**Preconception indicators and associations with health outcomes reported in UK routine primary care data: a systematic review**

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**Abstract**

**Background:** Routine primary care data may be a valuable resource for preconception health research and informing provision of preconception care.

**Aim**: To review how primary care data could provide information on the prevalence of preconception indicators and examine associations with maternal and offspring health outcomes.

**Design and Setting**: Systematic review of observational studies using UK routine primary care data.

**Method**: Literature searches were conducted in five databases (March 2023) to identify observational studies that used national primary care data from individuals aged 15-49 years. Preconception indicators were defined as medical, behavioural and social factors that may impact future pregnancies. Health outcomes included those that may occur during and after pregnancy. Screening, data extraction and quality assessment were conducted by two reviewers.

**Results:** From 5,259 records screened, 42 articles were included. The prevalence of 37 preconception indicator measures was described for female patients, ranging from 0.01% for sickle cell disease to >20% for each of advanced maternal age, previous caesarean section (among those with a recorded pregnancy), overweight, obesity, smoking, depression and anxiety (irrespective of pregnancy). Few studies reported indicators for male patients (n=3) or associations with outcomes (n=5). Most studies had low risk of bias, but missing data may limit generalisability.

**Conclusion:** Findings demonstrate that routinely collected UK primary care data can be used to identify patients’ preconception care needs. Linking primary care data with health outcomes collected in other datasets is underutilised but could help quantify how optimising preconception health and care can reduce adverse outcomes for mothers and children.

**Keywords**: general practice; preconception care; pregnancy outcomes; pre-pregnancy care; primary care.

**How this fits in:**

* Provision of preconception care is not currently embedded into routine clinical practice but may be informed by routinely collected primary care data.
* This systematic review demonstrates that UK primary care data can provide information on the prevalence of a range of medical, behavioural and social factors among female patients of reproductive age, while limited research has examined male preconception health or associations with maternal and offspring health outcomes.
* Routinely recorded electronic patient record data can be used by primary healthcare professionals to search for preconception risk factors and thereby support individualised preconception care, while aggregate data can be used by public health agencies to promote population-level preconception health.
* Further data quality improvements and linkage of routine health datasets are needed to support the provision of preconception care and future research on its benefits for maternal and offspring health outcomes.

**Introduction**

Preconception care is the provision of biomedical, behavioural and social interventions to people of reproductive age (15-49 years) before conception may occur with the aim of improving short- and longer-term parental and child health outcomes.1 Primary care teams have a key role in providing preconception care as identified by patients and healthcare professionals.2, 3 Preconception care delivered in primary care improves knowledge and preconception health behaviours in female patients, but there is currently less evidence about male patients or the impact on pregnancy and longer-term health outcomes.4, 5 In line with the National Institute for Health and Care Excellence (NICE) Clinical Knowledge Summary on preconception advice and management, primary care teams are encouraged to consider discussions about preconception health when appropriate, and to assess, manage and potentially optimise a range of physical and mental health conditions, health behaviours, and social needs prior to potential pregnancy.6 However, routine provision of preconception care is not currently widespread in UK clinical practice.7

To build the case for implementation of strategies and guidelines that optimise the population’s preconception health, the UK Preconception Partnership proposed an annual report card to describe and monitor preconception health.8 Our scoping review to inform national surveillance identified 65 preconception indicators (medical, behavioural and social risk factors that may impact potential future pregnancies among individuals of reproductive age) that are recorded in existing UK routine health data.9 A first report card was produced based on 23 indicators recorded in the national Maternity Service Data Set (MSDS), demonstrating that nine in 10 women in England enter pregnancy with at least one potentially modifiable risk factor for adverse pregnancy and birth outcomes.10, 11 Similarly, an analysis of primary care data from the Royal College of General Practitioners Research and Surveillance Centre found that 91% of women of reproductive age have a behavioural or medical risk factor for adverse pregnancy outcomes.12 These studies have to date focussed on preconception health of women (not men), and have not examined trends and trajectories in medical, behavioural and social indicators during the years leading up to pregnancy. Doing so would improve our ability to identify the population’s preconception care needs throughout their reproductive years. Routinely collected primary care data is potentially a unique resource to describe and monitor preconception health, and to examine the impact of (changes in) preconception indicators on improving outcomes such as gestational diabetes and preterm birth.

To inform future research and surveillance in the UK, and develop policy and clinical practice recommendations, we aimed to systematically review the literature to explore how UK routine primary care data could provide information on the prevalence of preconception indicators and examine associations with maternal and offspring health outcomes.

**Methods**

**Search strategy and selection criteria**

The protocol for this review was registered with PROSPERO,13 and the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA 2020) guideline used to ensure transparent reporting.14 A search strategy was developed, and searches conducted on 27 March 2023 (from inception date) in five databases: MEDLINE (Ovid), EMBASE (Ovid), Scopus, CINAHL, Web of Science (Supplementary Table 1). Supplementary searches using ‘preconception’ and ‘prepregnancy’ terms were conducted using databases from the British Journal of General Practice, and UK primary care datasets.13 Reference lists of included articles were screened for additional studies.

Articles were selected if they included findings from an observational study among individuals of reproductive age (15-49 years), used national patient-level routine primary care data collected in England, Wales, Scotland and/or Northern Ireland, and reported on the prevalence of at least one preconception indicator (Table 1). Included indicators were based on a list of 65 indicators (e.g. weight) and 117 indicator measures (e.g. underweight, overweight, obesity) across 12 domains (e.g. health behaviours and weight) identified from our previous scoping review.9 Articles not including new/original peer-reviewed results, and conference abstracts, were excluded.

**Selection process**

Search results were collated in EndNote and duplicates removed, before uploading to Covidence software. Titles and abstracts, followed by full text articles, were screened independently by two reviewers for inclusion. Disagreements or uncertainties were resolved through discussion.

**Data extraction and synthesis**

A standardised data extraction form was developed and piloted. Data were extracted by one reviewer and checked by a second reviewer. Disagreements were resolved between the two reviewers. All extracted data on study characteristics (grouped by primary care database), prevalence of preconception indicators, and measures of association between preconception indicators and outcomes (grouped by preconception indicator), were presented in tables. To obtain population-level estimates of preconception indicators, prevalence data were extracted only if reported (or could be calculated) for the overall study population of females or males of reproductive age (i.e. not if reported only in sub-populations such as patients with a specific condition or characteristic). Meta-analysis was not conducted due to heterogeneity in preconception indicator definitions and inclusion and exclusion criteria of study populations.

**Risk of bias assessment**

Risk of bias was assessed for study findings on the prevalence of preconception indicators using the 10-item scale developed by Hoy et al rating internal and external validity.15 The Newcastle-Ottawa Scale (NOS) was used to rate risk of bias of study findings on associations between preconception indicators and health outcomes based on seven items related to selection, comparability, and exposure/outcome.16 Risk of bias was assessed by one reviewer, and checked by a second reviewer. Disagreements were resolved between the two reviewers. Studies were classified as low, moderate or high risk of bias (findings on prevalence),15 and good, fair or poor data quality (findings on associations)16 (scoring guides in Supplementary Tables 2, 3A-3B). In addition, we report potential additional biases not captured through these risk of bias assessment tools, including the ability for indicator and outcome data to be accurately captured in primary care, high proportion of excluded or missing data (defined as >20%), and no or limited linkage with other routine health datasets (for studies reporting indicator-outcome associations).

**Results**

From 9,401 identified records, 4,142 duplicates were removed and after title and abstract screening (n=5,259), 117 full-text articles were evaluated for eligibility (Figure 1). 42 articles were included, reporting findings from 11 primary care databases such as the Clinical Practice Research Datalink (CPRD) and The Health Improvement Network (THIN).

Most articles reported findings from primary care databases that included patients from three (n=1) or all four UK nations (n=30), or from England (n=6), Scotland (n=3) or Northern Ireland only (n=2) (Supplementary Tables 4-5). In 11 studies, a primary care dataset was linked with at least one other dataset, such as Hospital Episodes Statistics (HES), Office for National Statistics (ONS) mortality register, community prescribing data, or the Avon Longitudinal Study of Parents and Children. All studies included data on female patients; three studies also reported preconception indicators for male patients.

**Prevalence of preconception indicators**

Articles reported findings on 25 preconception indicators (37 indicator measures) across seven domains (Table 2). Most studies included people of reproductive age irrespective of past/future pregnancy (n=26), while other studies included women with a pregnancy or birth recorded during the study period (n=15) or women with a recorded pregnancy and their partners (n=1) (Supplementary Table 6).

Data on overall prevalence were available for 21 of the 42 studies, with the other 21 studies reporting prevalence estimates only in sub-populations. Additional preconception indicators reported in sub-populations included housing, domestic abuse, routine GP check-up in the past year, paternal age, previous pregnancy loss, history of assisted reproduction, alcohol consumption, substance misuse, cervical screening, and cardiovascular disease (Supplementary Table 5).

The prevalence of preconception indicators reported across studies and primary care databases varied widely, possibly due to differences in preconception indicator definitions, year of data collection (Supplementary Table 7), and study populations (Supplementary Table 6). The prevalence of preconception indicators defined in line with our scoping review (i.e. excluding individual methods of contraception, and prescribed folic acid supplements),9 ranged from 0.01% for sickle cell disease to >20% for each of advanced maternal age, previous caesarean section (among those with a recorded pregnancy), overweight, obesity, smoking and diagnosis of depression and anxiety among female patients (irrespective of pregnancy). Only three studies reported preconception indicators for male patients, showing for example that the prevalence of depression among fathers (9.2%) was lower compared with mothers (22.2%),17 and the proportion of patients prescribed valproate was comparable among female (0.31%) and male patients (0.37%) in 2004, but much lower among females (0.16%) than males (0.36%) in 2018.18

**Associations of preconception indicators with maternal and offspring outcomes**

Five studies reported associations of preconception indicators (contraception prescription [n=1], sexually transmitted disease [n=1] and polycystic ovary syndrome [PCOS] [n=3]) with pregnancy and birth outcomes (Supplementary Table 8). Outcome data were obtained from primary care data and/or linked HES data. Where two studies reported on comparable indicators and outcomes, consistent findings were shown for associations of PCOS with preterm delivery (<37 weeks gestational age) (positive association), high birthweight (>4kg) (no association) and low birthweight (<2.5kg) (inconclusive findings).19, 20

**Risk of bias and data quality**

Risk of bias for findings on the prevalence of preconception indicators was generally low (n=18/21 studies), however, none of the studies received a minimal score (no bias) (Supplementary Table 2). Potential biases were introduced based on representativeness and sampling frame (e.g. excluding women with no pregnancy reported or no linked data available), and indicator definition and measurement (e.g. reporting individual methods of contraception rather than population prescribed contraception, or reliance on medication prescription rather than dispensing data). Moreover, details of non-response (e.g. impact of missing data) were not reported in approximately half the studies, and data on some indicators will not be accurately captured in primary care data (e.g. use of over the counter 400mcg folic acid supplements). Data quality for studies examining associations of preconception indicators with health outcomes was rated as good for four of the five studies (Supplementary Tables 3A-3B).

**Discussion**

**Summary**

This systematic review found that UK routine primary care data can provide valuable information on patients’ medical, behavioural and social risk factors before (a potential) pregnancy. Based on 42 included studies among people of reproductive age or women with a pregnancy recorded during the study period, the prevalence of 37 preconception indicator measures was reported. Findings showed that >20% of female patients of reproductive age would benefit from support with smoking cessation, and management of weight, depression and anxiety. This would optimise their own health, and improve their chance of a successful pregnancy and healthy baby if that is something they want. Limited research has used primary care data to examine preconception indicators among male patients, or associations of preconception indicators with pregnancy outcomes and longer-term maternal and offspring health outcomes.

**Strengths and limitations**

This is the first systematic review to demonstrate how national routine primary care databases can be used to describe the population’s preconception health, to inform clinical practice and future research directions. Comprehensive, prospectively registered review methods were used. Our search was limited to national primary care data from the UK as routinely collected electronic patient record (EPR) data and its availability and use for research purposes may differ across countries. Our findings would therefore not have identified preconception indicators reported in any specific local datasets and may not be generalisable to other countries. Preconception indicators were selected based on our previous scoping review;9 so potentially relevant indicators not included in this review, not reported in the included studies, or not used and published for research purposes would have been missed. We have not reported on data completeness in terms of preconception indicators that are (and are not) reported within each primary care dataset, as this largely relies on the types of research that have been conducted and published using individual databases, which does not necessarily reflect availability of data. Moreover, some preconception indicators (such as dietary intake and physical activity) are not routinely recorded in general practice.

**Comparison with existing literature**

Findings from our review complement our previous preconception report card based on the MSDS,10 showing that national routine health data are a valuable resource to describe and monitor women’s preconception health. Half of the preconception indicators identified in this review were also reported in the MSDS, with comparable prevalence estimates for most indicators (e.g. teenage pregnancy, previous caesarean delivery, overweight, obesity), while other indicators may be underreported in primary care (e.g. over the counter folic acid supplementation) or in the MSDS (e.g. mental health conditions).10 Published primary care data reported an additional 15 indicators not included in the MSDS (e.g. fertility problems, contraception, relevant medical conditions, teratogenic medication use). Linkage of these (and other) national routine health datasets would enhance the quality of preconception report cards and surveillance (Box 1). Based on linkage of primary care and HES datasets, findings from our review (n=2 studies19, 20) confirm the previously reported association of PCOS with increased risk of preterm delivery.21

Findings from our review are also in line with previous research reporting primary care data quality issues.22-24 Studies included in our review documented substantial missing data (20-60%) for ethnicity and BMI category, likely varying across sub-populations. Coding quality is related to financial incentives such as the Quality and Outcomes Framework (QOF), which may improve accurate recording of selected indicators but also distort prevalence estimates over time.22 The prevalence of some preconception indicators may be underestimated as not all conditions are solely diagnosed and coded in general practice (e.g. sexually transmitted disease),25 or medications and supplements prescribed (e.g. contraception, 400 mcg folic acid supplements).26 Another commonly reported limitation is the representation of selected general practices in research databases,22, 23 often limited to practices that use one of four main software platforms to manage EPRs and further determined by voluntary ‘opt ins’.22, 23 As a result, primary care databases may underrepresent specific regions and bias national prevalence estimates of preconception indicators and associations with health outcomes.

**Implications for research and clinical practice**

Our findings demonstrate that many preconception indicators are routinely recorded in EPRs, allowing primary healthcare professionals to search for risk factors and provide individualised preconception care. A digital risk screening template has already been developed based on the NICE Clinical Knowledge Summary6 using Ardens Clinical Decision Support System software (Ardens is a UK-wide provider of digital templates and resources for over 3,300 GP practices27). This template can be used as a tool to bring together and analyse EPR data to help primary healthcare professionals identify and address individual patient preconception risk factors, make informed decisions, and thereby improve personalised patient care. The template may also improve coding and recording of indicators. Further work is required to co-develop practical guidance and resources to support integration of preconception care and use of the digital risk screening template into every day clinical practice (Box 1).

Our findings identify the need to use standardised definitions when reporting preconception indicators (Box 1). Due to heterogeneity in definitions, the prevalence of preconception indicators across UK nations, and changes over time, could not be directly compared across studies. However, Lee and colleagues applied standardised definitions to CRPD (UK) and SAIL data (Wales), showing comparable prevalence estimates for some indicators (e.g. obesity, depression), but higher (e.g. smoking, underweight, anxiety, asthma) or lower (e.g. advanced maternal age) prevalence for other indicators, when comparing pregnant women in Wales with those in the UK overall .28 Moreover, standardised reporting within the same database showed, for example, increases over time in the prevalence of type 2 diabetes (1995-2017),29 alongside decreases in poor diabetes control (2004-2017).29, 30

Lastly, the limited reporting of male preconception indicators, and associations of preconception health with pregnancy, maternal and offspring health outcomes, calls for further research. Many of the preconception indicators reported for female patients are also relevant to male patients (e.g. smoking, obesity), with increasing evidence suggesting better paternal preconception health is associated with reduced risks of infertility and adverse pregnancy and offspring health and developmental outcomes.31-33 To enable further research, improvements are needed in the way that families (i.e. biological parents and their children) can be identified and data linked.17, 34 Primary care data also provide a unique opportunity to examine trajectories of preconception health during reproductive years irrespective of pregnancy, and to quantify the extent to which these reduce adverse pregnancy and offspring health outcomes. Future research would be enhanced by linkage of primary care and other routine health datasets beyond the identified existing linkages (e.g. MSDS and Community Services Data Set) to determine the short- and longer-term benefits of preconception care (Box 1).

**Conclusion**

Collectively, findings from studies included in our review demonstrate that routinely collected primary care data in the UK can provide valuable information on patients’ medical, behavioural and social risk factors before (a potential) pregnancy. These data can guide the provision of individualised preconception care, and be used as a valuable resource for research and surveillance. Improvements in coding and reporting, and linkage of general practice systems and other national routine health datasets, would inform evidence-based provision of preconception care in primary care.

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**Figures**

Records identified (total n = 9,401):

Databases (total n = 7,942)

MEDLINE (n = 1,760)

EMBASE (n = 2,088)

Scopus (n = 2,683)

CINAHL (n = 381)

Web of Science (n = 1,030)

UK primary care database websites (n = 28)

Reference lists (n = 1,431)

Duplicate records removed (n = 4,142)

**Identification**

Records excluded based on title and abstract screening

(n = 5,142)

Records screened

(n = 5,259)

Reports not retrieved (n = 0)

Reports sought for retrieval

(n = 117)

**Screening**

Articles excluded (n = 75):

No new/original results (n = 2)

Not national primary care data (n = 15)

Not peer-reviewed or full-length (n = 23)

No data on preconception indicator (n = 24)

No data on reproductive-aged individuals (n = 11)

Articles assessed for eligibility

(n = 117)

Articles included (n = 42)

Primary care databases included (n = 11)

**Included**

**Figure 1.** PRISMA flow diagram for the identification and selection of studies included in the review.

* Development of coding practice standards with appropriate incentives to improve data quality.
* Standardisation of reporting of preconception indicators and pregnancy and offspring health outcomes, for example through the development of core outcome sets.
* Improvements in the coding and identification of family and household members to enable linkage of data from biological parents and their children.
* Nationwide linkage of general practice systems, and linkage of primary care datasets with other routine health datasets (such as Hospital Episode Statistics, Maternity Services Data Set and Community Services Data Set).

**Box 1.** Recommendations to improve the use of UK routine primary care data for clinical practice, research and surveillance of preconception health and care.

**Tables**

**Table 1.** PICOS statement

|  |  |
| --- | --- |
| Population | Individuals of reproductive age who may or may not be(come) pregnant/conceive a pregnancy (any gender, aged 15-49 years). |
| Intervention/ exposure | Preconception indicators as identified in Schoenaker et al.9  Preconception indicators are defined as medical, behavioural and social risk factors or exposures as well as wider determinants of health that may impact potential future pregnancies among all individuals of reproductive age.  Studies do not have to identify relevant factors or exposures as ‘preconception indicators’. |
| Comparator/ control | Not applicable. |
| Outcome | Maternal health outcomes: any outcome that may occur during pregnancy (e.g. gestational diabetes), delivery (e.g. caesarean section), postpartum (e.g. mortality), or beyond (no age limit) (e.g. type 2 diabetes).  Offspring health and developmental outcomes (including social/educational outcomes): any outcome that may occur during pregnancy (e.g. stillbirth), delivery (e.g. preterm birth), infancy (e.g. neonatal intensive care unit admission), or beyond (no age limit) (e.g. learning difficulty). |
| Study design | Observational studies (including cohort, cross-sectional and case-control studies). |

**Table 2.** Range of prevalence estimates of preconception indicators reported for people of reproductive age in UK routine primary care data

| **Preconception indicator** | **Preconception indicator measure1** | **Number of studies2** | **Prevalence range reported across included studies3** |
| --- | --- | --- | --- |
| **Domain: wider determinants of health** | | | |
| Deprivation | Percentage of women living in the most socio-economically deprived area (based on quintiles) | 6 | 13.6-22.6% |
| Ethnicity | Percentage of women from an ethnic minority background | 5 | 12.8-20.0% |
| **Domain: reproductive health and family planning** | | | |
| Maternal age | Percentage of women [with a birth recorded during the study period] aged ≤19 at time of childbirth (teenage pregnancy) | 3 | 3.1-6.7% |
| Percentage of women [with a birth recorded during the study period] aged ≥35 at time of most recent pregnancy (advanced maternal age) | 3 | 15.1-27.0% |
| Obstetric history | Percentage of women [with a birth recorded during the study period] with a previous caesarean delivery | 1 | 23.7% |
| Fertility problems | Percentage of women with a history of fertility problems | 2 | 1.2-3.8% |
| Contraception | Percentage of women who use contraception (specific individual methods of contraception) | 7 | 0.1-70.1% |
| **Domain: health behaviours and weight** | | | |
| Folic acid supplementation | Percentage of women prescribed folic acid supplements | 1 | 0.3% |
| Weight | Percentage of women in the underweight BMI category (<18.5 kg/m2) | 1 | 3.9-5.9% |
| Percentage of women in the overweight BMI category (25.0-29.9 kg/m2) | 1 | 26.0-26.1% |
| Percentage of women in the obesity BMI category (≥30.0 kg/m2) | 1 | 23.2-24.6% |
| Smoking | Percentage of women who currently smoke | 3 | 13.1-26.7% |
| **Domain: immunisation and infections** | | | |
| Sexually transmitted disease | Percentage of women diagnosed with gonorrhoea | 1 | 0.01% |
| **Domain: mental health conditions** | | | |
| Mental health condition | Percentage of women with any mental illness | 1 | 19.8 |
| Percentage of women with depression | 3 | 9.3-24.1% |
| Percentage of men with depression | 1 | 9.2 |
| Percentage of women with anxiety | 2 | 4.1-23.1% |
| Serious mental illness | Percentage of women with severe mental illness | 2 | 0.1-2.4% |
| **Domain: physical health conditions** | | | |
| Epilepsy | Percentage of women with epilepsy | 1 | 1.3-1.4% |
| Diabetes mellitus | Percentage of women with type 1 diabetes | 3 | 0.2-0.6% |
| Percentage of women with type 2 diabetes | 4 | 0.2-1.1% |
| Percentage of women with diabetes (any type) | 2 | 0.6-1.4% |
| Percentage of women with poor diabetes control (HbA1c ≥8.5%) (among type 1 diabetes patients) | 1 | 40.8-50.0% |
| Percentage of women with poor diabetes control (HbA1c ≥8.5%) (among type 2 diabetes patients) | 1 | 24.7-33.1% |
| Polycystic ovary syndrome (PCOS) | Percentage of women with PCOS | 3 | 0.2-6.5% |
| Endometriosis | Percentage of women with endometriosis | 2 | 0.1-1.7% |
| Eating disorder | Percentage of women with an eating disorder | 1 | 1.8-1.9% |
| Thyroid disease | Percentage of women with thyroid disease | 2 | 0.1-3.3% |
| Hypertension | Percentage of women with hypertension | 1 | 0.7-0.9% |
| Thromboembolism | Percentage of women with thromboembolism | 1 | 0.6-0.7% |
| Asthma | Percentage of women with asthma | 1 | 14.6-17.2% |
| Inflammatory bowel disease | Percentage of women with inflammatory bowel disease | 2 | 0.5-0.6% |
| Sickle cell disease | Percentage of women with sickle cell disease | 1 | 0.01% |
| Cancer | Percentage of women with previous cancer diagnosis | 1 | 0.5-0.6% |
| **Domain: medication** | | | |
| Medication not recommended when planning pregnancy | Percentage of women prescribed valproate | 1 | 0.2-0.3% |
| Percentage of men prescribed valproate | 1 | 0.4% |
| Percentage of women prescribed anti-depressant medication | 1 | 16.3% |

1 Preconception indicator measures are based on Schoenaker et al (2022).9 Definitions of indicator measures may differ slightly across studies (see Supplementary Table 7).

2 Some studies include multiple primary care databases, or multiple timepoints.

3 Full details on the prevalence of preconception indicators reported in each study can be found in Supplementary Table 7.