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Perception of the SARS-CoV-2 pandemic by pregnant women during the first lockdown in France: worry, perceived vulnerability, adoption and maintenance of prevention measures according to the Covimater study

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ABSTRACT

Background: We aimed to describe pregnant women's worry about the SARS-CoV-2 pandemic, the associated reasons, their perceived vulnerability to this infection, and factors influencing continued poor/non-existent or decreased implementation of preventive measures over time.

Method: A cross-sectional study was conducted in July 2020 using a web-questionnaire completed by 500 women who were pregnant during the first lockdown in France (March–May 2020). Questions focused on worry caused by the pandemic, perceived vulnerability to infection by SARS-CoV-2 and implementation of preventive measures during and after lockdown. A robust variance Poisson regression model was used to estimate adjusted prevalence ratios (aPR) for perceived vulnerability and continued poor/non-existent or decreased implementation of preventive measures.

Results: Participants felt significantly more vulnerable to infection than women of childbearing age who were included in a parallel study on the French general population, but were significantly less worried about the pandemic. Obese participants and those who unsuccessfully sought exchanges with healthcare professionals about their infection risk felt significantly more vulnerable (aPR = 1.32 95%CI[1.05–1.64] and 1.88 [1.43–2.48], respectively). Participants with continued poor/non-existent or decreased implementation of preventive measures two months after the lockdown ended were more likely to have experienced violence during the lockdown (2.06, [1.32–3.22]), or to live in areas less affected by the pandemic (1.66 [1.05–2.62]). A good knowledge of viral transmission (0.54 [0.30–0.97]) and a high perceived vulnerability score (0.66 [0.44–0.99]) were associated with maintained/increased implementation of preventive measures.

Conclusions: Our results can guide prevention and support policies for pregnant women during pandemics, current or future.

1. Introduction

Data from previous coronavirus outbreaks in 2002 and 2013 showed that pregnancy was a risk factor for severe forms of associated respiratory diseases. More specifically, SARS-CoV-1 and MERS-CoV were associated with significant acute respiratory distress syndrome (Jamieson et al., 2006; Schwartz and Graham, 2020). Given this history and following the recommendations of scientific bodies (Monteleone et al., 2020; Peyronnet et al., 2020; Poon et al., 2020), in March-April 2020 several countries, including France declared that pregnant women should be considered a population at greater risk of severe forms of COVID-19, the disease caused by SARS-CoV-2 (Centers for Disease

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Control and Prevention, 2020; Federal Office of Public Health (FOPH), 2020; Haut Conseil de la santé publique (HCSP) (2020a); Public Health Agency of Canada, 2020; Public Health England (2020); World Health Organisation (WHO) (2021)). In the absence of vaccines and effective pharmaceutical treatments at that time, most governments decided to reduce the spread of the virus by implementing strict lockdowns of their entire population for several months. In France, the first such lockdown took place between 17 March and 11 May 2020. It brought major changes in the organisation of health systems, which may have affected the monitoring of pregnancies (Royal College of Obstetricians and Gynaecologists (RCOG) (2020); Vivanti et al., 2020). Furthermore, at the beginning of the pandemic, conclusions about the risk of COVID-19 for pregnant women were contradictory. This may have contributed to greater general worry or a higher degree of perceived vulnerability among pregnant women, whether in regard to their own and/or their baby's risk of SARS-CoV-2 infection, compared to the general population.

Pregnant women, just as other subgroups in the general population (Lasbeur et al., 2020), may have had a particular profile in terms of adopting and maintaining preventive measures against SARS-CoV-2.

Before and during the lockdown in France, preventive measures to contain the spread of the SARS-CoV-2 (Haut Conseil de la santé publique (HCSP) (2020b); Ministry of health, 2020a) included hygiene recommendations (hand hygiene, coughing or sneezing into one's elbow, etc.), physical distancing in professional and social situations, and, later, generalised mask wearing both in enclosed spaces and outdoors whenever physical distancing could not be respected (Appendix). These recommendations were maintained after the lockdown ended to prevent the spread of the virus, as several studies showed the importance of such behaviours over the medium and long terms (Pradhan et al., 2020; Santé Publique france, the french agency of public health, 2020).

This study aimed to (i) describe pregnant women's general level of worry about the pandemic in France and the main associated reasons, (ii) study factors influencing their perceived vulnerability to the risk of infection from SARS-CoV-2, (iii) compare their implementation of preventive measures with women of childbearing age during the first lockdown (March-May 2020) and two months after it ended (July 2020), and (iv) study the factors influencing continued poor/non-existent or decreased implementation of these measures two months after the lockdown ended.

2. Material and methods

2.1. Study population (Covimater)

Our sample comprised 500 women who were: i) pregnant during the first lockdown in France (from 17 March to 11 May 2020), ii) aged 18 and over, and iii) residents in metropolitan France. We excluded two groups of women pregnant during lockdown but with limited exposure to it: those who delivered in the two first weeks of lockdown and those whose first week of gestation began during the last two weeks of lockdown.

2.2. Study methodology

At our request, a service provider (BVA group) interviewed its unpaid pre-pandemic internet panel of 15,000 future parents or parents of children under 3 years to create a pseudonymised non-probabilistic sample of 500 pregnant adult women who met the inclusion criteria (described below) and volunteered to participate in our survey. Covimater is a cross-sectional study using quotas sampling, whereby the study sample is assigned a structure similar to that of the target population (i.e., all pregnant women) in order to tend towards representativeness. The population of parents of children under 1 year old - as per the National Institute of Statistics and Economic Studies 2016 census - was used to set the quotas (French National Institute of Statistics and Economic Studies, 2020). By its broad representation, the latter was judged a good proxy for our target population of pregnant women in France. The quotas for mothers of children under 1 year old were applied to calculate weightings using Newton's algorithm (Deville and Särndal, 1992) and obtain weighted individual data for the statistical analysis presented herein (see below). Specifically, these quotas comprised age group, socio-professional category (SPC), region of residence, size of urban area, and parity. Eligible women were invited by BVA to answer an online questionnaire between 6 and 20 July 2020 i.e. two months after the end of the first lockdown in France (March–May 2020). The two-month interval was chosen i) to avoid the memory bias associated with a longer interval, and ii) because the major recommended prevention measures had not changed in the two months after lockdown. No significant difference in available data for age group, region of residence, or parity was observed between the women participating in Covimater and women in the whole French population who gave birth in a hospital maternity ward (i.e., 99% of pregnant women in France (Piffaretti et al., 2018)).

This methodology (same quotas sampling) was also used in the CoviPrev study, a survey conceived to monitor the general population's mental and behavioural health in the SARS-CoV-2 context (Raude et al., 2020). CoviPrev started on 23 March 2020 and by 20 July 2020, twelve survey waves had taken place. To compare the prevention behaviours of women of childbearing age (18–49 years) in France with those of pregnant women, Covimater featured several questions that were also used in CoviPrev during the first lockdown (waves 1 to 7) and two months after it ended (wave 12).

Covimater received approval from the Saint Maurice Hospital Ethics Committee on 01/07/2020 (approval number n°2020-1).

2.3. Definition of variables of interest

2.3.1. Self-perception of the pandemic during the first lockdown (scores of worry and vulnerability)

Two different scale-based scores were recorded (as in the CoviPrev survey): one for participants' general worry about the pandemic situation in France during the first lockdown and another for their perceived vulnerability to SARS-CoV-2 infection during the first lockdown (from 0 (not at all worried/vulnerable) to 10 (very worried/vulnerable)). Two dichotomous low/high variables were then created for 'worry' and 'vulnerability', with 7/10 and 6/10 as the thresholds, respectively, corresponding to the average worry or vulnerability observed (7.0 +/- 0.1 and 6.2 +/- 0.1, respectively). The reasons why women felt worried about the pandemic during the lockdown were explored through eleven questions phrased as follow: "During the lockdown, were you especially worried about…" (see Fig. 1).

2.3.2. Preventive measures during the first lockdown and two months after it ended.

Participants answered eight questions related to their implementation both during France's first lockdown and at the time of the survey (i.e., two months after lockdown ended), of each specific preventive measure: *(i)* hand washing, *(ii)* mask wearing *(iii)* avoiding professional/social gatherings and face-to-face meetings, *(iv)* keeping a distance of at least one metre from other people, (*v*) avoiding public transport, (*vi*) staying at home as much as possible, (*vii*) adapting the workplace to limit the risk of infection, and (*viii*) choosing to work from home (Haut Conseil de la santé publique (HCSP) (2020b)). For each of the eight questions, the following replies were possible: A) Yes, systematically, B) Yes, often, C) Yes, occasionally, and D) No, never. Only the first six questions were also asked in CoviPrev.

2.3.3. Continued poor/non-existent or decreased implementation of preventive measures two months after the lockdown ended

Questions *i,ii,iii, and iv* reflected the major recommendations of the French public authorities during the lockdown and in the two months

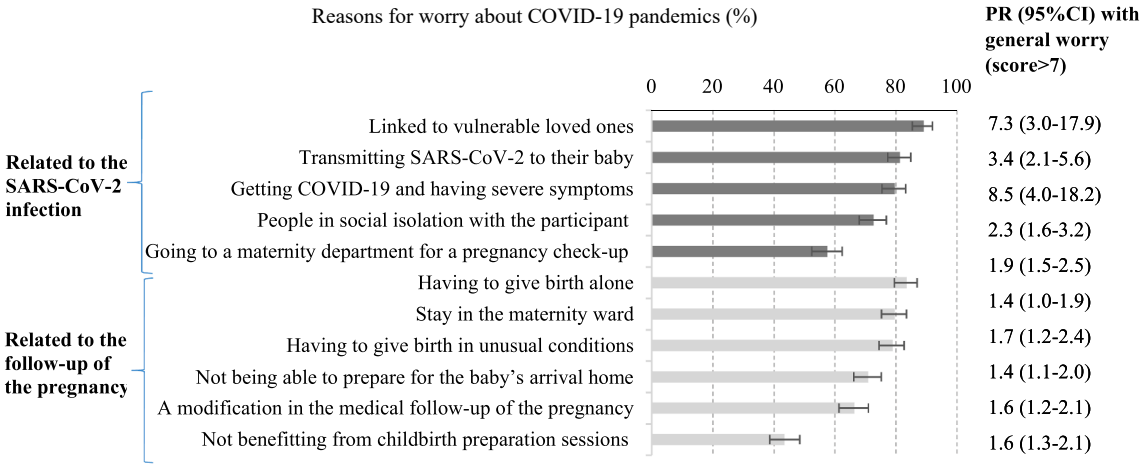

Fig. 1. Description of the reasons for worry about the COVID-19 pandemic as reported by pregnant women during the first lockdown in relation to their general worry score; Covimater survey (n = 485), France, 2020. The reasons why women felt worried about the pandemic during the lockdown were explored through eleven questions phrased as follows: "During the lockdown, were you especially worried about…" (see left-hand side of Fig. 1, for question topics). For each of these eleven questions, the following answers were possible: a) Yes, absolutely, b) Yes, slightly, c) No, not really, or d) No, not at all. In the analysis, for each question, women who answered a) or b) were considered worried during the lockdown (coded "1") while those who declared c) or d) (coded "0") were not. The percentage of women worried for each topic and 95%CI were calculated. The right-hand side of the Fig. 1 ranks the importance of each reason to explain the general self-perceived worry score of pregnant women. The prevalence ratio and 95%CI of each reason were obtained with robust variance Poisson bivariate regression models. No documented data for 15 pregnant women concerning their self-perceived worry score.

immediately after it. We used these four questions to create a dichotomous variable 'Continued poor/non-existent or decreased implementation of preventive measures' (yes = 1/no = 0). Specifically, for each question, a decrease was coded '1′ when the answer regarding implementation of the relevant measures was: a) A or B for during the lockdown but C or D two months after it ended; or, b) C or D for both periods. Similarly, the variable was coded '0′ when the answer was c) C or D for during the lockdown but A or B two months after it ended; or, d) A or B for both periods. A 'continued poor/non-existent or decreased implementation of preventive measures' score (from 0 to 4) was then calculated for each participant by summing the individual scores for all four measures. Women with a score >=2 were considered to have continued poor /non-existent or decreased implementation ("yes") whereas women with a score <2 were not ("no").

2.4. Covariates

Explanatory variables (relative modalities detailed in Table 1) were divided into five main categories:

2.4.1. Demographic and socio-economic

Age, socio-professional category (SPC) reduced into SPC+ (self-employed women, managers, intermediate professions), SPC- (employees, blue-collar workers) and Inactive (students and other professionally inactive persons), education level, perceived financial situation.

2.4.2. Pandemic and lockdown-related:

Partner and/or child(ren) under six years of age (i.e., younger than required school age in France) in the household during the lockdown, SARS-CoV-2 strain on healthcare system in region of residence (coded as green, orange or red, reflecting increased epidemic pressure) (Ministry of health, 2020b), professional workload, access to a private/common outdoor space, living with the same people as usual, level of knowledge about the virus' modes of transmission (score based on seven questions, see details in Table 1), self-perceived social support (from family, friends, etc.), experience of serious disputes/climate of violence, presence of COVID-19-type symptoms, family member or friend with COVID-19 diagnosis or symptoms suggestive of the disease.

2.4.3. Pregnancy and health

Parity, gestational age at the end of lockdown or at the time of the questionnaire, childbirth (during or after first lockdown), at least one pre-existing chronic disease or pregnancy-related pathology (see details of pathologies in Table 1, notes g and i), overweight/obesity status before pregnancy (based on body mass index; see Table 1, note e), possibility to exchange with healthcare professionals about the risk of SARS-CoV-2 infection.

2.5. Statistical analysis

Percentages obtained for the implementation of preventive measures in Covimater and those obtained for women of childbearing age (i.e., aged 18–49 years old) in the CoviPrev survey (Raude et al., 2020) were compared using Pearson's chi-squared test of independence (p-value < 0.05). The weightings applied to the women in CoviPrev were recalculated to find the closest possible estimate for the structure of the French female population (French National Institute of Statistics and Economic Studies, 2020) of childbearing age.

A robust variance Poisson regression model was used to estimate unadjusted and adjusted prevalence ratios (aPR) (Barros and Hirakata, 2003) for the worry, perceived vulnerability and continued poor/non-existent or decreased implementation of preventive measures. Factors associated with each of these two outcomes which either had a p-value <0.20 in bivariate analysis or were judged to be clinically relevant based on the literature (gestational age at completion of study questionnaire, gestational age at end of lockdown period, parity), were introduced into the multivariate models. When several variables were possibly collinear, the model with the best likelihood score (lowest Bayesian information criterion) was selected. Fractional polynomials showed a linear relationship between continuous variables included in the models and the studied prevalence of each of the two outcomes. A manual descending stepwise procedure was then applied to identify factors independently associated (p-value < 0.05) with each outcome. Hosmer-Lemeshow tests were performed to verify the goodness of fit of each final model. Estimates of aPR, their 95% confidence intervals (95%CI) and associated p-values are presented. As indicated by Zou, PRs can be interpreted in the same way as relative risk (RR) (Zou, 2004).

Only a descriptive analysis was presented for the worry variable

Table 1
Description of pregnant women during the first COVID-19-related lockdown (March-May 2020) who participated in the Covimater survey (n = 500), France, July 2020.

	N (%)*	95%CI**
Demographic and socio-economic characteristics		
Age (in years)		
18–24	53 (10.7)	7.4–15.2
25–34	323 (64.6)	59.7–69.2
35–49	124 (24.7)	21.1–28.8
Socio-professional category (SPC)[a]		
SPC +	192 (38.4)	33.9–43.2
SPC -	180 (36.1)	31.8–40.6
Inactive	128 (25.5)	20.5–31.2
Educational level		
Equal to or higher than secondary school diploma	391 (78.1)	73.6–82.1
Lower than secondary school diploma	109 (21.5)	17.9–26.4
Perceived financial situation		
Comfortable	246 (49.2)	44.2–54.2
Just getting by	159 (31.7)	27.2–36.6
Difficult to make ends meet	95 (19.1)	15.2–23.7
Pandemic and lockdown related variables		
Child(ren) under 6 years of age in the household during the lockdown	234 (46.8)	41.8–51.8
SARS-CoV-2 strain on healthcare system (colour-coded) for the region of residence[b]		
Green zone	127 (25.4)	21.1–30.2
Orange zone	150 (30.0)	25.7–34.7
Red zone	223 (44.6)	39.7–49.6
Working conditions during the lockdown (n = 385)[c]		
Working from home	96 (24.8)	20.7–29.4
Working at usual place of work	43 (11.3)	8.5–14.7
Working from home and at usual place of work	10 (2.6)	1.5–4.5
Did not work because unemployed (partially or not)	64 (16.7)	13.4–20.6
Did not work for other reasons (maternity leave, etc.)	158 (40.9)	36.0–46.0
Other situation	14 (3.7)	1.9–7.2
Professional workload		
Did not work	351 (70.1)	65.7–74.2
Lighter or same as usual	85 (17.1)	14.0–20.7
Heavier than usual	64 (12.8)	10.1–16.0
Access to a private/common outdoor space	434 (86.8)	82.8–90.1
Lived with the same people (n = 488)[d]	472 (96.8)	93.7–98.4
Self-perceived social support		
Very good	180 (36)	31.3–40.9
Good	231 (46.1)	41.2–51.1
Little or None	89 (17.9)	14.5–21.8
Serious disputes or violence		
Very-often / Often / Sometimes	39 (7.9)	5.7–10.9
Rarely	101 (20.2)	16.4–24.5
Never	360 (71.9)	67.2–76.2
Level of knowledge about SARS-CoV-2 transmission[e]		
Low	14 (2.8)	1.5–5.2
Moderate	35 (7.0)	4.8–10.1
High	451 (90.2)	86.7–92.9
Experiencing COVID-19 type symptoms	92 (18.4)	14.9–22.6
Family member or friend with COVID-19 diagnosis or symptoms suggestive of the disease	171 (34.2)	29.7–39.0
Exchange with a professional about the risks of SARS-CoV-2 infection		
Yes	202 (40.4)	35.6–45.3
No, because I didn't need it.	161 (32.2)	27.7–37.0
No, but I would have liked to	137 (27.4)	23.0–32.3
Pregnancy and health		
Primiparous	203 (40.6)	35.8–45.6
Gestational age (weeks) at the end of first lockdown[f]		
<10	34 (6.8)	4.7–9.8
10–20	177 (35.4)	30.8–40.3
20–30	180 (36.1)	31.4–41.0
30–40	77 (15.4)	12.1–19.4
> 40	32 (6.3)	4.3–9.2
Childbirth		
During lockdown	34 (6.8)	4.7–9.8
After lockdown	466 (93.2)	90.2–95.2
Pre-existing chronic disease(s)[g]	152 (30.3)	25.8–35.1
Overweight/obesity status before pregnancy[h]	212 (42.4)	37.5–47.4
Overweight	120 (23.9)	19.9–28.5
Obesity	92 (18.4)	14.8–22.7
Pregnancy-related pathology(ies)[i]	119 (23.7)	19.9–28.0
Self-perception of the pandemic during first lockdown		
Perceived general worry about the SARS-CoV-2 pandemic score (max. 10; n = 485) > 7/10[j]	234 (48.3)	43.3–53.3
Perceived vulnerability score to SARS-CoV-2 infection score (max. 10; n = 459) > 6/10[j]	250 (54.6)	49.4–59.6

* Weighted and rounded values using Newton's algorithm (Deville and Särndal, 1992).
** 95% Confidence Interval.

a Women on maternity leave and unemployed women were classified according to their current SPC category or their most recent category prior to ending work, respectively. Due to small numbers, students and the unemployed could not be studied separately and were grouped together as the lowest income group.
b Estimated by the Ministry of Health on 1 May 2020 on the basis of two variables: i) Virus circulation level (i.e., percentage of emergency room admissions for suspected COVID-19) and ii) Strain on hospital intensive care unit capacity (i.e., occupancy rate of intensive care beds by patients with COVID-19), coded as green, orange or red, reflecting increased epidemic pressure on the healthcare system (Ministry of health, 2020b).
c 115 women were at home at time of study (July 2020).
d 12 women lived alone during the first lockdown.
e Score based on seven questions (Low, Moderate or High levels of knowledge if correct answers given to <=4, =5 or >=6 questions respectively).
f At the end of the first lockdown (11 May 2020) or at the date of childbirth if women gave birth during lockdown.
g Diabetes, Overweight/obesity status before pregnancy, High blood pressure, Asthma, Cardiac condition, Autoimmune disease, Mental illness, Inherited bleeding disorders.
h Based on body mass index (BMI): "Overweight" if BMI [25–30 kg/m^2[; "Obesity" if BMI >=30 kg/m^2; "No overweight/obesity" in other cases.
i Gestational diabetes, Pre-eclampsia, Preterm labour, Gestational hypertension.
j Scores for participants' general worry about the pandemic situation and for their perceived vulnerability to SARS-CoV-2 infection during the first lockdown (from 0 (not at all worried/vulnerable) to 10 (very worried/vulnerable)). Two dichotomous 'low/high' variables were then created for 'worry' and 'vulnerability', with 7/10 and 6/10 as the thresholds, respectively (see details in methods). No documented data for 15 and 41 pregnant women in terms of level of perceived worry about the pandemic and vulnerability to SARS-CoV-2 infection, respectively.

(mean and standard deviation (sd), percentage and 95%CI, PR and 95% CI concerning the general worry score for each declared reasons for worry) as none of the variables selected in the bivariate analyses emerged as significantly associated with worry in a multivariate model.

All statistical analyses were performed using Stata software ®version 14.2 (Stata Corp., College Station, TX, USA).

3. Results

3.1. Characteristics of women included in Covimater (Table 1)

Mean age was 31.4 years (+/-5.1). Almost a third (36.1%) were classified SPC-, 25.5% were professionally inactive, 31.7% declared they just got by financially, while 19.1% reported that they could not make ends meet. During the lockdown, among professionally active women, 38.7% worked from home and/or at their usual place of work and 43% declared that they had worked more than usual.

From a medical perspective, 42.4% of the sample were overweight or obese before pregnancy, and 23.7% had pregnancy-related pathologies. Finally, 17.9% perceived little or no social support during the lockdown, and 28.1% had experienced serious dispute or a climate of violence during the lockdown.

3.2. Scores for self-perceived general worry and self-perceived vulnerability during the first lockdown

Participants' main worries were related to their pregnancy and the risk of infection to their relatives (Fig. 1). Compared with women of childbearing age in CoviPrev, which used the same self-perceived worry score, the mean self-perceived worry score was lower in Covimater participants (7.0+/-2.5 and 8.0+/-2.2 out of 10; $p < 0.01$). None of the variables studied was significantly associated with worry in the multivariate model.

Our participants' perceived vulnerability score for their own risk of SARS-CoV-2 infection was significantly higher (6.2+/-2.9) than that in CoviPrev (5.7+/-3.0) ($p < 0.01$). Obese women and those who unsuccessfully sought exchanges with healthcare professionals about their infection risk were significantly more likely to have a high perceived vulnerability score (aPR = 1.32 95%CI[1.05–1.64] and 1.88 [1.43–2.48], respectively; Table 2).

3.3. Implementation of preventive measures during and after the lockdown

Most women systematically applied the recommended preventive measures during the lockdown. Of the 149 who worked during the lockdown, 73.0% had their workplace adapted and 59.5% decided to work from home (Fig. 2).

However, two months after the end of lockdown, the proportion of pregnant women who systematically applied protective measures had decreased. This decrease mostly concerned three of the six protective measures studied: a) staying at home as much as possible (82.5% reduction), b) avoiding professional/social gatherings (80.6% reduction, and c) keeping a distance of at least one meter from other people (38.3% reduction). In terms of the implementation of preventive measures, both during and after the lockdown, the patterns observed among pregnant women in our study were significantly different among women of childbearing age participating in CoviPrev (Fig. 3). Covimater participants were significantly more likely to wear a mask in public during the first lockdown. Furthermore, two months after it ended, they were significantly more likely to maintain physical distancing ($p < 0.01$) and to avoid taking public transport ($p < 0.05$), but significantly less likely to avoid professional/social gatherings/face-to-face meetings and to stay at home as much as possible (Fig. 3).

3.4. Continued poor/non-existent or decreased implementation of preventive measures two months after the end of France's first lockdown (Table 3)

Out of the 500 pregnant women who participated, 105 (21%) decreased their overall implementation of these four measures (score >=2).

Independently of the other co-factors studied, living in a zone where the pressure on the healthcare system was low, or having experienced violence during the lockdown, were both significantly linked to a decreased implementation of preventive measures two months after the lockdown ended (aPR = 1.66 95%CI[1.05–2.62] and 2.06 [1.32–3.22], respectively). A good level of knowledge about the modes of transmission of the virus (see Methods) and a high perceived vulnerability score (p-value close to 0.05) were protective factors for reducing their implementation level (aPR = 0.54 95%CI[0.30–0.97] and 0.66 [0.44–0.99], respectively).

4. Discussion

Compared with women of childbearing age in the CoviPrev study, the pregnant women in Covimater were significantly less worried about the pandemic but significantly more likely to have a high perceived vulnerability score for their risk of SARS-CoV-2 infection. Participants who were obese and those who unsuccessfully sought exchanges with a healthcare professional about the risk of SARS-CoV-2 infection felt significantly more vulnerable. Women with continued poor/non-existent or decreased implementation of preventive measures two months after the lockdown ended, were more likely to have experienced violence during lockdown or to live in areas less affected by the pandemic. A good knowledge of viral transmission and high

Table 2
Factors associated with a perceived vulnerability score greater than six in pregnant women during the first lockdown, Covimater survey (n = 459)[a], France, 2020.

	High perceived vulnerability score[b] (i.e., score >6, n = 250)			
	Yes (n %)*		Adjusted PR (95%CI)**	p-value**
Socio-demographic characteristics				
Age (in years)	31.7	(4.9)	1.01 (0.99–1.03)	0.49
Socio-professional category[c]				
SPC +	110	(43.8)	1	
SPC -	89	(35.5)	0.95 (0.79–1.14)	0.60
Inactive	51	(20.6)	0.85 (0.63–1.14)	0.29
Pregnancy and health				
Overweight/obesity status before the pregnancy[d]				
No overweight/obesity	132	(52.8)	1	
Overweight	67	(26.7)	1.16 (0.95–1.43)	0.14
Obesity	51	(20.5)	1.32 (1.05–1.64)	**0.01**
Parity				
Primiparous	107	(42.7)	1	
Multiparous	143	(57.3)	0.90 (0.75–1.08)	0.27
Pregnancy term[e]	23.7	(8.6)	1.01 (1.00–1.02)	0.20
Variables related to the pandemic and first lockdown				
Living with the same people as usual during the first lockdown[f]				
No	3	(1.3)	1	
Yes	242	(98.7)	2.46 (0.88–6.86)	0.08
Exchange with a professional about the risks of SARS-CoV-2 infection				
Yes	118	(47.2)	**1.76 (1.36–2.29)**	**<0.01**
No, because I didn't need it.	53	(21.2)	1	
No, but I would have liked to	79	(31.5)	**1.88 (1.43–2.48)**	**<0.01**

* Weighted and rounded values using Newton's algorithm (Deville and Särndal, 1992) for discrete or qualitative variables. For continuous variables (age, pregnancy term), mean (standard deviation) were presented.
** Adjusted prevalence ratio (aPR), Confidence Interval 95% (95% CI) and p-value obtained with robust variance Poisson regression model.
a No documented data for 41 pregnant women concerning their perceived vulnerability to SARS-CoV-2 infection.
b Score for participants' perceived vulnerability to SARS-CoV-2 infection during the first lockdown (from 0 (not at all vulnerable) to 10 (very vulnerable)). Dichotomous variable created with 6/10 as threshold corresponding to average vulnerability observed.
c Women on maternity leave and unemployed women were classified according to their current SPC category or their most recent category prior to ending work, respectively.
d based on body mass index (BMI): "Overweight" if BMI [25–30 kg/m^2[;"Obesity" if BMI >=30 kg/m^2; "No overweight/obesity" in other cases.
e At the end of first lockdown (11/05/2020).
f 12 women lived alone during the first lockdown.

vulnerability score were both positively associated with maintaining/increasing implementation of preventive measures.

At the early stage of the pandemic, there was a lot of confusion about the risk of COVID-19 on pregnant women: while some studies declared an increased risk of complications in infected pregnant women (Allotey et al., 2020; Badr et al., 2020; Hantoushzadeh et al., 2020), others claimed that risk was no greater than for non-pregnant women (Breslin et al., 2020; Chen et al., 2020; Zhu et al., 2020). This uncertainty may have increased the feeling of vulnerability. The role of co-morbidities (in particular obesity) in the development of severe forms of COVID-19, as widely reported in the media, could also increase the feeling of vulnerability in pregnant women who were overweight/obese or suffering from pre-existing chronic or pregnancy-related pathologies. In our bivariate analyses, significant associations between a heightened feeling of vulnerability and chronic disease, pregnancy-related pathologies or obesity were visible but only the association for obesity was maintained after adjustment. Our study also shows that pregnant women who unsuccessfully sought exchanges with a healthcare professional about the risk of SARS-CoV-2 infection felt the most vulnerable during the first lockdown in France. This could be a consequence of the high number of pregnancy consultations cancelled by health professionals (36.3% in Covimater) during the first lockdown (Doncarli et al., 2021). However, healthcare consultations are an opportunity to raise the patient's awareness of the SARS-CoV-2 pandemic. And a study in Iran reported that women with a very good level of knowledge about the pandemic had a lower perceived level of vulnerability (Aghababaei et al., 2020).

The main areas of pandemic-related worry highlighted by pregnant women in Covimater reflected those reported in previous studies in Israel and Ireland (Corbett et al., 2020; Taubman-Ben-Ari et al., 2020). In the latter study, half of the respondents declared they were often or always concerned about their own health, and that they were even more concerned about the health of their parents (83.3%), their children (66.7%), and their unborn child (63.4%). In Israel, respondents were most worried about the impact on their unborn child.

Just as CoviPrev observed in women of childbearing age (Lasbeur et al., 2020), an overwhelmingly majority of pregnant women in Covimater implemented preventive measures them during the first lockdown. Even though preventive measures were still systematically applied by a large proportion of women (pregnant or not) two months after the end of the lockdown (as was also the case in the general population), a decrease in the implementation of preventive measures was observed. Investigations of previous epidemics have shown the role of habituation in the implementation of preventive measures, with less adherence to recommendations being observed over time (Loewenstein and Mather, 1990). One interesting finding in our study is that women in France who were living in regions less affected by the pandemic were more likely to decrease their implementation of preventive measures. This finding highlights how one section of the population who has adapted and habituated to the epidemiological situation could foster clusters in these regions.

In contrast to women of childbearing age, pregnant women were more likely to respect social distancing and avoid public transportation but less likely to avoid professional/social gatherings and face-to-face meetings, or to stay at home (at the time of the study, the latter measure was no longer mandatory). Most of the women we interviewed in Covimater were still pregnant two months after the lockdown ended, so it is possible that their perceived level of vulnerability to their risk of infection had not diminished.

Our results highlight the importance of protecting and supporting

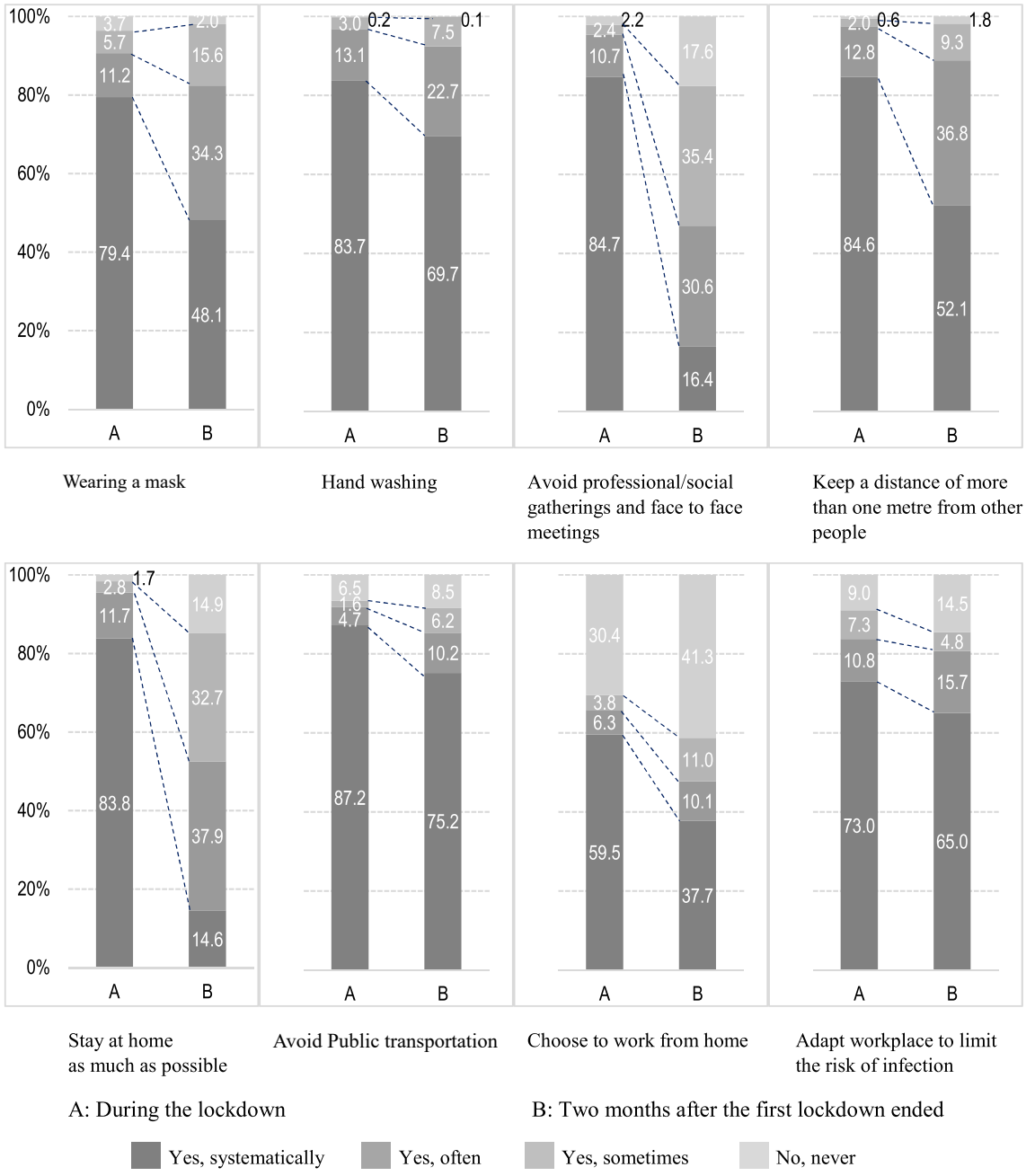

Fig. 2. Description of the implementation of preventive measures both during the first COVID-19-related lockdown and two months after it ended; Covimater survey (n = 500), France, 2020. Women answered eight questions, related to their implementation both during France's first lockdown and at the time of the survey (i.e., two months after the lockdown ended), of each specific preventive measure.

pregnant women who experienced violence or serious disputes during the first lockdown, since we found that they were more likely to continue to have poor/non-existent or decreased implementation of preventive measures. We hypothesize that the immediate social danger linked to physical or verbal violence outweighs any long-term risks linked to infection, resulting in lesser preventive measures adopted and decreased adherence over time. As reported in other studies on risk perception, in a context where several risks are simultaneously present, the different risks compete with each other (Loewenstein and Mather, 1990).

Finally, continued implementation of preventive measures was associated with a high level of knowledge SARS-CoV-2 infection risks. Consequently, it appears important to provide simple and accessible information for people who are less willing or motivated to process complex or multi-source information, such as that relating to the SARS-CoV-2 pandemic (Paakkari and Okan, 2020).

To the best of our knowledge, Covimater was the first national study in France that explores the experiences and behaviours of pregnant women during the SARS-CoV-2 pandemic.

Covimater also had some limitations. First, even though the study

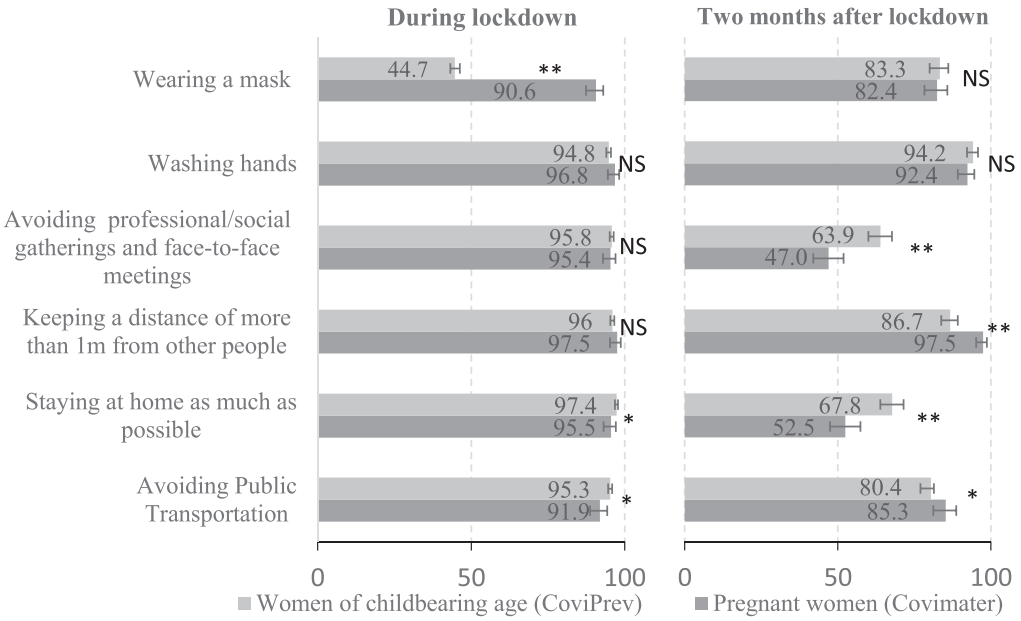

Fig. 3. Implementation of preventive measures by women who were pregnant or of childbearing age in the general population; Covimater survey (n = 500) and CoviPrev survey (n = 2098 during the first lockdown and n = 537 two months after it ended), France, 2020. The percentage of women who adopte prevention measures was calculated using the number of women who answered A) 'Yes, systematically', or B) 'Yes, often' to each of the six questions studied as the numerator. The 95% confidence intervals (95%CI) are also presented.

Table 3
Factors associated with a continued poor/non-existent or decreased implementation of preventive measures two months after the first lockdown ended, Covimater survey (n = 500), France, 2020.

	Continued poor/non-existent or decreased implementation of preventive measures[a] two months after the end of the first lockdown ended (n = 105)			
	Yes (n %)*		Adjusted PR (95%CI)**	p-value**
Socio-demographic characteristics				
Age (in years)	30.3	(4.9)	0.96 (0.93–1.00)	0.06
Socio-professional category (SPC)[b]				
SPC+	33	(31.1)	1	
SPC -	42	(39.9)	1.24 (0.82–1.90)	0.31
Inactive	31	(29.0)	1.53 (0.87–2.70)	0.14
Educational level				
Equal to or higher than secondary school diploma	88	(83.8)	1.73 (0.99–3.02)	0.05
Lower than secondary school diploma	17	(16.2)	1	
Pregnancy and variables related to the pandemic and first lockdown				
Pregnancy term[d]	31.9	(7.5)	1.02 (0.99–1.04)	0.16
SARS-CoV-2 strain on healthcare system (colour-coded) for the region of residence[c]				
Green zone	34	(32.0)	**1.66 (1.05–2.62)**	**0.03**
Orange zone	34	(32.6)	1.29 (0.81–2.07)	0.28
Red zone	37	(35.4)	1	
Serious disputes or violence during first lockdown				
Very-often / Often / Sometimes	16	(15.1)	**2.06 (1.32–3.22)**	**<0.01**
Rarely	18	(17.4)	0.92 (0.54–1.57)	0.77
Never	71	(67.5)	1	
Perceived vulnerability about risk of infection by SARS-CoV-2 during first lockdown [e]				
Low score	58	(57.9)	1	
High score	42	(42.1)	**0.66 (0.44–0.99)**	**0.05**
Level of knowledge about modes of SARS-CoV-2 transmission[f]				
Low	5	(4.8)	1	
Moderate	6	(6.0)	0.55 (0.24–1.29)	0.17
High	94	(89.2)	**0.54 (0.30–0.97)**	**0.04**

* Weighted and rounded values using Newton's algorithm (Deville and Särndal, 1992) for discrete or qualitative variables. For continuous variables (age, pregnancy term), mean (standard deviation) were presented.
** Adjusted prevalence ratio (aPR), Confidence Interval 95% (95% CI) and p-value obtained with robust variance Poisson regression model.
a Based on four questions dealing with major recommendations of the French public authorities both during and after the lockdown until july. A dichotomous variable 'Continued poor/non-existent or decreased implementation of preventive measures' (yes = 1/no = 0) was created for each question. Women with a score >=2 were considered to have continued poor /non-existent or decreased implementation ("yes") whereas women with a score <2 were not ("no") (See details in Methods).
b Women on maternity leave and unemployed women were classified according to their current SPC category or their most recent category prior to ending work, respectively.
c Estimated by the Ministry of Health on 1 May 2020 on the basis of two variables: i) Virus circulation level (i.e., percentage of emergency room admissions for suspected COVID-19) and ii) Strain on hospital intensive care unit capacity (i.e., occupancy rate of intensive care beds by patients with COVID-19), coded as green, orange or red, reflecting increased epidemic pressure on the healthcare system (Ministry of health, 2020b).
d At time of study (July 2020).
e Score for participants' perceived vulnerability to SARS-CoV-2 infection during the first lockdown (from 0 (not at all vulnerable) to 10 (very vulnerable)). Dichotomous variable was created with 6/10 as the thresholds corresponding to the average vulnerability observed. No documented data for 41 pregnant women in terms of level of vulnerability to SARS-CoV-2 infection.
f Score based on seven questions (Low, Moderate or High level of knowledge if correct answers given to <=4, =5 or >=6 questions respectively).

has a consistent internal validity, the use of a panel and quota sampling imply that these findings lack external validity (cannot be generalized to the whole French population of pregnant women). However, no alternative method would have allowed this study to take place such a short time after the lockdown, thus avoiding a significant recall bias. Second, sampling bias could explain the overestimation of the percentage of pregnant women with pre-existing chronic diseases or obesity. Third, as the study questionnaire was self-administered, there is a risk of recall biases or potential social desirability. However, the above-mentioned limitations would affect any population sample and are not exclusively associated with the sub-group of pregnant women studied.

The results of this study highlighted the importance of i) implementing complementary health actions for pregnant women during the current pandemic period, ii) pursuing efforts to distribute information on how the virus is transmitted (including via support to health professionals), and iii) upholding information campaigns that promote preventive measures, and encourage adherence to health recommendations.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author contributions

L.A., A.D. and N.R. conceived of the presented idea. L.A. and A.D. developed the theory and performed the computations. N.R. verified the analytical methods. All authors discussed the results and contributed to the final manuscript.

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Appendix A. Supplementary data

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