

Temporal trends of key preconception indicators among women in Northern Ireland, UK: an analysis of maternity healthcare data 2011–2021

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Abstract

Optimizing preconception health offers an opportunity to reverse unfavourable trends in modifiable risk factors and improve reproductive outcomes. This study aims to report the yearly prevalence of key biopsychosocial preconception indicators for over a decade, as reported at antenatal booking appointments in Northern Ireland (UK). The indicators include area-level deprivation, planned pregnancies, and body mass index (BMI) between 2011 and 2021, as well as pre- and early-pregnancy folic acid supplement use between 2015 and 2020. This population-based study was conducted using annual routinely collected maternity data from the Northern Ireland Maternity System (NIMATS). R, accessed via the UK Secure eResearch Platform, was used to calculate yearly proportions. Multinomial regression models explored the relationship between each preconception indicator and year of booking appointment. Patient and Public Involvement and Engagement were integrated throughout the study. Of the 255 117 pregnancies included between 2011 and 2021, 21.4% were from women living in the most deprived quintile and 70.6% from women who reported a planned pregnancy. Obesity rates increased over the study period (e.g. obesity class I: 12.0%–16.1%), and preconception folic acid supplement use remained inadequate, though the use of supplements containing 5 mg of folic acid increased between 2015 and 2020 (400 µg: 34.4%–30.03%; 5 mg: 3.6%–5.0%). Efforts are needed to reverse negative public health consequences of sub-optimal preconception health indicators. Notably, folic acid supplement use was predominantly initiated after conception, suggesting that a renewed focus is needed, particularly supporting women with the greatest need, such as those in the most deprived areas.

Introduction

Worldwide, population health has seen significant changes in recent decades, including increasing levels of obesity and associated co-morbidities such as diabetes [1–3]. Behavioural factors influencing health such as insufficient physical activity have also been on the rise globally [4], and evidence suggests that mental health disorders have increased globally since 1990 [5]. Optimizing preconception health (i.e. the health of non-pregnant individuals of childbearing age) offers an opportunity to reverse unfavourable trajectories in modifiable risk factors and improve reproductive outcomes [6]. Certain preconception indicators are more amenable to change than others, through individual behavioural modifications (e.g. smoking) or population-level initiatives (e.g. folic acid fortification).

In Northern Ireland (NI), one of four countries in the United Kingdom (UK), data on key preconception indicators are recorded in the Northern Ireland Maternity System (NIMATS). It includes approximately 22 000 pregnancies each year from women cared for within the National Health Service (NHS) maternity services [2]. Building on a previous study exploring the prevalence of key preconception indicators in NIMATS (2011–2021) [7] and the changing public health landscape, an investigation of temporal trends was

undertaken to gain further insight into preconception indicators, highlight areas requiring significant public health action, and explore implications for the delivery of preconception care. These insights can inform policymakers and healthcare professionals (HCPs) on the priority areas of need within the population, thereby assisting the development of future campaigns and interventions [8].

Aims

The current study aims to report the yearly prevalence of key preconception indicators, namely area-level deprivation, planned pregnancy, smoking, and body mass index (BMI), as recorded in NIMATS between 2011 and 2021 during antenatal booking appointments (i.e. the initial consultations pregnant women have with HCPs, which usually takes place by the 10th–12th week of pregnancy) [9, 10]. The temporal trends of periconceptual folic acid supplement use were explored between 2015 and 2020, including a sub-analysis based on women's area-level deprivation, age at booking, gravidity, planned pregnancy, and BMI. This sub-analysis focused on folic acid supplement use due to a higher-than-expected incidence of neural tube defects (NTDs) in the UK and Ireland compared to other countries in Europe since the early 1980s [11, 12], and recent UK Government legislation calls for mandatory folic acid fortification of non-wholemeal wheat flour [13].

Additionally, there are ongoing debates regarding the optimal level of folic acid supplement use and, therefore, a deeper understanding of this behaviour is pivotal. For example, while guidelines have so far recommended that women at high risk of an NTD, including women with obesity ($\text{BMI} \geq 30 \text{ kg/m}^2$), should be advised to take 5 mg of folic acid daily [14], recent suggestions have specified that women with a $\text{BMI} \geq 25 \text{ kg/m}^2$ may not need the higher dosage unless an additional co-morbidity is identified, for example diabetes or taking anti-epileptic medications [15]. Because the investigations on folic acid supplement use trends have been limited in recent years and previously described as ‘patchy’ in the UK [16–18], this study aims to contribute to a better understanding of folic acid supplement use in NI, alongside other key biopsychosocial preconception indicators.

Methods

A repeated cross-sectional population-based study was conducted using annual routinely collected maternity data from NIMATS. The selection of the indicators to analyse was informed by previous literature [19, 20] and input from Patient and Public Involvement and Engagement (PPIE) representatives (previously reported) [7]. The analysed biopsychosocial indicators included planned pregnancy, smoking, and folic acid supplement use, representing behavioural factors, as well as BMI as a biological factor and deprivation as a social determinant of health. Further analyses exploring the temporal trends of periconceptual folic acid supplement use were conducted (i.e. based on women’s area-level deprivation, age at booking, gravidity, planned pregnancy, and BMI) due to concerns with the intake of this micronutrient in the UK. Other relevant indicators (i.e. alcohol consumption, diet quality, pre-existing physical and mental health conditions, and previous obstetric complications) were explored in the initial analyses; however, these data are not reported due to significant data quality limitations.

Pregnancies with an antenatal booking appointment (and pregnancy outcome, such as a live birth) recorded between January 2011 and December 2021 were included. For the sub-analysis specifically investigating folic acid supplement use, pregnancies with a booking appointment between January 2015 and December 2020 were retained due to data availability. Details of the included indicators can be found in [Supplementary Material S1](#).

Analysis and statistical disclosure control

To avoid small counts ($n < 10$), certain results were combined. For example, the ‘Missing’ values of folic acid supplement use were aggregated to ‘None’ and, instead of yearly prevalences, folic acid supplement use based on women’s BMI was presented as prevalences in 2015–2016, 2017–2018, and 2019–2021. Missing values for the other indicators were retained and reported as such, as shown in [Supplementary Material S1](#). Numerical restrictions were applied to the BMI variable, with values retained only if between 14 and 70 kg/m^2 , after exploring the pattern of individual data points. In the analyses on folic acid supplement use, only complete cases were retained due to disclosure controls.

After calculating the yearly prevalences of the included preconception indicators, multinomial logistic regression models explored the relationship between each indicator (outcome variables) and year of booking appointment (explanatory variable). Both unadjusted models and models adjusted for maternal age group, gravidity (i.e. the number of times a woman has been pregnant, including the current pregnancy), and deprivation are presented. R [21], accessed via the UK Secure eResearch Platform, was used to conduct statistical analyses. Ethical approval and participant consent were not required.

Patient and Public Involvement and Engagement

Previously reported PPIE includes the involvement of the Healthy Reproductive Years advisory panel (which includes adults aged 18–45 years old residing in NI when recruited) in the application for

NIMATS data access and the prioritization of preconception indicators [7]. Further PPIE was conducted in collaboration with SureStart, a programme supporting parents with children under 4 years old living in disadvantaged areas in NI. Women attended an in-person session to aid the interpretation of the findings relating specifically to folic acid supplement use, given the particular concerns with trends identified for this indicator.

The Guidance for Reporting Involvement of Patients and the Public (GRIPP) 2 checklist was used to report PPIE activities [22] ([Supplementary Material S2](#)).

Terminology

The term ‘woman’ is used to also include those who do not identify as women but have been or may become pregnant [9].

Results

The trends in key preconception indicators (2011–2021) were analysed across 255 117 pregnancies. Most pregnancies were from women living in the most deprived quintile (21.4%) and women who reported a planned pregnancy (70.6%). Less than half of the pregnancies were from women with a healthy BMI at booking (45.7%). The cohort used for the analyses on folic acid supplement use (2015–2020) included 132 205 pregnancies. Within this cohort, just under a third of pregnancies were primigravida (30.9%), and over a fifth were conceived by women living in the most deprived quintile (21.6%). Greater detail on women’s characteristics for the two cohorts is presented in [Table 1](#).

Regression models are presented in [Tables 2–4](#) (accompanying tables and figures in [Supplementary Materials S3–S5](#)).

Fewer pregnancies were recorded in the least deprived quintile compared to the most deprived quintile. No notable variations in deprivation were observed between 2011 and 2021 (q1: 21.8%–21.4%; q5: 16.1%–17.4%), with the adjusted regression model not reaching statistical significance in most years. The yearly prevalence of pregnancies reported as planned slightly increased between 2011 and 2021 (70.8%–73.0%), though an adjusted OR (aOR) of 0.91 (95% CI 0.86–0.96, $P < .01$) was observed. Rates of smoking declined from 16.7% to 9.6%; women with a booking in 2021 had significantly lower odds of reporting smoking than those with a booking in 2011 (aOR 0.43, 95% CI 0.40–0.47, $P < .01$). A decline was observed in pregnancies conceived by women with a healthy BMI (50.3%–39.9%), with opposing trends (i.e. increases) shown for women with a $\text{BMI} \geq 25 \text{ kg/m}^2$ (overweight: 29.0%–31.0%; obesity class I: 12.0%–16.1%; obesity class II: 4.6%–7.4%; obesity class III: 2.1%–4.1%). These results were confirmed in the adjusted regression models; for example, women with a booking in 2021 were more likely to have class III obesity than women with a booking in 2011 (aOR 2.78, 95% CI 2.44–3.18, $P < .01$).

Analyses suggested an overall decrease in the preconception use of supplements containing $400 \mu\text{g}$ of folic acid between 2015 and 2020 (34.4%–30.0%) and a slight increase in preconception use of supplements containing 5 mg (3.6%–5.0%). Postconception use of $400 \mu\text{g}$ supplements declined between 2015 and 2019 (54.3%–51.4%) then slightly increased to 53.94% in 2020. Postconception use of 5 mg supplements steadily increased (4.0%–7.7%). Women with a booking in 2020 were more likely to report postconception supplement use rather than preconception (aOR 1.21, 95% CI 1.17–1.27, $P < .01$) and report using supplements with 5 mg rather than $400 \mu\text{g}$ (aOR 1.74, 95% CI 1.64–1.86, $P < .01$), compared to women with a booking in 2015.

Preconception use of $400 \mu\text{g}$ folic acid supplements declined between 2015 and 2020 (34.4%–30.0%), with the largest percentage difference per subgroup observed among women from the most deprived quintile (24.3%–19.5%), women aged 35+ years (44.0%–37.2%), subsequent pregnancies (34.3%–28.9%), planned pregnancies (45.4%–39.5%), and women with obesity class III (20.0%–10.9%).

Table 1. Characteristics of pregnancies in the 2011–2021 cohort (n: 255 117) and in the 2015–2020 cohort (n: 132 205)

2011–2021; n: 255 117			
Indicators	Indicator levels	N	%
Deprivation quintile	1, most deprived	54 621	21.4
	2	53 946	21.2
	3	52 174	20.5
	4	50 513	19.8
	5, least deprived	41 895	16.4
	Missing	1968	0.8
Planned pregnancy	Yes	180 006	70.6
	No	70 686	27.7
	Missing	4425	1.7
Smoking	Yes	35 194	13.8
	No	219 783	86.2
	Missing	140	0.1
Body mass index	Underweight (<18.50 kg/m ²)	4849	1.9
	Healthy weight (18.50–24.99 kg/m ²)	116 686	45.7
	Overweight (25.00–29.99 kg/m ²)	74 397	29.2
	With obesity class I (30.00–34.99 kg/m ²)	33 438	13.1
	With obesity class II (35.00–39.99 kg/m ²)	14 109	5.5
	With obesity class III (≥40 kg/m ²)	6809	2.7
	Missing	4829	1.9
2015–2020; n: 132 205			
Indicators	Indicator levels	N	%
Folic acid supplement use	Preconception 400 µg	43 864	33.2
	Preconception 5 mg	5901	4.5
	Postconception 400 µg	69 767	52.8
	Postconception 5 mg	8186	6.2
	None	4487	3.4
Gravidity	Gravidity 1	40 875	30.9
	Gravidity ≥2	91 330	69.1
Deprivation quintile	1, most deprived	28 604	21.6
	2	28 277	21.4
	3	27 208	20.6
	4	26 182	19.8
	5, least deprived	21 934	16.6
Age at booking	<25 years	22 765	17.2
	25–34 years	82 681	62.5
	35+ years	26 759	20.2
Planned pregnancy	Yes	94 792	71.7
	No	37 413	28.3
Body Mass Index	Underweight (<18.50 kg/m ²)	2437	1.8
	Healthy weight (18.50–24.99 kg/m ²)	59 167	44.8
	Overweight (25.00–29.99 kg/m ²)	39 865	30.2
	With obesity class I (30.00–34.99 kg/m ²)	18 627	14.1
	With obesity class II (35.00–39.99 kg/m ²)	8180	6.2
	With obesity class III (≥40 kg/m ²)	3929	3.0

Abbreviations: kg: kilograms; m: metres; µg: micrograms; mg: milligrams.

Table 2. Associations between year of booking interview and deprivation quintile, planned pregnancy, and smoking

Year of booking	Deprivation quintile ^a		Planned pregnancy		Smoking	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
2011	Ref	Ref	Ref	Ref	Ref	Ref
2012	1.01 (0.98–1.04)	0.99 (0.96–1.02)	1.06 (1.02–1.10)	1.02 (0.98–1.06)	0.99 (0.98–1.00)	0.95 (0.90–1.00)
2013	1.01 (0.98–1.04)	0.98 (0.95–1.02)	1.08 (1.04–1.13)	1.02 (0.97–1.06)	0.98 (0.98–0.99)	0.89 (0.85–0.94)
2014	0.99 (0.96–1.02)	0.96 (0.93–0.99)	1.04 (1.00–1.08)	0.96 (0.92–1.00)	0.98 (0.97–0.98)	0.85 (0.81–0.90)
2015	1.01 (0.98–1.04)	0.97 (0.94–1.00)	1.08 (1.04–1.12)	0.98 (0.94–1.02)	0.97 (0.96–0.97)	0.80 (0.76–0.84)
2016	1.02 (0.99–1.06)	0.97 (0.94–1.00)	1.08 (1.04–1.13)	0.95 (0.91–0.99)	0.96 (0.96–0.97)	0.80 (0.76–0.84)
2017	1.04 (1.00–1.07)	0.98 (0.95–1.01)	1.05 (1.01–1.09)	0.91 (0.87–0.95)	0.96 (0.96–0.97)	0.80 (0.76–0.85)
2018	1.01 (0.98–1.04)	0.94 (0.91–0.97)	1.02 (0.98–1.07)	0.87 (0.84–0.91)	0.96 (0.95–0.97)	0.78 (0.74–0.82)
2019	1.05 (1.02–1.08)	0.97 (0.94–1.00)	0.99 (0.95–1.03)	0.83 (0.79–0.87)	0.94 (0.94–0.95)	0.67 (0.63–0.71)
2020	1.03 (1.00–1.06)	0.95 (0.92–0.98)	1.06 (1.01–1.10)	0.87 (0.83–0.91)	0.92 (0.91–0.93)	0.50 (0.47–0.53)
2021	1.05 (1.01–1.10)	0.96 (0.93–1.00)	1.11 (1.06–1.17)	0.91 (0.86–0.96)	0.91 (0.90–0.92)	0.43 (0.40–0.47)

Abbreviations: OR: odds ratio; CI: confidence interval; adjusted: age group + gravidity + deprivation quintile.

a: Range from 1, most deprived, to 5, least deprived; ordinal regression model; the adjusted model for this indicator is only adjusted by age group + gravidity.

Table 3. Associations between year of booking interview and BMI categories

Year of booking	BMI categories											
	Unadjusted OR (95% CI)						Adjusted OR (95% CI)					
	Underweight	Healthy weight	Overweight	With obesity I	With obesity II	With obesity III	Underweight	Healthy weight	Overweight	With obesity I	With obesity II	With obesity III
2011	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
2012	1.12 (0.99–1.27)	Ref	1.02 (0.98–1.06)	1.02 (0.97–1.08)	1.03 (0.95–1.13)	1.12 (0.99–1.27)	1.28 (1.13–1.44)	Ref	1.02 (0.98–1.06)	1.00 (0.94–1.05)	0.98 (0.90–1.06)	1.31 (1.16–1.48)
2013	1.04 (0.91–1.18)	Ref	1.03 (0.99–1.08)	1.03 (0.98–1.09)	1.07 (0.98–1.17)	1.11 (0.98–1.25)	1.07 (0.95–1.22)	Ref	1.03 (0.99–1.08)	1.00 (0.94–1.06)	1.10 (1.01–1.20)	1.27 (1.12–1.43)
2014	1.01 (0.89–1.15)	Ref	1.03 (0.99–1.07)	1.07 (1.01–1.13)	1.17 (1.07–1.27)	1.22 (1.08–1.38)	1.16 (1.03–1.32)	Ref	1.04 (1.00–1.09)	1.05 (0.99–1.11)	1.16 (1.06–1.26)	1.43 (1.26–1.61)
2015	1.12 (0.98–1.27)	Ref	1.10 (1.06–1.15)	1.12 (1.05–1.18)	1.21 (1.12–1.32)	1.26 (1.12–1.43)	1.30 (1.15–1.47)	Ref	1.11 (1.07–1.16)	1.09 (1.03–1.15)	1.13 (1.04–1.23)	1.48 (1.31–1.67)
2016	1.01 (0.89–1.15)	Ref	1.13 (1.08–1.18)	1.23 (1.16–1.30)	1.38 (1.27–1.50)	1.49 (1.32–1.67)	1.13 (1.00–1.29)	Ref	1.16 (1.11–1.21)	1.21 (1.14–1.28)	1.50 (1.39–1.63)	1.55 (1.37–1.75)
2017	1.07 (0.94–1.22)	Ref	1.13 (1.09–1.18)	1.26 (1.19–1.33)	1.46 (1.34–1.58)	1.41 (1.25–1.59)	1.13 (0.99–1.29)	Ref	1.14 (1.10–1.20)	1.22 (1.15–1.29)	1.56 (1.44–1.69)	1.70 (1.50–1.91)
2018	0.93 (0.81–1.07)	Ref	1.15 (1.10–1.20)	1.35 (1.27–1.43)	1.54 (1.42–1.68)	1.61 (1.43–1.82)	1.10 (0.96–1.25)	Ref	1.10 (1.05–1.15)	1.24 (1.18–1.32)	1.29 (1.19–1.40)	1.76 (1.56–1.99)
2019	1.03 (0.90–1.18)	Ref	1.25 (1.19–1.30)	1.49 (1.41–1.58)	1.63 (1.50–1.77)	1.81 (1.61–2.04)	1.32 (1.16–1.50)	Ref	1.24 (1.18–1.29)	1.46 (1.38–1.55)	1.57 (1.45–1.71)	2.09 (1.85–2.35)
2020	0.96 (0.83–1.10)	Ref	1.28 (1.23–1.34)	1.50 (1.42–1.59)	1.91 (1.76–2.07)	2.07 (1.84–2.32)	1.14 (1.00–1.31)	Ref	1.28 (1.22–1.34)	1.43 (1.35–1.52)	1.93 (1.78–2.09)	2.28 (2.03–2.57)
2021	0.94 (0.78–1.12)	Ref	1.35 (1.28–1.43)	1.69 (1.58–1.81)	2.02 (1.83–2.22)	2.47 (2.16–2.82)	1.48 (1.26–1.74)	Ref	1.34 (1.26–1.41)	1.61 (1.50–1.72)	2.00 (1.82–2.20)	2.78 (2.44–3.18)

Abbreviations: BMI: body mass index; OR: odds ratio; CI: confidence interval; adjusted: age group + gravidity + deprivation quintile.

Table 4. Associations between year of booking interview and folic supplement use

Year of booking	Folic acid supplement use (timing)						Folic acid supplement use (dosage)					
	Unadjusted OR (95% CI)			Adjusted OR (95% CI)			Unadjusted OR (95% CI)			Adjusted OR (95% CI)		
	Pre	Post	None	Pre	Post	None	400 µg	5 mg	None	400 µg	5 mg	None
	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
2015	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
2016	Ref	0.99 (0.95–1.02)	0.90 (0.82–1.00)	Ref	1.00 (0.96–1.04)	0.93 (0.84–1.03)	Ref	1.19 (1.11–1.27)	0.93 (0.84–1.02)	Ref	1.19 (1.11–1.27)	0.94 (0.85–1.04)
2017	Ref	1.01 (0.97–1.05)	0.86 (0.77–0.95)	Ref	1.03 (0.99–1.08)	0.89 (0.80–0.99)	Ref	1.48 (1.39–1.58)	0.88 (0.80–0.98)	Ref	1.47 (1.38–1.57)	0.90 (0.82–1.00)
2018	Ref	0.99 (0.95–1.03)	0.91 (0.82–1.01)	Ref	1.01 (0.97–1.05)	0.96 (0.86–1.06)	Ref	1.55 (1.45–1.65)	0.96 (0.87–1.06)	Ref	1.54 (1.44–1.64)	0.99 (0.89–1.09)
2019	Ref	1.01 (0.97–1.05)	0.88 (0.80–0.98)	Ref	1.06 (1.02–1.10)	0.96 (0.86–1.07)	Ref	1.82 (1.71–1.94)	0.93 (0.84–1.03)	Ref	1.81 (1.70–1.93)	0.98 (0.88–1.09)
2020	Ref	1.15 (1.10–1.19)	0.99 (0.89–1.10)	Ref	1.21 (1.17–1.27)	1.10 (0.99–1.22)	Ref	1.76 (1.65–1.88)	0.96 (0.87–1.07)	Ref	1.74 (1.64–1.86)	1.01 (0.92–1.12)

Abbreviations: OR: odds ratio; CI: confidence interval; Pre: preconception; Post: postconception; µg: micrograms; mg: milligrams; adjusted: age group + gravidity + deprivation quintile.

Postconception folic acid supplement use of 400 µg exhibited no major variations across deprivation quintiles, though it was highest in women from the most deprived quintile. Based on maternal age, it was highest in women younger than 25 years, but in the last year (2019–2020) women aged 25–34 years exhibited the greatest increase (49.3%–52.8%). In first-time pregnancies, it was varied across the studied years and lowest in 2016 (51.9%) and 2019 (51.7%); in subsequent pregnancies, a decline was observed between 2015 and 2019 (53.8%–51.2%), followed by a slight increase between 2019 and 2020 (51.2%–53.9%). Postconception use of 400 µg folic acid supplements decreased among unplanned pregnancies between 2015 and 2020 (79.2%–75.5%). In pregnancies conceived by women with underweight, healthy weight, and overweight, it slightly increased throughout the study period (62.5%–64.4%, 54.1%–54.9%, and 54.7%–55.6%, respectively).

The use of supplements containing 5 mg of folic acid before or after conception increased between 2015 and 2020, with no notable differences across deprivation quintiles. It increased for all age groups, though in the last year preconception supplement use of 5 mg declined among women aged 35+ years (9.0%–7.1%). The use of 5 mg supplements also increased irrespective of gravidity. Regarding pregnancy planning status, the largest percentage change was observed among unplanned pregnancies, where postconception use of 5 mg supplements increased (6.0%–10.2%). The use of supplements with 5 mg of folic acid steadily increased among pregnancies by women with obesity before (e.g. class III: 8.3%–15.7%) and after conception (e.g. class III: 23.1%–38.0%).

Figures illustrating these trends in folic acid supplement use are included in [Supplementary Material S6](#).

Patient and Public Involvement and Engagement

During a drop-in breastfeeding support group session organized by SureStart, nine women informed the interpretation of the present findings reporting periconceptual folic acid supplement use. Some women acknowledged the importance of folic acid supplement use, but often lacked awareness of dosage options and benefits. Women also participated in related discussions on preconception health and care ([Supplementary Material S7](#)).

Discussion

This study explored temporal trends in key preconception indicators in NI. Many changes were observed in the prevalence of indicators between 2011 and 2021, with trends suggesting areas of public health concern such as increasing obesity rates. Certain changes were negligible, such as those observed among planned pregnancies. Investigations of folic acid supplement use between 2015 and 2020 highlighted groups of women in greatest need of support, including women under 25 years of age, women living in the most deprived quintiles, and women who did not report having a planned pregnancy.

Trends in preconception indicators

Trends in area-level deprivation remained relatively constant between 2011 and 2021, potentially indicating limited positive changes in tackling inequalities; however, the proportion of planned pregnancies slightly increased. There may be many reasons behind this trend, including delayed maternal age for childbearing [23] and the availability of contraception [2], though these trends may warrant further research (e.g. investigating the trends in planned pregnancies across subsequent pregnancies conceived by the same woman). Given the retrospective nature of the question used to collect data on pregnancy planning in NIMATS, social desirability and recall bias should also be considered as possible influencing factors. Of public health concern and echoing previous evidence [1, 2], this study showed a decreasing prevalence of pregnancies conceived by women with a healthy BMI. The associated increasing prevalence of pregnancies by women with obesity is in line with the rising trends in the number of adults with obesity in

NI [24] and globally [3]. Meaningful efforts are needed to address these trends given the evidence that living with obesity can impact fertility, time to conceive, and increase the risk of adverse maternal and infant outcomes [25].

Emerging concerns about periconceptual folic acid supplement use and its known link to NTDs [14] prompted a more in-depth investigation of this indicator using data over a 5-year period (2015–2020). Notably, preconception supplement use of 400 µg of folic acid declined. Although it was lowest in the most deprived quintile, it declined across all area-level deprivation quintiles. Echoing previous literature [26–28], it was also low in pregnancies conceived by women aged <25 years and unplanned pregnancies. A pronounced decline in preconception use of 400 µg folic acid supplements was observed among pregnancies by women with obesity, especially class III. This may reflect a positive shift, as women with obesity are typically prescribed the higher dose of folic acid (5 mg/day) [14], which increased over the study period. Postconception use of 400 µg also declined until 2019, though trends exhibited a slight increase in 2020. Use was high among pregnancies conceived by women living in the most deprived quintile, with minimal variation over time, women aged <25 years, and unplanned pregnancies. A trend demonstrating a slightly increasing postconception use of 400 µg supplements was noted in recent years among older women and planned pregnancies. The observed sub-optimal supplement use in preparation for subsequent pregnancies, as previously reported [28], indicates the need for improved interconception care in NI.

Preconception and postconception use of supplements with 5 mg of folic acid increased over the timeperiod regardless of deprivation quintile, age, gravidity, and planned pregnancy, although it was often more pronounced in the postconception period. This trend was particularly evident among women with obesity, potentially due to the rising prevalence of overall obesity. Women with obesity, being at an increased risk of co-morbidities such as diabetes and hypertension [25], may have more opportunities to interact with HCPs, potentially facilitating the prescription of high-dose supplements. However, this cannot be concluded from the current study. In NI, the Weigh to a Healthy Pregnancy programme, which aims to support women with a BMI > 38 kg/m² in managing their weight during pregnancy [29], may also contribute to information delivery regarding folic acid supplement use, particularly in subsequent pregnancies.

The current practice in the UK of recommending different doses of folic acid based on women's risk of NTDs has been debated. The availability of supplements containing 5 mg of folic acid only with a medical prescription has been contested, resulting in suggestions of standardizing the daily recommended dosage to 4 mg or 5 mg without requiring a prescription [30]. Moreover, while the analyses were conducted when guidelines recommended that women with obesity should take 5 mg of folic acid [14], this too is under consideration. For example, the 2025 National Institute for Health and Care Excellence (NICE) guideline on maternal and child nutrition [15] specified that women with a BMI ≥ 25 kg/m² planning to conceive or in the first 12 weeks of pregnancy do not need to take supplements containing more than 400 µg of folic acid, unless they have other specific health factors (e.g. having diabetes, taking anti-epileptic medications, having had a previous pregnancy complicated by an NTD). However, given that there is also evidence suggesting that women with overweight or obesity may be at a higher risk of having NTD-affected pregnancies, the Royal College of Obstetricians and Gynaecologists currently advises women with obesity wishing to become pregnant to take 5 mg folic acid supplements [31]. Overall, these differences highlight the continuing debate over optimal supplementation.

Implications and future research

Examining national maternity data with significant population coverage has highlighted key areas of concern for population health,

such as a need for addressing increasing rates of maternal BMI. Although beyond the scope of these analyses, data indicate increasing BMI trends also in males [32]. This suggests that additional research is warranted to explore the implications of both maternal and paternal obesity on preconception health, especially given that evidence indicates increased risks [33].

Within this study, a need for supporting appropriate preconception folic acid supplement use was also observed. It should be noted that women's reporting of supplement use does not ensure their adherence to recommendations (e.g. daily intake for at least 12 weeks before and after conception) [14], and that among those reporting postconception use, the timing of initiation after conception could not be determined (e.g. shortly after conception or just before the booking appointment). Therefore, future studies should strive to improve the recording of self-reported health behaviours such as supplement use, reporting timeframes (e.g. the weeks or months before conception when use was initiated), and adherence (e.g. daily intake) [34]. Furthermore, future assessments of supplement use could provide a better understanding without relying on self-reported measures (e.g. prescription records, biomarker assessments). Particularly vulnerable groups such as young women and women from areas of greatest deprivation may benefit from targeted interventions, including peer-delivered interventions [17] and provision of free supplements [18], though population-level approaches are also recommended. Reservations about the effectiveness and long-term impacts of campaigns have been expressed in the literature, as well as concerns about interventions' potential to exacerbate health inequalities [18]. HCPs such as GPs, gynaecologists, and obstetricians may be especially well positioned for the provision of advice and recommend uptake [18, 26], but the public's limited knowledge of preconception care and infrequent contact with HCPs before conceiving may be barriers to consider, as well as lack of time and resources for HCPs [35, 36]. Emerging technologies and social media may also be harnessed to further promote preconception health, alongside PPIE input.

Findings suggest improving trends of other preconception indicators, such as smoking. This improvement may be influenced by individuals' high level of perceived importance placed on preconception smoking cessation and the significant public health investment into smoking cessation services [37]. However, the proportion of women of reproductive age reporting using e-cigarettes has been rising in NI [24].

Patient and Public Involvement and Engagement

Overall, PPIE activities were well received by public members. Topics discussed by contributors included the reluctance to openly talk about pregnancy intentions before conception, retrieval of advice online or from HCPs, and desire to receive reliable and personalized advice [36]. These discussions involved women who already had children and were breastfeeding, but other groups of women may report different views or have a different knowledge base of preconception health. Future research and initiatives should be informed by the views expressed by women with varied lived experiences of the preconception period.

Strengths and limitations

This study presents novel findings from pregnancy-level analyses using routinely collected maternity data across NI to enhance the current epidemiological understanding of preconception health.

Pregnancy planning, smoking, and folic acid supplement use were self-reported, potentially introducing recall and social desirability bias. Certain behaviours may, therefore, be underestimates. However, findings still offer valuable insights into women's behaviours and needs, highlighting the need for improved data collection methods that more comprehensively capture preconception health-related information. Ethnicity is a factor associated with preconception health [18, 28], though due to the limited ethnic diversity in NI [38] and disclosure

controls, it was not included in the present analyses. Similarly, factors including educational attainment were not directly explored in this study due to data unavailability. However, the calculation of the deprivation quintiles used in this study, based on the NI Multiple Deprivation Measure 2017, also accounts for women's employment, education, skills, and training [39]. Other factors associated with preconception health, such as locality of residence, housing, immigrant status, and access to healthcare services [28, 34] may warrant further investigations. Future research linking NIMATS to other datasets, for example the Electronic Prescribing Database, may provide more comprehensive insights on preconception health in NI. The COVID-19 pandemic may also have affected childbearing behaviours, for example by affecting mental health and distress [40], or access to folic acid supplements. Because the data included in these analyses covered pregnancies with a booking appointment until 2020 or 2021, there were insufficient data collected following the outbreak to draw firm conclusions on its impact. Finally, it should be noted that pregnancies ending before an antenatal booking appointment (typically occurring by the 10th-12th week of pregnancy) [9, 10] or with an outcome unknown to the maternity services in NI were not included in the dataset, though they still warrant future investigations.

Conclusions

This study offers an overview of key preconception indicators over time in NI, as recorded in routinely collected maternity data. Key findings reveal both improving and concerning trends: while smoking rates declined, obesity increased. Additionally, analyses showed that preconception folic acid supplement use is still inadequate among women in NI, though the use of 5 mg supplements increased, trend potentially associated with the increasing prevalence of women with obesity. A renewed focus on particular subgroups of women, including young women and women living in the most deprived areas, is recommended as a result of this study's findings.

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Supplementary data

Supplementary data are available at *EURPUB* online.

Conflict of interest: No interests to disclose.

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Data availability

The data used in this study were obtained from the Honest Broker Service (HBS) within the Business Services Organisation Northern Ireland (BSO). Access to the data may be granted upon reasonable request and with permission from HBS BSO.

Key points

- Temporal trends of key biopsychosocial preconception indicators among women in Northern Ireland (UK) are presented, between 2011 and 2021 or between 2015 and 2020, based on data availability in the Northern Ireland Maternity System dataset.
- A key finding suggesting an area of public health concern in NI was the increasing prevalence of obesity during the study period.
- Periconceptual folic acid supplement use differed across the population. For example, women living in the most deprived quintile and younger women were more likely to report reliance on postconception, rather than preconception, folic acid supplement use (as per recommendations), compared to women living in the least deprived quintile or women aged 25 years or over, respectively.
- The discussion of findings with Patient and Public Involvement and Engagement representatives identified a level of confusion on certain aspects of folic acid supplement use recommendations, reluctance to openly talk about pregnancy intentions before conception, and desire to receive personalized preconception advice.

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