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Prenatal stress, health, and health behaviours during the COVID-19 pandemic: An international survey

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ABSTRACT

Background: Pregnant women's stress, mental and physical health, and health behaviours can have important implications for maternal and child health outcomes.
Aim: To examine pregnant women's levels of stress, mental and physical health, and health behaviours during the COVID-19 pandemic.
Methods: A cross-sectional survey was conducted online, with recruitment and data collection occurring between 16/6/20 and 17/7/20. Participants were pregnant women recruited via online pregnancy/parenting communities. Participants self-reported their levels of general stress, pregnancy-specific stress and COVID-19 related stress, mental and physical health, general health behaviours, and COVID-19 related health behaviours.
Findings: 573 pregnant women participated in the survey. Participants were most commonly resident in the United States (42.6%, n = 243), Ireland (41.2%, n = 235) or the United Kingdom (10%, n = 57). The majority (80.0%, n = 457) were married and educated to degree level or above (79.3, n = 453). Pregnant women reported high levels of pregnancy-specific and COVID-19-related stress, and low levels of mental and physical health, during the pandemic. Encouragingly, pregnant women in this study generally reported high levels of adherence to public health advice and pregnancy health behaviours. Stress and general mental health outcomes were best predicted by well-being factors (including stress and social support). Health impairing behaviours (e.g. poor diet) were predicted by both well-being and demographic factors.
Discussion: Interventions targeting pregnancy- and pandemic-specific stress at the population level will be essential to support mental health and minimise adverse outcomes for women and children during the pandemic.

Statement of significance

Problem

The COVID-19 pandemic may increase prenatal stress and, in turn, adversely impact both health behaviours and health outcomes.

What is already known

The pandemic has been associated with increased incidence of mental health symptoms in general and pregnant populations, and poses a threat to protective factors like social support.

What this paper adds

A multidimensional examination of prenatal general, pregnancy-specific, and COVID-19 related stress, health, and health behaviours during the COVID-19 pandemic. The study found high adherence to both pregnancy- and pandemic-related health advice. Evidence of high levels of pregnancy- and pandemic-related stress provide insight into potentially useful targets for stress intervention.

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Introduction

Many women experience disruptions to mental health during pregnancy. It is estimated, for example, that between 7% and 30% of women exhibit symptoms of depression during their pregnancies [1]; between 18.2% and 24.6% report anxiety [2]; and up to 84% experience stress [3]. Depression, stress and anxiety are related yet distinct psychological constructs [4,5] which have been associated with a range of poor outcomes including increased risk of premature birth and reduced length of gestation [6] and disruptions to hormonal regulation in children [7]. Prenatal mental health issues may also be associated with poorer physical health and health behaviours, with further direct and indirect effects on maternal and infant outcomes [8]. For instance, low physical activity, poor diet, and substance use during pregnancy are associated with increased risk of adverse prenatal [9], health [9–12], and child developmental [13] outcomes.

Prenatal stress and mental health issues can arise from multiple factors, including from experiencing stressful life events like the COVID-19 pandemic [14,15]. COVID-19, which was declared a pandemic by the World Health Organisation in March 2020 [16], is a significant global public health crisis. The pandemic and pandemic-related restrictions, such as lock-downs and quarantining, are already demonstrating significant negative effects for psychological well-being [17]. In frontline workers and general populations, COVID-19 has been associated with increased risks for depression, anxiety [17–19] vicarious trauma, and sleep disruptions [17,19]. High rates of substance use and suicidal ideation have also been reported among a general population during the pandemic [17].

Pregnant women are potentially at increased risk of adverse outcomes during the pandemic due to compounding pregnancy-specific concerns. For example, women may experience distress due to fear of coronavirus infection during pregnancy and/or in fetuses and children [20]; lack of clarity about pregnancy-specific risks of COVID-19 and which precautions are most effective at reducing infection risks to infants [21]; and changes to maternity services and birth plans due to public health restrictions [20,21]. In addition, COVID-19 restrictions have placed significant limitations on women's levels and types of social support, which has the potential to further strain their coping resources [20,22]. Given the proposed stress-buffering effects of social support, this may also increase women's risk of adverse outcomes both during pregnancy and beyond [23].

To date, some negative outcomes of the COVID-19 pandemic have been demonstrated in pregnant populations. For instance, one Canadian study reported increased incidences of anxiety, depression, post-traumatic stress, and dissociative symptoms among women pregnant during the COVID-19 pandemic, compared to a pre-pandemic cohort [24]. Another study reported increased levels of depressive symptoms in pregnant women in China after COVID-19 was declared an epidemic there in late January, again compared to a pre-pandemic baseline in the same population [25]. Reduced perceived social support has also been found among women pregnant in Ireland during the pandemic [26], and women also self-reported lower physical activity, compared to those pregnant before the pandemic [27]. These early findings suggest that women pregnant during the pandemic may be at risk for impaired prenatal psychological well-being and health behaviours. Examinations of stress have been limited however, with studies tending to focus on depression and/or anxiety symptoms. Similarly there has been little to no examination of prenatal health behaviours. Given the importance of maternal mental health, stress and health behaviours for maternal and child outcomes, examining these factors during the COVID-19 pandemic is essential to inform approaches to supporting pregnant women during this, and potential future, pandemics. The aim of this study is to examine pregnant women's levels of stress, mental and physical health, and health behaviours during the COVID-19 pandemic.

Participants, ethics and methods

Design

A cross-sectional online survey of pregnant women was conducted. This study forms part of a larger project examining prenatal stress, social support and health behaviours [28].

Ethical considerations

Ethical approval was granted by the [redacted] Research Ethics Committee and the Clinical Research Ethics Committee at [redacted]. Funding organisations were not involved in conceptualising the study, collecting data, analysing/reporting results, or any decisions related to publication.

Participants

Participants in this study were pregnant women over 18 years of age. No exclusions were made based on nationality or current place of residence. Participants were recruited between June 16th, 2020 and July 17th, 2020. All participants were recruited online via public postings on forums associated with pregnancy websites (e.g What To Expect, Mumsnet), and on social media pregnancy/parenting communities (e.g. Facebook, Twitter, Instagram, Reddit); a full list of targeted communities is available in Supplement 1. Participants were provided with a brief study description and link to the study survey, containing the full study information leaflet and consent form. Participants provided consent prior to completing the survey.

Measures

The survey included open and closed questions on demographic factors, stress, mental and physical health, health behaviours, social support, and perceived satisfaction and quality of antenatal care.

Details and findings in relation to social support, quality of antenatal care, stress-reduction strategies, and experiences of distress during the pandemic are presented in our complementary paper [29]. As such they are not reported as outcomes in the current paper but are presented here for completeness.

Demographic factors

Data on the following demographic factors were collected: age, marital status, education, household income, ethnicity, nationality, country of residence, weeks of pregnancy, and number of previous pregnancies.

General stress

General stress was measured using the 4-item Perceived Stress Scale Short Form (PSS-4) [30]. This validated scale asks participants to report frequency of experiencing stress on a 5-point Likert scale ranging from 0 = "never" to 4 = "very often". Items include "How often have you felt that you were unable to control the important things in your life?" In the current study the PSS-4 had a reliability coefficient of $\alpha = .75$.

Pregnancy-specific stress

Pregnancy-specific stress was measured using the validated 17-item Revised Prenatal Distress Scale (NuPDQ) [31]. Items ask

participants to report whether they are feeling "bothered, upset, or worried at this point in their pregnancies" about pregnancy-specific issues such as concerns about their pregnancy or baby, and changes to self-image and social relationships. Items are rated on a 3-point Likert scale ranging from 0 = "not at all" to 2 = "very much." In this study the NuPDQ had a reliability coefficient of $\alpha = .76$.

COVID-19 related stress

At the time of this study there was no published validated scale available to measure COVID-19 related stress during pregnancy. As such, and guided by available evidence from a recent study by Zhong et al. [32], 6 items were developed to examine women's concerns about the COVID-19 pandemic in this study. Participants were asked to indicate how worried they were about the coronavirus overall using a single item, and 5 items assessing concerns about coronavirus infection, being able to sleep because of coronavirus concerns, restrictions in place due to the coronavirus, and access to antenatal care due to the coronavirus. Items were measured using a 3-point Likert scale ranging from 0 = "not at all" to 2 = "very much." The internal validity for this measure was $\alpha = .77$.

Mental and physical health

Mental and physical health were measured using the mental and physical domains of the validated 12-item Short Form Survey (SF-12) [33]. Participants indicated their general perceived health on a 5-point Likert scale (ranging from 1 = "excellent" to 5 = "poor"). Participants were also asked to indicate health-related limitations to activities using a 3-point Likert scale (ranging from 1 = "Limited a lot" to 3 = "Not at all limited"), and by answering "yes" or "no" to questions about specific limitations. Participants indicated how much pain was interfering with their ability to work using a five-point Likert scale (ranging from 1 = "not at all" to 5 = "extremely"). Participants were also asked about the frequency of emotional experiences, such as "feeling down-hearted or blue" and whether their health interfered with social functioning, on a 6-point Likert scale (ranging from 1 = "all of the time" to 6 = "none of the time").

Prenatal health behaviours

Frequency of engaging in prenatal health behaviours was measured using the validated 20-item Prenatal Health Behaviour (PHBS) scale [34]. Health behaviours were grouped into a health-promoting behaviours subscale ($\alpha = .72$) and a health-impairing behaviours subscale ($\alpha = .55$) as per previous guidance [35]. Health-promoting behaviours included exercise, stretching, getting enough sleep, taking vitamins, and maintaining a good diet. Health-impairing behaviours included skipping meals, consuming snack foods instead of balanced meals, consuming drinks with caffeine, and smoking cigarettes. Items are measured on a Likert scale ranging from 0 = "never" to 4 = "very often". The internal consistency of the health-promoting subscale was $\alpha = .72$. The internal consistency of the health-impairing subscale was $\alpha = .55$, which, though lower than desired, is in keeping with previous examinations [34].

COVID-19 related health behaviours

Six items were developed to assess women's adherence to COVID-19 related health behaviours. Women were asked to report whether they were using a mask outside the home and in hospital, avoiding crowded places, leaving the house only when essential, shaking hands or making close contact with people, and disinfecting frequently touched objects, by answering either "yes" or "no."

Social support

Social support was measured using the 12-item Multidimensional Perceived Social Support Scale (MSPSS) [36]. This validated scale asks women rated their perceived degree of support from significant others, family and friends, by rating statements (for example: "There is a special person with whom I can share my joys and sorrows") on a 7-point Likert scale ranging from 1 = "very strongly disagree" to 7 = "very strongly agree." The overall scale reliability was $\alpha = .96$; the reliability of the significant other, family, and friends subscales were $\alpha = .98$, $\alpha = .94$, and $\alpha = .96$ respectively.

Open-ended questions

Women were also invited to provide additional qualitative feedback on their prenatal stress experiences including what they found stressful, what stress-reduction strategies they engaged in, and what services and supports they use/want/need during their pregnancies.

Analysis

Descriptive statistics were used to summarise information on participant demographics, stress, mental and physical health, social support, health behaviours, and COVID-19 related behaviours. Associations between demographic factors, stress, mental and physical health, social support, and all health behaviours were examined using Spearman's rank order correlations. Hierarchical multiple regressions were conducted to examine the role of sociodemographic and well-being factors (stress, mental and physical health, and social support) in predicting general stress, pregnancy-specific stress, COVID-19 related stress, mental and physical health, and health behaviours. Sociodemographic factors were entered at Step 1 of the hierarchical regressions; followed by well-being factors at Step 2 to determine the impact of well-being factors when controlling for sociodemographic factors. Dummy variables were created from multilevel categorical variables for inclusion in the regression models. Chi square tests of independence were conducted to examine potential demographic differences in COVID-19 related health behaviours. Due to the use of multiple inferential tests, Bonferroni corrections were applied with a more stringent significance value, calculated by dividing an alpha of .05 by the number of regression tests (n = 7), which results in a significance value rounded up to $p < .01$. This more stringent significance value was used in all analyses.

Results

573 pregnant women took part in the survey. Participants were most commonly resident in the United States (42.6%, n = 243), Ireland (41.2%, n = 235), or the United Kingdom (10%, n = 57). The majority of participants were married (80%, n = 457) and educated to degree level or above (79.3%, n = 453). The majority (57.2%, n = 325) had been pregnant before. See Table 1 for complete participant characteristics.

Details of women's self-reported general stress, pregnancy-specific stress, COVID-19 related stress, and perceived mental and physical health are presented in Table 2. For COVID-19 related stress, 58% of participants reported feeling "very" concerned about COVID-19 related restrictions; 39.4% of women reported feeling "very" concerned about their babies becoming unwell because of the coronavirus; and only 31.7% of participants felt confident that COVID-19 would be successfully controlled. Participants reported normative levels [37] of general stress (M = 6.54, SD = 2.84), and high [31] levels pregnancy-specific stress (M = 13.89, SD = 5.37). Participants also reported low levels of physical (M = 44.3, SD = 9.2) and mental health (M = 42.5,SD = 11.3) [38].

Participants reported high frequency of engagement in health-promoting behaviours and low engagement in

Table 1
Participant characteristics.

	M(SD)	Range
Age (years)	32.38 (4.6)	19–43
No. weeks pregnant	26.22 (9.43)	4–42
No. children	.78 (.993)	0–7
	n	%
Nationality		
American	220	39.2
Other	53	9.9
British	60	10.7
Canadian	13	2.3
Irish	215	38.3
Current country of residence		
America	243	42.6
Australia	4	.7
Bahrain	1	.2
Canada	15	2.6
Ireland	235	41.2
United Kingdom	57	10.0
Germany	2	.4
Guam	1	.2
New Zealand	2	.4
Northern Ireland	3	.5
Norway	1	.2
Scotland	1	.2
South Africa	2	.4
Spain	1	.2
Wales	2	.4
Ethnic/cultural background		
Irish	224	39.2
Irish Traveller	1	.2
Other white background	289	50.5
African	6	1.0
Other Black background	3	.5
Other Asian background	7	1.2
Hispanic/Latina	13	2.3
Mixed Ethnicity	13	2.3
Other	10	1.7
Not stated	6	1.0
Highest level of education		
Secondary school	26	4.6
Technical/vocational qualification	39	6.8
Non-degree qualification	53	9.3
Undergraduate degree	213	37.3
Postgraduate degree	197	34.5
Doctorate	43	7.5
Relationship status		
Married	457	80.0
Cohabiting	76	13.3
In a relationship	29	5.1
Single	9	1.6
First pregnancy		
No	325	57.2
Yes	243	42.8
Prior pregnancy loss		
Never	365	63.7
Yes, once	141	24.6
Yes, twice	39	6.8
Yes, 3 or more times	28	4.9

health-impairing behaviours. For example, most participants reported abstaining entirely from alcohol (87.2%) and cigarettes (96.2%); as such these variables were excluded from further analyses. Participants also reported high levels of adherence to COVID-19 public health advice; for instance, 95.6% of participants reported that they had stopped shaking hands or making close contact with others, while 76.3% reported wearing masks when leaving home (see Table 3).

Findings of associations between stress, mental and physical health, and health behaviours using Spearman's correlations are presented in Supplement 2.

Predictors of stress, mental and physical health, and health behaviours

Hierarchical multiple regressions were conducted to examine the role of sociodemographic and well-being factors in predicting stress, mental and physical health, and health behaviours. Preliminary analyses confirmed normality, linearity, multicollinearity and homoscedasticity. A summary of regression outcomes is provided in Table 4 below; full details of each regression are available in Supplements 3–5.

COVID-19 related stress

Sociodemographic factors were entered at Step 1 and explained 4.9% of the variance in perceived stress. After entry of the well-being factors (general stress, pregnancy-specific stress, social support, and mental and physical health) at Step 2, the total variance explained by the model was 31.1%, $F(23, 474) = 9.31$, $p < .001$. The well-being factors explained an additional 26.2% of the variance in stress after controlling for sociodemographic factors; R squared change = .26, F change $(5, 474) = 36.07$, $p < .001$. In the final model, only general stress (beta = –.41, $p < .001$) and pregnancy-specific stress (beta = .17, $p = .002$) predicted COVID-19 related stress. See Supplement 3.

Pregnancy-specific stress

Sociodemographic factors entered at Step 1 explained 7.5% of the variance in pregnancy-specific stress. After entry of the COVID-19 related stress, general stress, social support, and mental and physical health at Step 2, the total variance explained by the model was 39.4%, $F(23, 474) = 13.42$, $p < .001$. The well-being factors explained an additional 32% of the variance in stress, after controlling for sociodemographic factors; R squared change = .32, F change $(5, 474) = 50.07$, $p < .001$. In the final model, the number of children women had (beta = –.21, $p < .001$), COVID-19 related stress (beta = .36, $p < .001$), and mental health (beta = –.23, $p < .001$) predicted pregnancy-specific stress. See Supplement 3.

General stress

Sociodemographic factors entered at Step 1 explained 8.1% of the variance in general stress. After entry of the COVID-19 related stress, pregnancy-specific stress, social support, and mental and physical health at Step 2, the total variance explained by the model was 48.9%, $F(23, 474) = 21.72$, $p < .001$. The well-being factors explained an additional 43% of the variance in stress, after controlling for sociodemographic factors; R squared change = .43; F change $(5, 474) = 84.06$, $p < .001$. In the final model, COVID-19 related stress (beta = .12, $p = .002$), mental health (beta = –.59, $p < .001$) and physical health (beta = –.11, $p = .003$) predicted general stress. See Supplement 3.

Perceived mental health

Sociodemographic factors, entered at Step 1, explained 7.9% of the variance in mental health as measured by the SF-12. After entry of the stress measures, social support and physical health at Step 2, the total variance explained by the model was 52.1%, $F(23, 474) = 24.54$, $p < .001$. The well-being factors explained an additional 43% of the variance in mental health, after controlling for sociodemographic factors; R squared change = .43, F change $(5, 474) = 89.60$, $p < .001$. In the final model, gestational weeks (beta = .09, $p = .006$), pregnancy-specific stress (beta = –.15, $p < .001$), general stress (beta = –.55, $p < .001$), and physical health (beta = –.23, $p < .001$) predicted mental health. See Supplement 4.

Perceived physical health

Sociodemographic factors, entered at Step 1, explained 7.6% of the variance in physical health measured by the SF-12. After entry of the stress, social support, and mental health measures at Step 2,

Table 2
Participant stress, mental and physical health, and social support.

	M(SD)	Range
General stress (PSS)	6.54 (2.84)	.00–15.00
Pregnancy-specific stress (PDQ)	13.89 (5.37)	.00–30.00
COVID-related stress	7.14 (2.84)	.00–12.00
SF-12 Mental Health Component	42.49 (11.30)	10.44–65.55
SF-12 Physical Health Component	44.25 (9.17)	14.19–64.27
Perceived Social Support (total) (MSPSS)	67.61 (15.89)	12.00–84.00
From significant other	24.84 (5.65)	4.00–28.00
From family	21.93 (6.21)	4.00–28.00
From friends	20.79 (6.42)	4.00–28.00

	n	%
Unable to fall or stay asleep due to thinking about the coronavirus		
Not at all	264	46.2
Somewhat	213	37.3
Very much	94	16.5
Worried about being infected by the coronavirus		
Not at all	111	19.4
Somewhat	260	45.5
Very much	200	35.0
Worried about baby becoming unwell because of the coronavirus		
Not at all	89	15.5
Somewhat	258	45.0
Very much	226	39.4
Worried about restrictions in place due to the coronavirus (e.g. social distancing, travel restrictions)		
Not at all	46	8.0
Somewhat	194	33.9
Very much	332	58.0
Worried about access to antenatal care because of the coronavirus		
Not at all	133	23.4
Somewhat	206	36.2
Very much	230	40.4
Overall, worry about the coronavirus		
Not at all	30	5.3
Somewhat	283	49.7
Very much	256	45.0
Belief that COVID-19 will be successfully controlled		
No	132	23.1
Yes	181	31.7
I don't know	258	45.2

MSPSS = Multidimensional Scale of Perceived Social Support PSS = Perceived Stress Scale PDQ = Prenatal Distress Questionnaire SF-12 = SF-12® Health Survey.

the total variance explained by the model was 19.5%, F (23, 474) = 6.24, p < .001. The well-being factors explained an additional 12.3% of the variance in physical health, after controlling for sociodemographic factors; R squared change = .123, F change (5, 474) = 15.20, p < .001. In the final model, gestational weeks (beta = −.23, p < .001), pregnancy-specific stress (beta = −.29, p < .001), general stress (beta = −.17, p = .003), and mental health (beta = −.38, p < .001) predicted physical health. See Supplement 4.

Health-promoting behaviours

Sociodemographic factors entered at Step 1 explained 10.2% of the variance in health-promoting behaviours. After entry of stress measures, social support, and mental and physical health (well-being factors) at Step 2, the total variance explained by the model was 24.8%, F (24, 473) = 6.52, p < .001. The well-being factors explained an additional 14.7% of the variance in health-promoting behaviours, after controlling for sociodemographic factors; R squared change = .147, F change (6, 473) = 15.39, p < .001. In the final model, having a technical or vocational qualification (beta = .17, p = .008) or a doctorate (beta = −.189, p = .004), physical health (beta = .24, p < .001), mental health (beta = .27, p < .001) and social support (beta = .12, p = .005) predicted health-promoting behaviours. See Supplement 5.

Health-impairing behaviours

Sociodemographic factors were entered at Step 1 and explained 12.3% of the variance in health-impairing behaviours. After entry of stress measures, social support, and mental and physical health at Step 2, the total variance explained by the model was 16.9%, F (24, 473) = 3.99, p < .001. The well-being factors explained an additional 4.5% of the variance in health-impairing behaviours, after controlling for sociodemographic factors; R squared change = .045, F change (6, 473) = 4.31, p < .001. In the final model, age (beta = −.17, p = .002), number of children (beta = .25, p < .001), being resident in the UK (beta = −.18, p = .007), and pregnancy-specific stress (beta = .19, p < .001) predicted health-impairing behaviours. See Supplement 5.

Demographic differences in COVID-19 health behaviours

Chi square tests conducted to examine potential demographic differences in COVID-19 related health behaviours indicated that wearing a mask when leaving home was significantly associated with relationship status ($\chi^2(3) = 19.49$, p < .001): married women were most likely to wear a mask. Wearing a mask was also associated with country of residence ($\chi^2(3) = 87.30$, p < .001), with women in America more likely to report wearing a mask than their counterparts in Ireland or the United Kingdom. Wearing a mask when in hospital/maternity services was also associated with the country of residence ($\chi^2(3) = 41.08$, p < .001): women in America were most likely to do so. Going to crowded places was associated with education ($\chi^2(5) = 22.92$, p < .001), women with a postgraduate degree being least likely to go to crowded places; and with country of residence ($\chi^2(3) = 24.34$, p < .001), women in Ireland being most likely to go to crowded places. Disinfecting and cleaning, leaving

Table 3
General and COVID-19 Specific Health Behaviors.

	M (SD)	Range
Health-promoting behaviors (PHBS)	24.91 (4.33)	10.00–32.00
Health-impairing behaviors (PHBS)	10.22 (3.75)	.00–26.00
	n	%
Frequency of drinking alcohol[a]		
Never	499	87.2
Almost never	53	9.3
Sometimes	17	3.0
Fairly often	2	.3
Very often	1	.2
Frequency of smoking cigarettes[a]		
Never	551	96.2
Almost never	10	1.7
Sometimes	6	1.0
Fairly often	2	.3
Very often	4	.7
Frequency of exercising for at least 15 min[a]		
Never	39	6.8
Almost never	79	13.8
Sometimes	171	29.8
Fairly often	149	26.0
Very often	135	23.6
Frequency of getting enough sleep[a]		
Never	10	1.8
Almost never	84	14.7
Sometimes	180	31.6
Fairly often	198	34.7
Very often	98	17.2
Going to any crowded place		
No	441	77.0
Yes	132	23.0
Wearing a mask when leaving home		
No	136	23.7
Yes	437	76.3
Wearing a mask when in hospital/maternity service		
No	78	13.6
Yes	494	86.4
Cleaning and disinfecting frequently touched objects/surfaces		
No	98	17.1
Yes	475	82.9
Leaving the house only when absolutely essential		
No	152	26.6
Yes	420	73.4
Shaking hands or making close contact with other people		
No	24	4.2
Yes	548	95.8

PHBS = Prenatal Health Behavior Scale.
[a] Frequency of prenatal health behaviours is for the preceding month.

home only when essential, and avoiding handshakes/close contact were not significantly associated with any demographic factors. See Supplement 6 for complete details of findings regarding demographic differences in COVID-19 related health behaviours.

Discussion

This study examined pregnant women's levels of stress, mental and physical health, and frequency of health behaviours during the COVID-19 pandemic. Building upon existing evidence that pregnant women are experiencing more anxiety, depression, and post-traumatic stress during the pandemic [24,25], this study found high levels of pregnancy-specific stress and COVID-19 related stress, but low levels of mental and physical health and social support. The majority of women in this study engaged in recommended prenatal health behaviours and COVID-19 related behaviours. Psychological outcomes and health-promoting behaviours were mostly predicted by well-being variables including stress and social support; sociodemographic factors had limited impact on outcomes.

Our findings indicated that during the pandemic, pregnant women in our study were experiencing normative levels of general stress [37], but reported high levels of pregnancy-specific stress [31] and COVID-19 related stress. That prenatal and COVID-19 stress were heightened in this sample, but general stress was not, suggests that the experience of being pregnant during the pandemic may function as a contextual stressor. This is supported by our findings that nearly all participants reported feeling somewhat or very concerned about COVID-19/related restrictions, many were concerned about their babies becoming unwell due to the coronavirus, and many reported disruptions to sleep associated with thinking about the coronavirus. That is in line with previous evidence that the coronavirus has prompted pregnancy-specific concerns [20,21]. More generally, our findings of increased COVID-19 related stress are in keeping with previous examinations that indicated high levels of anxiety during the pandemic [24] as stress and anxiety are highly related, though distinct, constructs [5]. These findings provide insight on the specific content of women's stress during the pandemic, and specifically suggest that stress reduction interventions which target pregnancy and coronavirus-related concerns may be particularly useful.

In addition, although significant differences in stress were not previously observed between women pregnant before or during the pandemic in Ireland [26], the current paper did not find any sociodemographic predictors of any stress outcomes in this international sample. This suggests that while experiences of stress during the pandemic may be contextually specific, they may not be place- or demographic-specific, a finding which suggests that population-level approaches to addressing and supporting prenatal mental health may be effective in the pandemic context. However, given the overall homogeneity of this sample in terms of ethnicity and education, and in light of existing evidence of the relationship between sociodemographic factors and mental health concerns [1], this likely bears further examination.

In this sample, the strongest predictors of stress outcomes were other types of stress and general mental health. Stressors identified by participants included concerns about COVID-19 infection during pregnancy and/or in infants, limitations on travel and social contact imposed by public health restrictions, and limitations on access to prenatal care as a result of public health measures. Additional qualitative feedback from this sample (presented in a complementary paper) suggests that changes to antenatal care, conflict with social support networks, and feelings of uncertainty and isolation were also important sources of stress for this population [29]. This suggests that the development and implementation of prenatal mental health supports and interventions should include a specific focus on pregnancy- and COVID-19-related concerns. Further, though our findings did not suggest an influence of demographic factors, predisposing psychological factors should be considered in the development and implementation of interventions.

In line with previous findings about the relationship between prenatal stress and health outcomes [8], general stress was shown to have a significant impact on both mental and physical health in this sample. Notably, pregnancy-specific stress was also a significant predictor of mental health, suggesting that pregnancy-related concerns may put women at increased risk for mental health impairment and could be useful targets for mental health intervention in pregnant populations. This may be of particular significance as increased mental health symptoms have been reported in pregnant populations since the beginning of the pandemic [24,25]. In addition, our findings suggest a bi-directional relationship between mental and physical health. Previous findings have demonstrated associations between prenatal stress and engagement in health behaviours [8]. However, our findings indicate that despite high levels of pregnancy related and

Table 4
Summary of regression outcomes (full details in Supplementary files 3–5).

	R	R^2	ΔR^2	p Values
Covid-19 related stress				
Step 1[a]	.22	.05	.05	.14
Step 2[b]	.59	.31	.26	<.005
Pregnancy-specific stress (PDQ)				
Step 1[a]	.27	.08	.08	.004
Step 2[b]	.63	.39	.32	<.005
General stress (PSS)				
Step 1[a]	.29	.08	.08	.16
Step 2[b]	.72	.51	.43	.03
Mental health (SF-12 mental component)				
Step 1[a]	.34	.11	.11	<.005
Step 2[c]	.74	.54	.43	<.005
Physical health (SF-12 physical component)				
Step 1[a]	.33	.11	.11	<.005
Step 2[c]	.48	.23	.12	<.005
Health promoting behaviours				
Step 1[a]	.32	.10	.10	<.005
Step 2[c]	.49	.25	.15	<.005
Health impairing behaviours				
Step 1[a]	.35	.12	.12	<.005
Step 2[c]	.41	.17	.05	<.005

[a] Variables entered at Step 1: age, parity, gestational age, country of residence, relationship status, education, previous pregnancy loss.
[b] Variables entered at Step 2: Stress measures, Mental and physical health measures, social support.
[c] Variables entered at Step 2: Stress measures, health measures, social support
PSS = Perceived Stress Scale PDQ = Prenatal Distress Questionnaire SF-12 = SF-12® Health Survey.

COVID-19 related stress, women in this study reported high adherence to health-promoting behaviours (e.g. eating healthily, exercising, taking vitamins). Similarly, women reported low engagement in health-impairing behaviours (e.g. alcohol consumption and smoking). This finding differs from two recent studies demonstrating lower reported physical activity during the pandemic [26,27]. It is important to note that high levels of self-reported appropriate health behaviours may reflect socially desirable responding in the current study. Unlike stress outcomes, sociodemographic factors including education, number of children, and country of residence, were predictors of health-promoting and health-impairing prenatal behaviours in the current study. The finding that the number of children women have impacts health behaviours is likely related to childcare and caring responsibilities; as there is evidence that changes to schooling and childcare provision during the pandemic have placed significant strain on families with children [39].

Finally, while women generally reported very high levels of adherence to COVID-19 related health behaviours (such as social distancing, wearing masks, and disinfecting surfaces), some sociodemographic differences in adherence were observed. Observed associations between some pandemic-related behaviours (avoiding public places and wearing masks) and country of residence, suggest that national guidance, regulations, and sociocultural contexts may significantly impact on pregnant women's health-related decision-making during the pandemic. Unlike the findings related to stress outcomes, these findings suggest a need for potentially more targeted interventions within countries and groups to improve and/or maintain appropriate prenatal behaviours during a pandemic.

Strengths/limitations

The cross-sectional nature of this study is limited as we are unable to track how the pandemic may impact participants' wellbeing- and behaviours over time/as perceived COVID-19 risk and restrictions change. In addition, while assessment of stress during the pandemic was conducted using validated measures of general stress and pregnancy-specific stress, there was not, at the time of data collection, a published validated scale to measure COVID-19 related stress in pregnant women. While the measure of COVID-19 related stress designed for this study had good internal validity, a validated measure of prenatal stress and anxiety has since been published [40], and this would prove useful for future research in this area. We also did not assess whether women had received a positive COVID-19 test result, which might have influenced their well-being and behaviours.

Furthermore, participants in this study were largely married or in a relationship, educated to degree-level or higher, socioeconomically advantaged, and resident in Ireland, the United Kingdom or America. Thus these results may tend to understate the economic and social drivers of stress and adherence to health advice during the pandemic. However, the international sample enhances generalisability of our findings and interpretations. In addition, our comprehensive approach to examining multiple types of stress and a range of health behaviours provides important insights into as yet under-examined aspects of women's experiences of pregnancy during the pandemic.

Conclusion

This study found high levels of pregnancy-specific and COVID-19 related stress, and low levels of mental and physical health during the COVID-19 pandemic. In this sample, these variables were mostly predicted by well-being factors rather than sociodemographic factors. Pregnant women in this study reported good engagement with healthy behaviours and high adherence to COVID-19 public health recommendations during the pandemic.

Our findings highlight the need for prenatal mental health supports that target pregnancy- and coronavirus-specific concerns, and that can be implemented at population levels to support prenatal mental health. While experiences of stress did not appear to be place- or demographic-specific in this study, the association between certain health behaviours (including mask-wearing and avoiding crowded places), and sociodemographic factors, suggest that some elements of prenatal health behaviour may be influenced by national guidance and cultural context, further illustrating the need for structured interventions for women pregnant during the pandemic. These supports are clearly greatly needed and may help to mitigate adverse effects for women and children.

Author agreement

The authors hereby certify that the work presented in this submission is the authors' original work, has not been published (and is not under consideration for publication) elsewhere, and has been reviewed and approved by all authors. The authors also agree to abide by the copyright terms and conditions of Elsevier and the Australian College of Midwives.

Author contributions

KMS conceptualised and designed the study, collected and analysed the data, wrote and revised the final manuscript.

JP contributed to study design, collected data and assisted with data analysis, and critically reviewed and revised the manuscript.

EKO designed the study, contributed to analyses and critically reviewed and revised the manuscript.

SL conceptualised and designed the study and critically reviewed and revised the manuscript.

SM conceptualised and designed the study, contributed to analyses and critically reviewed and revised the manuscript.

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Ethical statement

All procedures were approved by the University College Cork School of Public Health Research Ethics Committee and the Clinical Research Ethics Committee of the Cork University Teaching Hospitals (Ref ECM 4 (zz) 10/01/12).

Conflict of interest

The authors have no conflict of interest to declare.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.wombi.2021.03.007.

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