up with higher BMIs over time [123]. Some of the consequences already observed of higher BMI among MCS children include lower levels of cognitive development (with respect to pattern construction [128]) and higher levels of reliance on medication [129] among obese children. Parents of children with elevated BMIs may be reluctant to recognise health issues with their children until their children become obese, given that parents of obese children were significantly less likely than children of normal weight children to give a high

rating of their children's health although there was little difference when considering the parents of children with normal weights [136].

- Some of the patterns observed in obesity and overweight described above make having a tool for identifying children at risk possible as discussed in a number of studies, although there remain concerns around the ethics, practicality and sensitivity of such a tool [145, 148, 149].

What impact has the analysis MCS BMI data had?

- Studies that have used MCS BMI data have been cited a total of 967 times (correct November 2015)[12].
- BMI data has formed an important component part in five theses.

What are the main strengths and weaknesses of SDQ data in MCS? [13]

Strengths

- The strengths identified were generic to the MCS data and not specific for BMI data. These included the large sample size and its representativeness, particularly of disadvantaged areas and ethnic minorities [35, 81, 125, 134, 150], the longitudinal nature of the data [129, 133, 143], and the breadth of indicators collected [37, 125, 129, 133].

Weaknesses

- Most of the reported difficulties were generic to the MCS and to longitudinal studies more broadly. These included the possibility that the study was underpowered for some smaller groups or rarer outcomes [37, 125, 129, 146], the potential influence of missing data and attrition on the results [93, 124, 125, 142] including implausible height and weight data [142], and finally that the observed associations did not necessarily imply causality due to the study design [93, 120, 125].
- Two studies reported specific limitations of the BMI data with regards to validity as a measure of adiposity, making the argument that BMI does not discriminate between lean and fat mass [120, 133].

What recommendations do researchers make for future research using BMI data?[14]

- Researchers tended to make recommendations around further understanding of the associations observed in their studies, such as understanding why some ethnic minority groups were at elevated risk for becoming obese or overweight [139], further understanding of the role of maternal employment and weight gain in childhood [151], and understanding why children living in some English regions

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[12] This includes citations for whole reports where citations for individual chapters are unavailable.
[13] Note, while the studies named here are coded as explicitly discussing these strengths and weaknesses, these are likely to have been considerations shared among all study authors in their choice of data and others too, besides those named above, may have expressed similar points in less explicit ways.
[14] Note, while the studies named here are coded as explicitly making these recommendations, these may have been considerations shared among all study authors and others too, besides those named above, may have made similar recommendations in less explicit ways.

(e.g. South East England) were at lower risk of becoming obese or overweight compared to other similar children [142].

- Some recommendations for future research that could be applied across studies included examining the strength of associations across future sweeps [143], further understanding and mapping of obesogenic environments [129], and testing whether observed associations were actually bidirectional in nature [81].

3.5 Children's self-rated feelings

Which questions are available by sweep?

Table 5: Screen time questions fielded in MCS surveys

	Age 3	Age 5	Age 7
How often do you feel happy			✓ (CM)
How often do you get worried			✓ (CM)
How often do you feel sad			✓ (CM)
How often are you quiet?			✓ (CM)
How often do you like to be alone?			✓ (CM)
How often do you laugh?			✓ (CM)
How often do you lose your temper?			✓ (CM)

PR: Parental report; CM: Cohort member report; G: Variable response pattern is grouped;

- Children were asked about how they were feeling directly for the first time at age 7; prior to this parental perceptions of their children's feelings alone were collected. Three additional questions around the frequency of having fun with family, relationship with siblings, and what children do when they are worried were asked in the same section but are not included here.

How many studies are using children's self-reported feelings as their main focus and what did they find?
- We found two studies that used data on children's self-reported feelings as the main focus of their study (that included measures taken at waves 2, 3 and 4).
- Both studies corresponded with those using data on children's friendships and included a chapter from the descriptive report of initial findings for the sweep [109] as well as a report on children's well-being which included more in-depth analyses [13].
- In the descriptive report, all the questions in Table 5 were included in analyses [109] while the report included analyses of how often children felt happy and free from worry as indicators of well-being [13].
- Descriptively, girls were more likely than boys to say that they were happy all of the time (40% vs 33%). However, boys were almost twice as likely as girls to say that they lost their temper all the time (13% vs 7%). There were also substantial

differences by ethnicity, with Pakistani, Bangladeshi and black children twice as likely to worry all of the time as white children (8-9% vs 5%). Pakistani and Bangladeshi children were also most likely to be sad of any ethnic group. However, much of the association may be a reflection of socioeconomic position, and may not be substantiated in multivariate analyses [109]. Conversely, black children were more likely than other ethnic groups to report laughing all the time. Children in Northern Ireland were also more likely to report laughing all the time compared to children in England; there was also a ten percentage point difference between Northern Irish children reporting that they were happy all of the time (46%) and English children (35%) [109]. Chanfreau and colleagues undertook multivariate analyses and also found that children in countries outside England were more likely to be happy all of the time, while non-white children were more likely than white children to report worrying all of the time [13].

- Chanfreau and colleagues also report a potential disadvantage of feelings data in that young children may be more prone than older age groups to be subject to social desirability bias. However, they also conclude that children age 7 can have great insight into their own feelings and that they were able to establish patterns in well-being that were consistent with parental reports of their children's well-being [13].

3.6 Diet and Nutrition

Questions in focus by sweep?

- Table 6 below shows the questions on children's diet that are of interest in the current review. We do not include the circumstances around children's diet (i.e. who the child eats with and whether child receives (free) school meals) and we do not include later observations of breastfeeding in our scope here.

Table 6: Diet questions fielded in MCS surveys

	Age 3	Age 5	Age 7
Does child eat meals at regular times	✓ (PR)	✓ (PR)	
Does child eat a portion of fresh fruit or vegetables daily	✓ (PR)		
How many portions of fruit consumed		✓ (PR)	✓ (PR)
Frequency of consumption of breakfast		✓ (PR)	✓ (PR)
If child eats between meals, what does he/she eat?		✓ (PR)	✓ (PR)
When child drinks between meals, what does he/she drink?		✓ (PR)	✓ (PR)
Do parents control the diet		✓ (PR)	✓ (PR)

PR: Parental report

How many studies are using questions on children's diet as their main focus?

- We identified 11 studies with a focus on the questions included in the table above. Notable exclusions on the basis of full text included one study where diet questions

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around the regularity of meal times were included in model but were not a central feature of the study [82]; similarly a further study also looked at the regularity of mealtimes but was excluded as this was not a focus of the study and was not featured in the conceptual framework or discussion of the results [138].

Table 7: Diet questions used in the literature as the main outcome or predictor of interest

	Age 3	Age 5	Age 7
Does child eat meals at regular times	4 [?]	2 [?][15]	
Does child eat a portion of fresh fruit or vegetables daily	[?]		
How many portions of fruit consumed		3	1
Frequency of consumption of breakfast		3	3
If child eats between meals, what does he/she eat?		3	1
When child drinks between meals, what does he/she drink?		1	
Do parents control the diet			1

Red = no evidence of use; Yellow = at least one study discovered; Green = multiple studies discovered

- The regularity of mealtimes was included in a number of studies, with observations at age 3 [144, 152-154] and age 5 utilised [144, 153, 155]. One study featured the regularity of mealtimes as a covariate of interest, although it was not clear whether this was measured at age 5 (contemporaneous to BMI) or at age 3 [156]. Consumption of breakfast was also explored in a number of studies, commonly as a predictor of overweight/obesity at ages 5 [141, 157, 158] and 7 [134, 157, 159].
- Questions on the consumption of fruit were analysed for data collected at age 5 [141, 158, 160] and age 7, but we did not find clear evidence that the age 3 variable was used, with one possible exception [156].
- Questions on in-between-meal snacks were analysed at age 5 [141, 158, 160] and age 7 [134], although age 7 data had only been used within the descriptive report of initial findings for that sweep.
- Questions on the drinks consumed between meals were only analysed for age 5 [160]. At age 7, these were mentioned in the descriptive report [134], but the results were not presented. Similarly, data on whether the child's food or drink intake had been controlled for any particular reason were rarely used as the focus of studies, featuring only for the descriptive report at age 7 and not as the focus of any subsequent publications [134].

How are diet data used in the literature?
- Six of the eleven included studies relied almost entirely on descriptive methods (bivariate analysis) to examine children's diets [20, 134, 154, 158{Kneale, 2010

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[15] One study did not clearly report which sweep of data was used.

#13]{Smith, 2006 #146}[155], with the remaining studies employing more advanced regression-based methods.

BMI

- Data on children's diets are commonly used in studies that examine how nutritional factors influence children's BMI. These included chapters on the initial findings for the sweeps [134, 158], two reports that presented in-depth examinations on the health of Scottish children (and comparisons with the rest of the UK) [20, 159], a book chapter [132] and a journal article [156, 160].
- These studies established links between regular breakfast consumption and lower BMI at different ages (ages 5 and 7) [134, 156, 158, 159]. Some of these analyses extended to examining how family characteristics influence whether children had breakfast on a daily basis. In particular both studies identified that children in workless families were less likely to eat breakfast daily than children in families whose parents were working, with one study positing that the lack of routine in workless families may be one underlying factor [158]. Explorations of similar patterns at age 3 in terms of having a regular mealtime did not uncover statistically significant associations [132, 157].
- Association between breakfasting and BMI were more identifiable than those between BMI and other dietary variables. Consumption of between meal snacks, for example, was not significantly associated with children's BMI [134, 158]; while overweight children were found to eat more fruit than normal-weight children and obese children less [158]. Furthermore, associations between consumption of snacks and fruit were found to follow a different pattern in Scotland compared to the UK as a whole [158].

Other factors

- Information on diet was occasionally used to examine other outcomes besides BMI among children. In Smith's exploration of parenting, associations between the regularity of mealtimes and other family characteristics were explored at age 3, with mothers in Northern Ireland most likely to report that their child always had regular meal times (54 per cent, compared to 47 per cent in England); other differences were also found on the basis of ethnicity and age of mother but all of these were limited to examinations through bivariate analyses [152]. Other studies looked at the associations between diet and SDQ (and cognitive ability), finding that children with regular mealtimes had fewer psychosocial problems and higher levels of cognitive ability [157].
- A study by Hawkins and colleagues was the only study to examine dietary variables as outcomes in multivariate analyses [160] through examining how maternal employment patterns shaped health behaviours among children. This study found that children whose mothers worked part-time or full-time were more likely to drink sweetened drinks between meals, and children whose mothers worked full-time were less likely to eat in between meals or to follow recommendations around eating three or more portions of fruit daily.

What impact has MCS diet data had?

- Studies that have used MCS diet data have been cited 231 times (correct November 2015[16]). Both studies that were published in peer review papers were published in Public Health/Epidemiology journals.

What are the main strengths and weaknesses of the screen time data in MCS?

Strengths

- Researchers did not highlight any particular strengths of the diet and nutrition variables per se. However, some did highlight some of the more general properties of the survey data more broadly including large sample and oversampling of ethnic minority children [156].

Weaknesses

- Some researchers highlighted that in a multipurpose survey such as the MCS, it was not practicable to collect comprehensive data on nutrition [158]. This included collecting objective data on children's diet and nutrition through tools such as food diaries [156]. The lack of nuanced objective data on children's nutritional intake was thought to undermine some of the observed associations between children's diet and other outcomes including BMI. For example, the association between irregular breakfasting and higher BMI uncovered in Brophy and colleagues' study may be an artefact of irregular dietary intake and compensatory snacking, although this cannot be investigated further as measures of nutritional intake are not collected [156]. Similarly, others have highlighted that accurate measures around the frequency of intake of snacks (in addition to the identification of snacks of choice) are not collected [158], as well as a more broadly, a detailed inventory of what the children eat, how frequently, and in what quantities [159].

What do recommendations do researchers make for future research?

- Unsurprisingly, given that three-out-of-six studies were limited to bivariate analyses, extending the research to a multivariate framework was a common recommendation [134, 158]. There were no recommendations around the use of diet variables per se, although these might be inferred from the need to collect more detailed measures of diet and nutrition described above.

3.7 Child Social Behaviour Questionnaire

Which questions are available by sweep and background to the measure?

- The third and fourth sweeps of MCS (age 5 and 7), provided the most complete measures of the child social behaviour questionnaire, which had been collected through parent report.
- These data represent three domains (independence and self-regulation, emotional dysregulation, cooperation), and the data are deposited with derived scores for the different domains (see Table 8 and [6] for further information on the domains). These measures are associated with a series of studies that sought to evaluate the short and long-term impact of early years education on child outcomes (EPPE project) [161, 162]. Elsewhere, some of these questions have been described as belonging to the Child Social Competence and Behaviour scale [14].

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[16] Citations for descriptive reports used for individual chapters unless otherwise stated

Table 8: Child Social Behaviour Questionnaire questions fielded in MCS (see also [6])

		Age 3	Age 5	Age 7
Independence and self-regulation	Likes to work things out for self	✓ (PR)	✓ (PR)	✓ (PR)
	Does not need much help with tasks	✓ (PR)	✓ (PR)	✓ (PR)
	Chooses activities on their own	✓ (PR)	✓ (PR)	✓ (PR)
	Persists in the face of difficult tasks	✓ (PR)	✓ (PR)	✓ (PR)
	Move to new activity after finishing task	✓ (PR)	✓ (PR)	✓ (PR)
Emotional dysregulation	Shows mood swings	✓ (PR)	✓ (PR)	✓ (PR)
	Gets over excited	✓ (PR)	✓ (PR)	✓ (PR)
	Easily frustrated	✓ (PR)	✓ (PR)	✓ (PR)
	Gets over being upset quickly (reversed)	✓ (PR)	✓ (PR)	✓ (PR)
	Acts impulsively	✓ (PR)	✓ (PR)	✓ (PR)
Cooperation	Is calm and easy going		✓ (PR)	✓ (PR)
	Works/plays easily with others		✓ (PR)	✓ (PR)
	Says please and thank you when reminded		✓ (PR)	✓ (PR)
	Waits his/her turn in games/activities		✓ (PR)	✓ (PR)
	Co-operates with requests		✓ (PR)	✓ (PR)

PR: Parental report; CM: Cohort member report; G: Variable response pattern is grouped

Which questions are used in the literature?
- Few studies have used questions included as part of the Child Social Behaviour Questionnaire (abbreviated to CBQ from this point forward), particularly in comparison with studies using SDQ. We uncovered seven studies that used these data as a focus of the study, although it should be borne in mind that three of these studies in particular were impactful in providing evidence for evaluating the impact of Sure Start at different developmental points [15, 163, 164].
- A further study by DelBono and Ermisch also utilise these data, but in the interest of consistency is not included in this section as SDQ data are used as 'the main behavioural assessments' [34]. Nevertheless, readers may also want to consult with this study for a fuller account of the use of CBQ data.
- A number of studies used items included in the CBQ in combination with others, primarily with items from SDQ, to create measures [14, 15, 39, 163, 164]. This adds to the possibility that the low number of studies using CBQ data may be a reflection of the difficulty in identifying these studies as they were found to be less likely to refer to the scale explicitly in describing their activities.

How are CBQ data used in the literature?
- Three of the studies examine the impact of living in a Sure Start area compared to living in a matched area with similar characteristics but where Sure Start was not running (using items included in CBQ alongside others in the SDQ). At age 3,

children living in Sure Start areas displayed higher levels of self-regulation and positive social behaviour [15]; however any differences had attenuated at later points [163, 164]. Bradshaw's study examined the role of poverty in explaining behavioural outcomes using similar measures at age 3, and concluded that although poorer children did have poorer behavioural development, poverty explained less than 5% of variation in models[17].

- One study examined socioeconomic differences in impulsivity, to better understand how differences in time discounting should be conceptualised. The authors used two questions from the CBQ: whether the children were impulsive/acts without thinking and whether the child persists in the face of difficult tasks. This study found that differences were present on the basis of socioeconomic status and that these were likely to be transmitted through the parents' own levels of non-cognitive skills [14].

- The focus of Del Bono and Rabe's study is not directly on examining socioeconomic influences on children's behaviour. Instead their focus is on the association between breastfeeding and children's behaviour, using the 'emotional sub-component of the child self-regulation score, as measured by selected items from the Child Social Behaviour Questionnaire used on the EPPE study'. They find positive evidence of a link between breastfeeding and improved behaviour stretching through to age 7; they posit that this may be a reflection of other maternal behaviours and maternal well-being [27].

- Finally, Flouri and colleagues take a different approach and examine how self-regulation, measured through the CBQ domain, can promote resilience and moderate the established associations between lower socioeconomic status and higher likelihood of problem behaviours (measured through SDQ) among children [42]. They find that self-regulation was associated with lower behavioural problems among all children, but that poorer children were more vulnerable to low self-regulation. Furthermore, poorer children were likely to have higher levels of emotional and behavioural problems whether they had high or low levels of self-regulation.

- Two studies fully exploited the longitudinal nature of CBQ through incorporating three waves of data [27, 42], while a further two studies undertook analyses examining change between two waves of data [17, 164]. Three studies examined CBQ data collected at age 3 only [14, 15, 39].

What impact has the analysis MCS screen time data had?
- Studies that have used MCS CBQ data have been cited 194 times (correct as of October 2015)[18]. Despite only a few studies using these data as their prime focus identified here, they have nevertheless been used in highly cited papers (mainly attributable to their use as part of Sure Start measures).

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[17] Although the authors don't explicitly list the items used in the study, they describe these as identical to those used in the EPPE/Sure Start studies.

[18] Note – two of the Sure Start Studies considered here were working papers but were selected into this study on the basis of the detail provided for this study not on the basis of which publication was most impactful. For the age 5 report, Google Scholar information on citations was unavailable.

What are the main strengths and weaknesses of the CBQ data in MCS?

- Specific strengths and weaknesses of the CBQ data are rarely mentioned in these studies, and more commonly reflect broader features of the MCS and its study design (e.g. breadth of information and size of sample [14] or the potential of selective attrition). In the case of the Sure Start evaluative studies, they also reflect caveats around the study design and the non-random allocation of the treatment [15]. Specific issues experienced in using CBQ data are discussed in Flouri and colleagues' study [42], which employed items from the self-regulation domain; these include low reliability at age 3, the potential statistical issue of regression to the mean that this measurement error may have induced, and questions around the extent of bias from using parents' reports of behaviour as opposed to more objective measures. A further challenge reported in using these data was that self-regulation was an unexpectedly stable measure across the different ages and missing data around parents' own self-regulation (and patterns/changes) prevented further exploration of this.

Recommendations following the use of CBQ data in MCS and additional summary points

- Despite the challenges identified in using CBQ data described above, Flouri and colleagues nevertheless identify important recommendations for intervention research in that improving children's self-regulation (as well as verbal cognitive ability) may be an important mechanism for offsetting anxiety and depression-related symptoms among those children at risk.
- While the use of CBQ data may be relatively limited in comparison to SDQ data, they have been used to evaluate important policy interventions in the UK, and to develop recommendations for intervention points to improve children's mental health.
- There was a tendency in several of the studies presented here to describe the CBQ measures in reference to EPPE and Sure Start studies, which in the latter are integrated with items from the SDQ. This meant that in some cases, full descriptions of which items were used in which combinations and how were not provided. This also meant that justification for the use of different domains was also absent in some cases. MCS investigators may be able to make a contribution to increasing the use of these data through providing further guidance around what these data purport to measure, how the data should be used and in which combination, and to provide further evidence of the robustness of the measures within MCS.

3.8 Feelings about school (school dis/like)

Which questions are available by sweep?

- At age 7, cohort members were asked to complete a paper-based questionnaire about their feelings (used elsewhere as a measure of self-reported mental well-being [13]), hobbies and interests, and their feelings about school, specific lessons, perceptions about peers, and how they think teachers and others view them.
- Here we concentrate on those questions that are about more general feelings about school, as opposed to subject specific questions (Table 9).

Table 9: Questions on general feelings about school fielded in the MCS

	Age 3	Age 5	Age 7
1. How much do you like school?			✓ (CM)
2. How often is school interesting?			✓ (CM)
3. How often do you try to do your best at school?			✓ (CM)
4. How often do you feel unhappy at school?			✓ (CM)
5. How often do you get tired at school?			✓ (CM)
6. How often do you get fed up at school?			✓ (CM)

PR: Parental report; CM: Cohort member report; G: Variable response pattern is grouped

- We uncovered two studies where the data above were a focus.
- The first was the chapter in the descriptive report on the initial findings and described how feelings about school varied across child characteristics. It showed that gender differences and ethnic differences were apparent in terms of school dis/like, with girls and non-white children more likely to report liking school a lot. The analyses also showed an unexpected trend with children of less educated mothers more likely to say that they liked school a lot [109]. Dislike of school was also covered in the media on the basis of this study[19]. A number of other trends were also discussed in the same study around reported effort in school and how often children found school interesting, with many of the same patterns repeated by gender and ethnic group as was the case for dis/like of school. The study also found that children who were in more disadvantaged families were more likely to report feeling tired than other children, with these results discussed as being indicative of less structured routines around bedtimes or a reflection of more cramped housing conditions.
- A second study also utilised the measures in Table 9 to assess the effectiveness of Foundation Phase Schools, a flagship project of the Welsh government which involved less of an assessment based approach to early years education. This study incorporated data on school dis/like into a measure of attitudes to school and measures 2-6 into a measure of educational well-being. The study found that children attending a Foundation Phase pilot school tended to have lower scores on some academic assessments, lower subjective educational well-being and more negative attitudes to learning. While there were some methodological limitations surrounding these results, particularly around the timing of the measurements in relation to the timing of expected effects from the pilot, the authors did conclude that further sweeps would be unlikely to find differences in the results [165].
- Despite being rarely used in studies, these questions on educational well-being and attitudes to learning are of transparent importance and have been used as a principal outcome measure in an assessment of a flagship educational project. Similar questions on attitudes to school have also been used in earlier cohorts to predict inauspicious transitions to adulthood, and these questions may similarly be utilised in the future.

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[19] https://www.tes.com/article.aspx?storycode=6060792

3.9 Immunisations and vaccinations during childhood

Which questions are available by sweep?

- Questions about immunisations and vaccinations are asked in the first three sweeps of MCS. Information collected at age 9 months feature in a number of publications (for example [166, 167]). However, our focus here is on information collected on immunisations at ages 3 and 5 (Table 10 below), particularly where authors have attempted to capture measures around the completeness of immunisation schedules in early childhood.
- Other data from the MCS have been used to assess serological immunity or strategies for targeting immunisations, for example based on oral swabs collected [168] or episodes of infection [169], but are not included in our focus here.

Table 10: Immunisations questions fielded in MCS surveys

	Age 3	Age 5	Age 7
How many doses of a vaccine against polio, diphtheria, tetanus, whooping cough (pertussis), meningitis C and hib (DTP/Hib) has child had?	✓ (PR)		
• If not had three doses for the above, why not? • Has child had hib booster in the past 18 months?	✓ (PR)		
Had child had any MMR vaccinations (singly or in combination) • Why not had combined MMR?	✓ (PR)		
Child offered any of the following vaccines: BCG, Hep B and Pneumococcal?	✓ (PR)	✓ (PR)	
Has child had three doses of vaccine against diphtheria, tetanus, whooping cough (pertussis), and hib (DTP/Hib)? • If not three doses, how many? • Has child had booster and if not, why?		✓ (PR)	
Has child had three doses of meningitis C? • If not, how many doses received?		✓ (PR)	
Has child had three doses of polio? • If not, how many doses received? • Has child had booster for polio? • If not had booster, why not?		✓ (PR)	
Had child had any MMR vaccinations (singly or in combination) • Why not had any? • Why not had combined MMR? • How many doses received (asked for combined or separate) • If not received a second dose, why not (asked for combined or separate)		✓ (PR)	

PR: Parental report; CM: Cohort member report; G: Variable response pattern is grouped;

Which immunisation questions are used in the literature?

- Eleven studies were identified as using MCS data contained in Table 10 (above) from sweeps 2 and 3 as their focus.
- Four of these were focussed on using information from age 3 only [15, 154, 170-172], while two used data from age 5 [158, 173]. The remainder incorporated data from multiple sweeps [93, 174-176].
- There was a division between studies that were focussed on examining uptake of the Measles, Mumps and Rubella (MMR) vaccine following the MMR vaccine controversy and the erroneous results published around the dangers of a combined vaccine as opposed to single vaccines [177], and those studies that examined the uptake of other vaccines or that otherwise took a broader approach in examining childhood immunisations.
- Studies that were focussed on understanding patterns of MMR vaccine uptake included [154, 170-172, 174]. Pearce and colleagues examined patterns of primary vaccination as a predictor of MMR vaccination, although the primary focus remained on understanding patterns of MMR vaccination [171]. All other studies had a broader frame of interest or were focussed on specific vaccination events [15, 93, 158, 173, 175, 176], such as Tung and colleagues' study on receipt of booster vaccinations [173].

How are immunisation data used in the literature?

- In all studies, immunisation data were used as the dependent variable and some of the foci of studies included understanding maternal educational differences in non-compliance with immunisation guidance [174], understanding how residential mobility influences immunisation uptake and how it may explain observed differences by family composition [175], and understanding how paternal involvement may moderate levels of immunisation uptake [93].

- Three of the studies employed descriptive methods [154, 158, 170] while the other studies employed various regression models including Poisson regression models [171-173, 175], Probit regression [174] and logistic (including multilevel logistic) regression [15, 93, 176].

- Three studies were available as descriptive reports [154, 158, 170], while all other studies were published in medical journals with the exception of Anderberg and colleagues' study, which was published in a (health) economics journal [174]. One was available as an abstract only at the time of writing [173].

What has using MCS immunisation data uncovered?

- In terms of DTP (diphtheria, tetanus and polio) vaccinations, children born in England (as opposed to other home countries) [173], residing with a lone parent [158, 173], and having a long-term condition [173] were most likely to miss having a booster shot or being effectively protected. Some of these patterns, for example around lone parenthood, were repeated in studies on MMR vaccine uptake [172]. In Pearce and colleagues' study, the focus was on residential mobility, which may be the underlying mechanism behind other associations, such as lone parenthood, being factors for lower vaccine uptake [175]. This study found that mobility was associated with partial

coverage for DTP and primary immunisations, and was associated with a higher likelihood of being unimmunised for MMR.

- Maternal education was identified as an explanatory factor for a lower level of MMR vaccine uptake in a number of studies [170, 172, 174]; mothers with higher levels of education were less likely to have had the complete dose of the combined vaccine.

- Older paternal age and maternal age were both found to be associated with lower levels of complete immunisations [15, 93, 176]; this may be an artefact of the higher socioeconomic status of older parents (and a reflection of the educational and income trends identified above).

- As part of the Sure Start evaluation, one study considered the impact of living in a Sure Start area on the likelihood of being fully immunised, finding no apparent significant effect of living in a Sure Start area compared to living in a similar (matched) area [15]

- Perhaps most concerning in Pearce and colleague's study is that of those children who had not been vaccinated against MMR, for around three-quarters this was through conscious choice [172], highlighting the level of misinformation around MMR combined vaccines that was prevalent at the time.

What impact has the analysis MCS immunisation data had?
- Studies that have used MCS immunisation data have been cited 386 times (correct as of November 2015).

What are the main strengths and weaknesses of the immunisation data in MCS?
- A number of studies report generic challenges or limitations to their conclusions such as the difficulties in attributing causation from quasi-experimental studies, attrition in the MCS and the impact of missing data; similar strengths of the data were also identified such as the size of the sample, representativeness, and capacity for analyses specifically among hard to reach groups [15, 93, 172, 175, 176].

- In one specific study that analysed the relationship between primary immunisation as a predictor of combined MMR vaccination, the potential for reverse causality in the results could not be discounted [171]. A further caveat of MCS immunisation data was that it was based on parental reports which were sometimes, but not always (and inconsistently), supplemented with data from Personal Child Health Records (Red books) [172, 174, 175]. While providing an unparalleled insight into how parents responded to the MMR vaccine controversy, due to their highly temporal-specific nature, the data may also have low generalisability to understand more recent patterns of vaccination uptake [172].

- An important feature that allowed MCS data to be analysed in a way that was not possible with other data sources was the collection of information on both single vaccinations as well as combined vaccinations [174].

3.10 Screen time

Which questions are available by sweep?

Table 11: Screen time questions fielded in MCS surveys

	Age 3	Age 5	Age 7
TV in bedroom			✓ (PR)
Computer access in home			✓ (PR)
Computer access – CM's own computer			✓ (PR)
Hours of TV watched on weekdays	✓ (PR; G)	✓ (PR; G)	✓ (PR; G)
Hours of computer/electronic games on weekdays		✓ (PR; G)	✓ (PR; G)
Frequency of playing computer/electronic games			
Frequency of using internet			
Frequency of using internet for homework			
Rules on spending time on computer			
Like watching TV/Video*			✓ (CM)
Like playing computer games*			✓ (CM)

PR: Parental report; CM: Cohort member report; G: Variable response pattern is grouped; *may be captured in hobbies literature

- Over successive sweeps, the focus of MCS on variables that could reflect screen time and access to screen time has expanded both in the range of questions fielded and the respondents. Screen time is defined as time spent on sedentary activities such as watching television or playing computer games, while access to screen time reflects whether cohort members have a television in their bedroom or a computer in their home.

Which questions are used in the literature?
- Nineteen studies were initially selected as either using screen time variables as an outcome or having screen time as their main focus; of these sixteen were eligible after full text screening for further analysis (including multiple entries for report chapters authored by different researchers). We did not include studies that were focussed on allied notions such as sedentary behaviour in our scope here [178].
- Furthermore, other studies also included screen time as covariates in models [43, 179, 180], and found significant associations with cognitive outcomes, but these are not discussed in detail in this section (for consistency with the earlier results) as their main focus was not (ostensibly) on screen time.
- The majority of the included studies use variables reflecting the hours of television watched or computer/electronic games played. Information on the hours of television viewing collected at age 5 have been used in eight studies [67, 68, 130, 138, 158, 160, 181, 182]; the most widely used of the screen time variables.
- Variables capturing computer access collected at age 7 have not been recorded as the main outcome or predictor of interest in any of the included studies. This is not to say that these variables are redundant across the literature, but the findings suggest that their use is confined to either: (i) studies that have not published their results (for example where statistically insignificant results were obtained

(publication bias)); or (ii) where they have been used either as composite indices or as part of a battery of predictors or outcomes.

Age 5 data are more frequently used than age 7 data. This discrepancy is not solely explained by the longer time that age 5 data have been available, since age 5 data are also used more frequently than age 3 data. Age 3 data are notable in not having featured in the descriptive report for that sweep [183].

How are screen time data used in the literature?

- In four studies [20, 109, 134, 158], screen time variables were used in descriptive analyses and these tended to be used as dependent variables in cross-tabulations with socioeconomic variables. In the other studies, screen time variables were used as independent variables in eleven studies [67, 68, 82, 130, 138, 153, 156, 159, 181, 182, 184], while just one study used screen time as the dependent variable [160].

- Screen time variables and variables reflecting access to screen time have been used as predictors of, among other topics: parental involvement in active play [182], levels of physical activity [130, 184]; mental health problems [67] and psychosocial adjustment [68]; and cognitive outcomes [181]. One of the most frequently employed uses was to examine the relationship between screen time exposure and overweight/obesity [20, 82, 138, 153, 156, 159]. The one (non-descriptive) study that used screen time as the dependent variable analysed the impact of maternal employment and flexibility of maternal employment on sedentary activities [160]. Each of these studies used a range of analytical methods to address their research questions, including various forms of linear and logistic regression and extending through to multilevel regression.

- Eight studies have published their findings from analysis of screen time/access to screen time variables in peer-reviewed journals [67, 68, 130, 138, 160, 184] of which two studies were coded as including repeated observations of MCS screen time variables [68, 181]; one of which is available as a full paper [68]. The low number of studies using screen time variables and the tendency of the extant literature to analyse these data from a single sweep indicate the untapped potential of these data. Other studies did use data from different sweeps, but only one observation of screen time data was used.

What has using MCS screen time data uncovered?

What are the characteristics that predict longer periods of screen time?

- At age 5, the majority of children (61%) used screen entertainment for over two hours a day [67, 160].

- Children in less financially comfortable households spend longer watching television [182] and are more likely to have a television in their bedroom [134]. There are also a number of differences across gender and ethnicity in terms of televisions in cohort members' bedrooms and computer ownership. At age 7, boys are more likely than girls to claim that they enjoy watching TV and to enjoy playing computer games [109]. Most of these relationships have only been tested in bivariate frameworks.

- Maternal employment has been associated with higher levels of sedentary activity (watching television/using a computer for over two hours per day) in one study [160]. Meanwhile, children who are obese or overweight are over represented

among those who watch over three hours of television a day, or who use a computer for over an hour a day, at age 5 [158].

What are the potential outcomes of screen time?

- Watching fewer hours of television is associated with higher levels of parental involvement in physically active play at age 5, although the same relationships are not observed for hours of computer screen time [182]. Similarly, watching television for long periods regularly (over three hours per day) was associated with lower levels of participation in organised activities [130].

- Having a television in a bedroom at age 7 is associated with lower levels of physical activity using parental reports of organised physical activity [134] but not when modelling levels of physical activity measured objectively using accelerometer data [184]. In fact, having a television in the bedroom was associated with raised activity levels (measured through counts per minute on accelerometer data). This may have been an artefact of the sub-sample of children with valid accelerometer measurements, as this group exhibited a different trend to the cohort as a whole, with better-off children more likely to have a television in their bedroom [184].

- Higher levels of screen time at age 5 did not appear to be associated with an increased risk of conduct problems when also combined with participation in sports (sport clubs); however, children who used screen entertainment for over two hours a day and did not participate in sports had higher levels of conduct problems [67].

- Children who did not watch television at age 3 exhibited signs of developmental delay at age 7 years, both in terms of their verbal and non-verbal skills. Television viewing at age 5 appeared to be insignificant in predicting developmental scores at age 7, while children who watched high amounts of television at age 7 had lower verbal skills than their counterparts (although no differences were found among non-verbal skills) [181]. In contrast, another study found that high levels of television viewing at age 5 was significantly associated with conduct problems at age 7 [68].

- A number of studies were focussed on establishing whether TV viewing and having close access to a TV were significant contributors to an obesogenic environment [20, 138, 153, 159]. Two of these studies were focussed on understanding how living in Scotland impacted on children's BMI, with Sullivan and Dex finding no evidence of an association between frequency of TV viewing and overweight/obesity at age 5 in Scotland (that was established in the UK as a whole [20]) while Connelly found a similar trend at age 7 (UK wide) but did find that having a TV in the bedroom was associated with a higher risk of overweight/obesity [159]. A further study also established that TV viewing at age 5 was not a significant part of the obesogenic ecology [138]. However, findings from Griffiths and colleagues suggest that this may be a lagged relationship, finding that higher levels of TV viewing at age 3 was associated with a higher risk of overweight/obesity at age 5.

What impact has the analysis MCS screen time data had?

- Studies that have used MCS screen time data have been cited 246 times (correct as of November 2015).

- Screen time data has been published most frequently in journals that are classified as 'Epidemiology and Health'.

- Screen time data formed an important component part in one thesis included among the 16 studies [182].

What are the main strengths and weaknesses of the screen time data in MCS?

Strengths

- Specific strengths of screen time data are not made explicit by most authors. However, the MCS is viewed as one of the few studies that allows for examination of patterns of screen entertainment while controlling for a breadth of sociodemographic factors [67]. It is also one of the few studies that allows for longitudinal analysis of relationships between screen time and outcome measures [68].

Weaknesses

- Parental reports of screen time and access to screen time may be biased towards what is established good practice [68, 130]. There is also no information on the content of screen time [179].

- One author reported difficulties in implementing their chosen modelling strategy and implementing weighting for the data simultaneously [182], although this is a generic challenge across the MCS and not specific to screen time.

- Although unreported by authors, one difficulty of the screen time data may lie in the disparity between the American Academy of Paediatrics recommendation that screen time be limited to 1-2 hours per day [160], and the response pattern available to MCS parents in responding to the screen entertainment questions, which are grouped in an incompatible way (none, less than an hour; 1-3 hours; 3-5 hours; 5-7 hours; 7+ hours). Authors have nevertheless derived variables according to a two hour cut off point in their analyses [67, 160].

- Some of the potential predictors and outcomes of screen time, such as the impact that excessive screen time has on the quality of relationships, the impact on educational outcomes, the impact on specific skills (for example potential associations between computer games and problem solving), the impact of sedentary activities on peer groups, and greater understanding of the relationship between screen time and BMI, and many more issues, remain unexplored. It is surprising that time spent using a computer has not been analysed more widely.

What recommendations are made for future research?

- Most researchers using screen time data have made recommendations for future research to examine the associations uncovered at a different sweep [160] or to establish whether observed patterns occur longitudinally. Among those descriptive reports included here, employing multivariate analysis to test bivariate associations has been a consistent recommendation. However, as exhibited in Table 2, these recommendations have not been pursued. Specific recommendations with regards to survey design include calls for better measures of home environment (which includes access to screen time) and neighbourhoods [184] and improving the validity of measures of screen time [68].

4. Summary and discussion

1998 saw the announcement that funding would be provided for a new cohort study tracking the development of individuals born in the new millennium. Two conditions were attached to this funding – the first that a high proportion of included children should be born in the year 2000 and the second, that the study should follow the multidisciplinary of the 1958 and 1970 born cohorts and not the medical model of the 1946 cohort. Joshi and Fitzsimmons [185] outline some of the founding principles of the MCS including that the study should 'capture as much detail on the child's origins that may later turn out to be relevant' to explain differentials in life course trajectories and outcomes. This included collecting information on new social conditions and phenomena, collecting information from the significant actors in a child's life, and providing information on the wider context in which children grow up. Other desired objectives included facilitating comparisons with older cohorts and enhancing the data through data linkages with other sources (for example census data or educational records).

While the host institution of the MCS, the Centre for Longitudinal Studies, is a centre of expertise in survey methodology[20] as well as hosting both the 1958 and 1970 cohorts and a number of substantive experts in child development and transitions to adulthood; meeting the needs of diverse groups of end users of a multipurpose study, including policy-makers, third sector organisations, academics, and ultimately the wider public, is not without its challenges. The properties of individual instruments may be appraised through measuring their reliability and validity, as well as establishing their responsiveness to change longitudinally, although determining the substantive focus of such instruments is usually dependent on the research question. In the case of the MCS, the research question itself is of such breadth that this has necessitated a consultative approach to attempt to ensure that the survey reflects the needs of a wide group of stakeholders. New proposals for questions are discussed openly as well as the usability of questions that were fielded in previous sweep(s), and different versions of the questionnaire will be circulated for comment.

Beyond measuring the scientific properties of the questions, there is no (known) standard method for determining the content for a survey, or more importantly for measuring the impact or success of fielding different instruments. Through systematically mapping the usage of ten different areas of questions or instruments in the published grey and peer-reviewed literature, this present study can contribute to understanding patterns of specific MCS data usage. However, this study can also have a broader reach through examining and contrasting the characteristics of data that are widely utilised and those that rarely feature in the published literature. Furthermore, through mapping where data

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[20] For example in terms of sampling methods, survey and question design and the development of scales and measures to capture latent constructs, data collection methods and methods to reduce attrition, tracing and cohort maintenance, and the interrogation and interpretation of longitudinal data.

are used and how, we are also able to develop (further) recommendations around the usage of MCS data.

4.1 Which data are utilised and which are underutilised?

	Repeated questions/ measures	Recognised scale or measurements used	Recognised thresholds for scale	Multi-informant	Number of studies	Approx. no. citations	Approx. citations per paper
SDQ (strengths and difficulties)	✓	✓	✓	✓	121	2355	19.5
CBQ (child social behaviour)	✓	✓	-	-	7	194	27.7
Hobbies (self-reported)	✓ (at 11)	-	-	n/a	1	*	*
BMI	✓	✓	✓**	n/a	49	967	19.7
Feelings (self-rated)	✓ (at 11)	-	-	n/a	2	*	*
Diet	✓	-	-	-	11	231	21
Feelings about school (self-rated)	✓ (at 11)	-	-	n/a	2	*	*
Friends (self-rated)	✓ (at 11)	-	-	n/a	2	*	*
Immunisations at age 3 and 5	✓	-	-	-	11	386	35.1
Screen time	✓	-	***	-	16	286	17.9

*we do not report number of citations where the number of studies was 3 or fewer
**different alternatives available; ***a (US) threshold for recommended maximum hours is available but not calculable in the data; n/a = not applicable; single informant construct

Strengths and Difficulties Questionnaire (SDQ) data have been most widely used of the ten measures in focus here. SDQ is a recognised scale, collected at different time points and from different informants, with defined thresholds for problem behaviour. In comparison, an allied measure of child behaviour, the CBQ, was collected solely from parents' reports and clear thresholds or cut-offs for identifying constructs of interest are not widely reported. Several of the studies identified as using CBQ data did not clearly report the measures that were being used, and there was also ambiguity as to how to refer to the CBQ scale. In the absence of publishing full details of the questions used, many authors referred to a technical report from the EPPE project on the usage of the CBQ measures. However, further details are required as this report in itself does not clearly provide

technical guidance on how to construct measures and whether thresholds for underlying constructs should be imposed (as in the case for SDQ) [186]. Further guidance is needed on the CBQ measure, its theoretical underpinnings, properties, and correct/intended usage. This may help to enhance their use in future studies.

BMI data were also widely used in the literature, reflecting concerns about increasing rates of childhood obesity, which was substantiated in one paper through comparing levels in MCS with previous cohorts. BMI data also shared many of the same properties as SDQ in terms of being a measure collected in a similar way across waves with defined thresholds for identifying overweight and obese children (albeit with different thresholds in use in the literature).

In the case of SDQ, which was collected from parents as well as teachers in some cases, collection from multiple informants was viewed as a positive aspect of the data. Some researchers also suggested that collection of such data from children themselves would enhance the data. However, collection of data from multiple informants did not always correlate with higher levels of usage, and teacher reports of SDQ were comparatively rarely utilised in these data (likely due in part to the low response rate and sampling strategy employed among teachers). Furthermore, where there was collection of some data from the perspective of the child on related concepts (some behaviours and feelings), these were seldom used, although it is not possible to ascertain whether this is an artefact of the question being asked (which was not one that belonged to a validated scale) or the informant. Overall, however, child reports were used infrequently. For example, some of the questions on hobbies at age 7 are arguably indicators of attitudes to screen time, but were not used extensively. In addition, some of the self-rated feelings of children may also approximate to parental reports of child well-being, but again were rarely used as a focus of studies. Child self-reported data will become more important as the MCS children grow older, but it is unclear why these data appear underutilised at age 7. One group of authors who did use these data did question the reliability of these data through suggesting that young children may be more prone than older age groups to be subject to social desirability bias. However, they also conclude that children age 7 can have great insight into their own feelings and that they were able to establish patterns in well-being that were consistent with parental reports of their children's well-being [13]. Further studies examining the reliability of child self-reported data with other allied constructs may be needed to demonstrate the properties of these data.

Unlike BMI, data on children's diets were utilised less frequently as the focus of a study. This may be due to the quality of the data, and several authors reported the need for objective measures of diet and for better measures of the frequency of consumption of different foods; food diaries were named as a necessary measure to ensure that these types of data were collected. Food diaries, or at least further (self-reported) measures of diet, could have been incorporated into the child self-reported module, although there are a number of methodological difficulties in collecting data through food diaries.

Data on immunisations at age 3 and 5 did not feature in a great number of publications. However, those using MCS data were highly cited. One of the unique strengths of the MCS data is that they were able to directly reflect and address the research needs of policy-makers in terms of understanding antecedents of MMR uptake. Crucially, MCS data were

able to provide a unique insight into uptake of single vaccines as well as combined vaccines; these data were not readily available elsewhere.

It comes as no surprise that data that are collected through a recognised scale with defined thresholds or cut-off points for identifying constructs of interest and/or data that can provide a unique insight into a policy-relevant issue, are those most widely used in the MCS data. However, these observations reinforce the need for those making a case for new data to be collected to respond to these concerns. Those making a case for data to be collected in future sweeps should also demonstrate clear examples of the use of the constructs in studies and the impact that they can have in informing the literature and/or decision-making and policies. Future studies among children may also use these results to carefully consider the types of questions that are asked to younger children and their suitability for that developmental stage.

4.2 Where is granularity lost?

A question that we wished to address in this research was to identify where granularity was lost in the data. That is where detailed data are collected from respondents, but where such granularity is obscured by the need to collapse response categories to achieve a workable sample size for that category. Contrary to our expectations, we saw little evidence of granularity being 'lost' in this way, although this is likely a reflection of data being underutilised. For example, the variable holding whether children's diets are restricted, including having 'fish on Fridays' was only used in the descriptive report for that sweep (and that level of granularity was lost in that particular case). We are therefore largely unable to comment on whether granularity is lost, suffice to say that those subject areas known to be well utilised are more likely to benefit from greater granularity in the data collected.

Nevertheless, two examples were found where grouping data seemed to be somewhat problematic. The first was in terms of screen time, where data on TV viewing and computer usage were collected in bands, but where these bands did not correspond to the American Academy of Paediatrics (AAP) recommendation that screen time be limited to 1-2 hours per day. The bands used in collecting these data meant that authors were not directly able to measure whether MCS children exceeded the AAP limits, although some did infer this regardless. A further potential mismatch between the recommended thresholds is also observed to some extent in the case of fruit consumption, where data are collected on the number of portions consumed, but the guidance around minimum consumption refers to fruit and vegetable consumption. Therefore, it is not possible to measure whether children are consuming the recommended number of portions of fruit or vegetables per day.

The second example where grouping data were found to be problematic was in the case of BMI, where a number of different thresholds for overweight and obesity were in use. The use of different thresholds can lead to substantial differences in the results obtained. Some users failed to report which definition was used, impeding the comparison of results. MCS data has traditionally been deposited with pre-constructed variables reflecting International Obesity Taskforce thresholds for obesity, although the National Obesity Observatory recommends that in England, the British 1990 (UK90) growth reference charts should be used to determine the weight status of an individual child and population of

children[21] (although other thresholds may be more appropriate dependent on the research question [115]). Depositing MCS data with different thresholds of obesity and allowing researchers to select the most appropriate threshold may allow users to observe the differences in results when using one measure over another, and may also serve as a reminder for users to specify the set of thresholds used.

4.3 Further ideas for good practice around the use of and reporting of MCS data

- **Encouraging notification of publication**: Currently CLS traces MCS publications through inviting users to notify the centre of publications and through additional web searching. Emphasising the importance of notifying CLS of publications using MCS data at the stage of accessing data may boost the number of studies that are traced.

- **Further development of a community of users (requires further funding/investment)**: Establishing a searchable database of MCS users on the CLS website could help to further foster the community of users. The database could hold a short entry with users' contact details, topic areas of interest and key variables of interest. This would allow MCS users to develop links with others with similar interests, and potentially foster collaborations between users and across institutions. This database could also be used as the basis of future work in contacting users for consultations for future sweeps and other forms of user engagement. Participation in such a database would be voluntary although it could be encouraged when users obtain the data.

- **Recording publications with study level meta-data (requires further funding/investment)**: Enhancing the functionality of the CLS library could allow for the recording of a greater number of fields on publications and a more efficient means of searching the library. Users notifying CLS of new publications could be invited to complete a template of meta-data about their publication including, for example, keywords, key variables used in the analysis, and other study-level meta-data. This enhanced functionality would assist in future exercises aimed at tracing MCS usage and would also be beneficial to future researchers to identify where data has been used previously and where they are underutilised. This would support the further development of a community of users.

- **Publishing the case for variables:** Most variables/measures included in MCS surveys go through a process of consultation which involves a written case being made by the research team/users for their inclusion. We recommend that a record of this process is published for new variables to allow users to understand why variables have been suggested (and included). For example, in the case of hobbies data, which are not widely used, publishing this information would allow users to understand the rationale underlying new questions and may stimulate further use of the data.

- **Nominating variable champions**: Each variable that is included in MCS surveys is included usually after a written case has been made. 'Variable champions' could be nominated to provide some support or engage in discussion around the use of

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[21] Also featured here (http://www.noo.org.uk/NOO_about_obesity/measurement/children (Accessed 07/03/16)

those variables. In some cases this could include policy-makers and practitioners, which would foster links between academic users and other stakeholders.

- **Making MCS studies more identifiable:** Further guidance or emphasis of the importance of naming of MCS in publications' titles/abstracts/keywords may facilitate other reviews of data usage in future, and may give additional prominence to the study in the literature.

- **Principles of good practice in data analysis**: Although MCS data users are required to adhere to good practice, in terms of data security and to ensure that the confidentiality of respondents is preserved (among other elements), there is no part in the End User Licence (EUL) that explicitly covers other aspects of the ethical treatment of data. For example, Social Research Association (SRA) Ethical Guidelines state that researchers 'must conduct their work responsibly and in light of the moral and legal order of the society in which they practice' and must also 'not engage or collude in selecting methods designed to produce misleading results, or in misrepresenting findings by commission or omission' [187, p18]. It would be expected that researchers using MCS data would be already adherent to the ethical guidelines set out by an association such as the SRA. A suggestion could be for the EUL for MCS data to include a reminder for users around the expectation that the data will be analysed appropriately and not in a way as to purposely misrepresent the results.

4.4 Specific recommendations around data and future research

- **Methodological development:** We recommend further exploration in terms of how a systematic approach to discovering, mapping and synthesising literature could be integrated with the further analysis of MCS data. An example might be the investigation of the relationship between BMI and behavioural outcomes. A systematic review could be conducted of studies using MCS data on BMI and child behaviour to synthesise the conceptual frameworks and to help design a model to be tested in the data, with covariates selected based on the results and/or recommendations of previous studies. This synthesised model (based on the synthesis of theory and previous results) could then be tested on MCS data, blending both the systematic review approach and new analysis of the data.

- **Further investigation of the Child Social Behaviour Questionnaire (CBQ)**: We recommend that funding be sought for a project that would aim to further validate and characterise the properties of the CBQ using MCS data. This could enhance further use of these variables.

- **Voice of the child studies**: Related to the earlier recommendation around publishing the written case for including variables in MCS, we recommend that this should start with those variables collected through child self-reports at age 7. This could provide a basis for a programme of further analysis of variables that reflect the voice of the child. This perspective has been a concern among policy-makers and voluntary sector practitioners for a number of years [188], and there is substantial potential for MCS to make further contributions in this area.

- **BMI measures**: As described earlier, we recommend that variables that are deposited with flags for whether the child is obese/overweight are clearly marked according to the thresholds used for categorising overweight/obesity. Furthermore, users should be encouraged to explicitly report the thresholds used. Further work is

currently underway to understand the implications of using different thresholds around overweight/obesity in MCS data.

4.5 What has the pilot exercise taught us for future exercises and what are the limitations of this study?

This study is one of the first to map systematically how data from a single survey are used in the literature. To fit within the resources for the exercise, the remit was restricted to ten priority areas which were selected in conjunction with the study depositors. We explored the utility of a complex search strategy compared to a much simpler search strategy. After testing the simpler search, but implementing this across a much wider set of databases, against the CLS bibliography, we found that any discrepancies could be accounted for and that our own search produced more results (481 vs 440). Our results were also a narrower set than those in the CLS bibliography, representing only those studies which met our inclusion criteria (i.e. excluding studies that were not reporting primary analysis of the data) and did not contain duplicates (i.e. working papers and journal articles). The results suggest that a simple search implemented across several databases can lead to a good level of discovery of studies using MCS data. However, there are limitations to our approach.

Firstly, some data sources only allow for title and abstract searching. Therefore we are dependent on users including MCS somewhere in a word-restricted abstract. We were concerned that this was unlikely to be common practice in economic literature in particular and expanded the search, although this produced no additional results after screening. Relying on title and abstract is likely to mean that we have undercounted working papers and conference papers, where the abstract is often unavailable or is not indexed. Furthermore, use of MCS data by third sector organisations as part of reports or briefings is also likely to be underrepresented. A further recommendation we would therefore make is that authors name the data in the title/abstract to increase the likelihood of discovery.

A second limitation is that our conclusions around utilisation of data are based around the different topics being the focus of papers. Often this can be hard to identify and rather subjective. While we did employ a definition of prime focus in our screening, this may still have been open to interpretation, particularly in terms of studies testing a range of different predictors simultaneously with only a broad research question guiding variable selection. While we can assume that the papers identified represent the majority published up to July 2015 across the chosen subject areas, there may be some omissions.

A third limitation is that our conclusions around utilising data are based on studies publishing their findings. Studies may have tested some variables in preliminary models but may have dropped these for parsimony and may not report on null findings. Very few studies reported results that were not statistically significant for their variable of focus; Kelly and colleagues' study provided one of the few examples where indicative although statistically insignificant associations were the focus of the paper [35].

Future work may choose to adopt a similar approach but with a defined research question; this could be reflected in the search, but would also allow for a more in-depth synthesis than is the case here. Example topics could reflect some of the strengths of the MCS data;

for example how have MCS data been used to examine country level differences in child outcomes; how have MCS data been used to examine health inequalities across social groups; or how have MCS data been used to examine differences in the outcome of motherhood compared to fatherhood. Extensions of more broad-brushed approaches, as is the case in this study, could be to examine the cost-impact of different questions, with impact measured through, for example, study citations, study media impact and mentions in Hansard.

Several studies were focussed on using a single sweep of data. For many, this may have been because of data reasons, or because incorporating different sweeps was not necessary for addressing the research question. Should this also be partly attributable to a lack of skills to analyse longitudinal data, then initiatives such as CLOSER will be instrumental in enhancing the capacity of social researchers to use these data.

Finally one of the most surprising findings to emerge was that some studies are published in peer-reviewed journals with an incorrect spelling of Millennium (spelt instead as millenium) appearing throughout the text [189]. While this was reflected in the search strategy, it was one of the more unusual findings of the mapping project.

5. Full list of studies discovered by subject area

5.1 SDQ

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Blanden Jo, Machin Steve (2010) Intergenerational inequality in Early Years assessments. In: Hansen Kirstine, Joshi Heather, Dex Shirley Children of the 21st century: The first five years. Bristol: Policy Press.

Bradshaw Jonathan, Holmes John, Percy A (2008) Family poverty assessed at three years old. London: Centre for Longitudinal Studies.

Brophy S, Cooksey R, Lyons RA, Thomas NE, Rodgers SE, Gravenor MB (2011) Parental factors associated with walking to school and participation in organised activities at age 5: analysis of the Millennium Cohort Study. BMC public health. 11: 14.

Brown Matt, Schoon Ingrid (2010) Child behaviour. In: Hansen Kirstine, Jones Elizabeth, Joshi Heather, Budge David Millennium Cohort Study Fourth Survey: A User's Guide to Initial Findings. London: Centre for Longitudinal Studies, London.

Carson C, Redshaw M, Sacker A, Kelly Y, Kurinczuk J J, Quigley M A, (2013) Effects of pregnancy planning, fertility, and assisted reproductive treatment on child behavioral problems at 5 and 7 years: Evidence from the Millennium Cohort Study. *Fertility and sterility*, *99*(2), 456-463

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Crawford Claire, Goodman Alissa, Greaves Ellen, Joyce Rob (2012) Cohabitation, marriage and child outcomes: an empirical analysis of the relationship between marital status and child outcomes in the UK using the Millennium Cohort Study. Child & Fam. LQ, 24, 176

CRAWFORD C, DEARDEN L, GREAVES E (2013) When you are born matters: evidence for England. London: Institute for Fiscal Studies.

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Cruise Sharon Mary; O'Reilly Dermot (2015) Are the differences in adulthood ill-health across the north-south divide and between Scotland and England also evident in early

childhood health indicators? *Social Science & Medicine*, *130*, 277-283
http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=psyc11&NEWS=N&AN=2015-12472-031

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Cullis A (2009) Neighbourhood and wellbeing in the early years. London: Centre for Longitudinal Studies, University of London (Thesis).

Dearden Lorraine, Sibieta Luke (2010) Ethnic inequalities in child outcomes. In: Hansen Kirstine, Joshi Heather, Dex Shirley Children of the 21st century: The first five years. Bristol: Policy Press.

Dearden Lorraine, Sibieta Luke, Sylva Kathy (2011) The socio-economic gradient in early child outcomes: evidence from the Millennium Cohort Study (IFS working paper no 03/11). London: Institute of Fiscal Studies

Del Bono , Emilia , Ermisch John (2009) Birth weight and the dynamics of early cognitive and behavioural development. Discussion Paper No. 4270. Bonn: Forschungsinstitut zur Zukunft der Arbeit/Institute for the Study of Labor (IZA).

Del Bono, Emilia; Rabe, Birgitta (2012) : Breastfeeding and child cognitive outcomes: Evidence from a hospital-based breastfeeding support policy, ISER Working Paper Series, No. 2012-29

Del Bono, Emilia , Francesconi Marco, Kelly Yvonne, Sacker Amanda (2014) Early Maternal Time Investment and Early Child Outcomes. Bonn: Forschungsinstitut zur Zukunft der Arbeit/Institute for the Study of Labor (IZA).

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Appendix 1 – search syntax

 ("Millennium Cohort") OR

("Millenium Cohort") OR

("Millennium Birth Cohort") OR

("Millenium Birth Cohort")

Note 'birth cohort' was also used in some databases (see methods section).

The Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre) is part of the Social Science Research Unit (SSRU), UCL Institute of Education, University College London.

The EPPI-Centre was established in 1993 to address the need for a systematic approach to the organisation and review of evidence-based work on social interventions. The work and publications of the Centre engage health and education policy makers, practitioners and service users in discussions about how researchers can make their work more relevant and how to use research findings.

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