

1        **SARS-CoV-2 (COVID-19) infection in pregnant women: characterization of**  
2        **symptoms and syndromes predictive of disease and severity through real-time,**  
3        **remote participatory epidemiology.**

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32

33 **Abstract**

34 **Background:** From the beginning of COVID-19 pandemic, pregnant women have been considered  
35 at greater risk of severe morbidity and mortality. However, data on hospitalized pregnant women  
36 show that the symptom profile and risk factors for severe disease are similar to those among women  
37 who are not pregnant, although preterm birth, Cesarean delivery, and stillbirth may be more  
38 frequent and vertical transmission is possible. Limited data are available for the cohort of pregnant  
39 women that gave rise to these hospitalized cases, hindering our ability to quantify risk of COVID-  
40 19 sequelae for pregnant women in the community.

41 **Objective:** To test the hypothesis that pregnant women in community differ in their COVID-19  
42 symptoms profile and disease severity compared to non-pregnant women. This was assessed in two  
43 community-based cohorts of women aged 18-44 years in the United Kingdom, Sweden and the  
44 United States of America.

45 **Study design:** This observational study used prospectively collected longitudinal (smartphone  
46 application interface) and cross-sectional (web-based survey) data. Participants in the discovery  
47 cohort were drawn from 400,750 UK, Sweden and US women (79 pregnant who tested positive)  
48 who self-reported symptoms and events longitudinally via their smartphone, and a replication  
49 cohort drawn from 1,344,966 USA women (162 pregnant who tested positive) cross-sectional self-  
50 reports samples from the social media active user base. The study compared frequencies of  
51 symptoms and events, including self-reported SARS-CoV-2 testing and differences between  
52 pregnant and non-pregnant women who were hospitalized and those who recovered in the  
53 community. Multivariable regression was used to investigate disease severity and comorbidity  
54 effects.

55 **Results:** Pregnant and non-pregnant women positive for SARS-CoV-2 infection drawn from these  
56 community cohorts were not different with respect to COVID-19-related severity. Pregnant women

57 were more likely to have received SARS-CoV-2 testing than non-pregnant, despite reporting fewer  
58 clinical symptoms. Pre-existing lung disease was most closely associated with the severity of  
59 symptoms in pregnant hospitalized women. Heart and kidney diseases and diabetes were additional  
60 factors of increased risk. The most frequent symptoms among all non-hospitalized women were  
61 anosmia [63% in pregnant, 92% in non-pregnant] and headache [72%, 62%]. Cardiopulmonary  
62 symptoms, including persistent cough [80%] and chest pain [73%], were more frequent among  
63 pregnant women who were hospitalized. Gastrointestinal symptoms, including nausea and  
64 vomiting, were different among pregnant and non-pregnant women who developed severe  
65 outcomes.

66 **Conclusions:** Although pregnancy is widely considered a risk factor for SARS-CoV-2 infection  
67 and outcomes, and was associated with higher propensity for testing, the profile of symptom  
68 characteristics and severity in our community-based cohorts were comparable to those observed  
69 among non-pregnant women, except for the gastrointestinal symptoms. Consistent with  
70 observations in non-pregnant populations, comorbidities such as lung disease and diabetes were  
71 associated with an increased risk of more severe SARS-CoV-2 infection during pregnancy.  
72 Pregnant women with pre-existing conditions require careful monitoring for the evolution of their  
73 symptoms during SARS-CoV-2 infection.

74 **Keywords:** pregnancy; community SARS-CoV-2 symptoms; SARS-CoV-2  
75 risk factors; SARS-CoV-2 severity; digital health; citizen science; syndromic surveillance;  
76 anosmia.

77

78

## 79 **Main text**

### 80 **1. Introduction**

81 The COVID-19 pandemic is caused by the SARS-CoV-2, a newly identified enveloped RNA  $\beta$ -  
82 coronavirus<sup>1,2</sup>. Early on, pregnant women were regarded as a vulnerable group considered at  
83 greater risk of severe morbidity and mortality, based on previous studies of smaller coronavirus  
84 outbreaks, and the theoretical risks associated with relative immunosuppression of pregnancy<sup>3-5</sup>.  
85 However, a substantial literature has now documented that among hospitalized pregnant women,  
86 antecedent symptoms and risk factors for severe disease are similar to those outside pregnancy<sup>6</sup>,  
87 and few hospitalized pregnant women require admission to intensive care or intubation, although  
88 preterm birth, Caesarean delivery, and stillbirth may be increased compared with women without  
89 COVID-19, and vertical transmission possible (86 studies to 8 Jun 2020)<sup>7-10</sup>. SARS-CoV-2  
90 positive patients develop dry cough, fever, dyspnea, fatigue and bilateral lung infiltrates on imaging  
91 in the severe cases<sup>11</sup>. Hospitalized pregnant women positive for SARS-CoV-2 manifest similar  
92 symptoms<sup>7,12,13</sup>. However, little is known about pregnant women affected by SARS-CoV-2  
93 infection who recover in the community without hospitalization<sup>14</sup>.

94 Smartphone and web-based applications for population-based syndromic surveillance are citizen  
95 science tools that can facilitate rapid acquisition of extensive epidemiological data as a pandemic  
96 evolves<sup>15</sup>. These data can inform public-health policies, enhance the speed of the healthcare  
97 response, shape the community services, and alert the general population to urgent health threats<sup>16</sup>.  
98 Smartphone applications (apps) were used prior to the COVID-19 pandemic to remotely advise on  
99 prenatal health, and maternal health behaviors, including gestational weight gain and smoking  
100 cessation<sup>17</sup>. Many eHealth initiatives were launched at the onset of the pandemic, with most using  
101 single, one-off reporting methods to inform SARS-CoV-2 epidemiology<sup>18</sup>. We present findings  
102 from a unique, longitudinal symptom-tracking system that identified both test positive and

103 suspected (but untested) SARS-CoV-2 infected pregnant women in the community, who were  
104 followed prospectively to assess the need for hospitalization. Furthermore, we evaluated whether  
105 our findings could be replicated, using an independent, cross-sectional symptom survey tool.

106 We present data from pregnant women in the community who report testing positive for SARS-  
107 CoV-2, yet who presented a wide spectrum of disease manifestations and who rarely required  
108 hospitalization.

109 We sought to characterize the differences in the SARS-CoV-2 symptom profiles and severity  
110 between pregnant and non-pregnant women who did and did not receive hospitalization. In  
111 addition, we identified demographic characteristics and comorbidities that modified symptom  
112 severity of SARS-CoV-2 in pregnancy.

113

## 114 **2. Materials and methods**

### 115 **2.1 Study Populations**

116 **Discovery Cohort.** The COVID Symptom Study smartphone-based application (app), developed by  
117 Zoe Global Limited, and having more than four million users from the general population in UK,  
118 and around 50,000 from Sweden. Users self-report daily information about their overall health  
119 status, as well as a set of pre-specified symptoms<sup>19, 14</sup>. We included all pre-menopausal (if  
120 menopausal status was reported) women aged 18 to 44 years, who specified their pregnancy status  
121 at baseline (pregnant or not pregnant) included symptom profiles, outcomes on testing positive for  
122 SARS-CoV-2, and hospitalization.

123 **Replication Cohort.** The Facebook COVID-19 Symptom survey, launched in the USA and hosted  
124 by the Carnegie Mellon Delphi Research Center. The cross-sectional survey had 1,876,130 female  
125 respondents who indicated their pregnancy status and age 18-44 years<sup>20</sup>. Users specified if they had  
126 experienced specific symptoms over the last 24 hours, in addition to answering demographic and

127 infection-related questions. Survey weights were calculated to improve representation of the source  
128 population<sup>21</sup> (Supplementary Material 1).

## 129 **2.2 Pregnancy groups, symptoms, syndromes and outcomes**

130 **Pregnancy status:** Women were divided into pregnant and non-pregnant subgroups, based on self-  
131 reported pregnancy status, ascertained once near the start of follow-up in the discovery cohort, and  
132 at each survey for the replication cohort. Gestational age, at the time pregnancy was ascertained,  
133 was available only for the discovery cohort.

134 **COVID-19 Test and Suspected Positive:** Self-reported COVID-19 testing was used to identify  
135 women with SARS-CoV-2 infection (termed *test positive*). Test positives were considered  
136 *symptomatic positive* if they reported at least one of the tracked symptoms. The type of test (e.g.  
137 PCR, serology) was not ascertained, and those reporting a pending test were excluded.

138 Suspected positive cases were imputed, based on a previously published method for the  
139 computation of a test-positive prediction score<sup>14</sup>, retrained for pregnancy age distribution, and  
140 using a strict mapping scheme to equate symptoms ascertained in the discovery and replication  
141 cohorts. We defined the outcome of suspected COVID-19 (termed *suspected positive*) for anyone  
142 with a score-based imputation probability above a computed threshold (Supplementary Material 2).

143 **Hospitalization and Disease Severity:** Individuals were considered to have been hospitalized when  
144 they indicated being either admitted to or discharged from hospital in their daily reporting, within  
145 one week before/after reporting at least one of the tracked symptoms. Symptom severity was  
146 defined as the weighted sum of symptoms based on peak presentation when comparing individuals  
147 reporting hospital visit with individuals who did not, in the training set (Supplementary Material 3).  
148 The weighting was then normalized so that the severity index ranges from 0 (no symptom) to 1 (all  
149 symptoms). Symptoms were equated in the two cohorts.

## 150 **2.4 Statistical analysis**

151 A power analysis was conducted to assess the suitability of the samples size. To account for the  
152 difference in age distributions between pregnant and non-pregnant groups, age-standardization was  
153 performed, by calculating weights for the non-pregnant women, to standardize to the age-  
154 distribution of the pregnant population (Supplementary materials 4 and 5).

155 **Symptoms.** To explore differences in the symptom profile between pregnant and non-pregnant  
156 women who tested or were suspected positive for SARS-CoV-2 and who also required  
157 hospitalization or sought care, we applied univariate unconditional age-weighted logistic regression  
158 for each of 18 symptoms ascertained in either the discovery cohort, the replication or in both. We  
159 then conducted multivariate analysis on symptoms grouped into clusters by body system, as shown  
160 in Table 2, and normalized to range from 0 to 1.

161 **Severity of disease.** To assess symptom severity between pregnant and non-pregnant women who  
162 tested or where suspected positive for SARS-CoV-2 infection and were hospitalized, univariate  
163 unconditional age-weighted regression was applied to the pregnant and non-pregnant groups of the  
164 discovery cohort, with the severity index as a response variable. As hospitalization data were not  
165 available for the replication cohort, the analysis was repeated for this cohort among those who were  
166 ‘seen at a hospital for their symptoms’, conditional on those who predicted or tested positive for  
167 SARS-CoV-2.

168 **Hospitalization.** To reveal differences in the symptom profiles between hospitalized and non-  
169 hospitalized pregnant women positive for SARS-CoV-2, the frequency and percentage of women  
170 reporting each symptom were calculated for the discovery cohort. Symptoms were ranked from the  
171 most to the least frequently reported.

172 **Disease modifiers.** To identify demographic characteristics, comorbidities and pre-conditions  
173 associated with COVID-19 symptom severity in pregnancy, a multivariate unconditional regression  
174 was applied to each dataset, with the severity index as a response variable and age, diabetes, heart,

175 lung (and asthma) and kidney diseases as factors. As the regression investigated within-group  
176 factors, age-weighting was not applied. Bonferroni correction for multiple tests was applied.

177 Statistical analyses were performed using STATA version 16 (discovery cohort) and R 3.6.3  
178 (replication cohort).

179

### 180 **3. Results**

181 **Cohort Characteristics and COVID-19 Outcomes.** The discovery cohort (N=400,750  
182 participants) includes records from 14,049 pregnant and 386,701 non-pregnant women who had an  
183 average duration of follow-up of 11 days and contributed to an average of 6.6 reports per woman.  
184 Among the 45% of pregnant women who self-reported their gestation week at baseline, 14% were  
185 in the first trimester, 43% were in the second trimester, and 43% were in the third trimester. The  
186 replication cohort (N= 1,344,966 reports) included about 149 thousand surveys administered to  
187 women each week over 9 weeks. There were 41,796 surveys from women who indicated they were  
188 pregnant (3.2% of the source population). Demography was consistent with US age-specific  
189 pregnancy rates and stable over the survey period  
190 (<https://www.cdc.gov/nchs/data/databriefs/db136.pdf>).

191 Demographic details are shown in Table 1, together with testing rates. In the discovery cohort, we  
192 identified 629 and 25,061 pregnant and non-pregnant women, respectively, who were suspected  
193 positive for SARS-CoV-2 infection based on the symptom-score-based imputation method. Of  
194 these suspected positive, 21 and 591 were hospitalized, respectively. In the replication cohort, the  
195 proportion of 1,076 (2.9%) suspected positive pregnant was slightly lower compared to 44,772  
196 (4.0%) suspected positive non-pregnant.

197 In the replication cohort, age-standardized testing proportions increased over time overall from the  
198 study launch (1.5%) through the most recent week (3.8%) as access to testing increased. Coincident

199 with the decline in COVID-19 infection in many areas of the USA over the study period, the  
200 number of suspected positive individuals imputed using the symptom score declined from 4.4% to  
201 2.9%.

202 *Insert Table 1 about here*

203 Validation of the imputation method in a subset of the discovery cohort, and in the replication  
204 cohort is depicted in Figure 1, with additional sensitivity analyses in Supplementary Material 2.

205 *Insert Figure 1 about here*

206 **Symptomatic, Syndromic and Severity Predictors:** Frequency of symptoms and body system  
207 clusters is reported in Table 2, and graphically in Figure 2. In the discovery cohort, the most  
208 frequent symptoms in the hospitalized pregnant women positive for SARS-CoV-2 were persistent  
209 cough, headache and anosmia (all 80.0%), chest pain (73.3%), sore throat and fatigue (66.7%). In  
210 the replication cohort, among pregnant test positive women who were seen at the hospital for their  
211 illness, the most frequent symptoms were fatigue (87.5%), cough (84.6%), nausea or vomiting  
212 (78.2%), muscle pain (76.2) and anosmia (75.2%).

213 *Insert Table 2 about here*

214 In the discovery cohort, univariate analysis on each symptom found significant effect of pregnancy  
215 for decreased cases of *skipped meals* ( $t=-9.8$ ) and of *delirium* ( $t=-16.2$ ) but not for the other  
216 symptoms. Multivariate logistic regression found lower frequency of neurologic symptoms ( $t=-7.6$ )  
217 for the hospitalized pregnant vs. non pregnant women. In the replication cohort, pregnancy status  
218 was most strongly associated with increased *nausea or vomiting* ( $t=+10.9$ ) and the *gastrointestinal*  
219 cluster ( $t=+6.0$ ), even among those seen at a hospital for their illness ( $t=+4.1$  and  $t=+3.7$ ,  
220 respectively), indicating how questions are asked can impact symptom profiles in this population.  
221 Other symptoms common in pregnancy including *shortness of breath* ( $t=+5.1$ ) and *nasal congestion*

222 (t=+3.6) were also predictive of pregnancy status (all age-standardized and p<5e-05 Bonferroni  
223 corrected).

224 *Insert Figure 2 about here*

225 Univariate weighted regression also showed that pregnancy had no statistically significant effect on  
226 the severity of manifestation of SARS-CoV-2 infection, when expressed as ‘severity index’ in both  
227 cohorts (p>0.001, uncorrected to test the null hypothesis). In the discovery cohort, overall duration  
228 of disease was similar for pregnant and non-pregnant women. However, time to peak of symptom  
229 manifestation was longer in pregnant women (mean time = 2.8 days) than in non-pregnant (2.2  
230 days, p=5.5e-7). In the replication cohort, pregnant women who tested positive and reported being  
231 seen at the hospital similarly reported a longer duration of illness.

232 As mentioned above, in the discovery cohort hospitalized positive pregnant women manifested  
233 persistent cough, headache and anosmia (all 80%), chest pain (73.3%), sore throat and fatigue  
234 (66.7%) as the most frequent symptoms. Non-hospitalised pregnant women positive for SARS-  
235 CoV-2 reported headache (71.9%), anosmia (62.5%), persistent cough (57.8%) and skipped meals  
236 (48.4%) most commonly (Figure 3). See Supplementary Material 6 for full list of symptoms and  
237 their associated prevalence.

238 *Insert Figure 3 about here*

239 **Comorbidities:** Lung disease was the comorbidity that most impacted on the severity of symptoms  
240 in pregnant positive women (t=4.1 for discovery cohort; t=14.1 for replication cohort, all p-  
241 val<0.0001 Bonferroni corrected).

242 *Insert Table 3 about here*

243 In the replication cohort heart disease ( $t=7.1$ ) also impacted on the severity of symptoms, followed  
244 by kidney disease ( $t=4.6$ ) and diabetes ( $t=3.6$ , all significant after Bonferroni correction at  $p$ -  
245  $val<0.0001$ ).

#### 246 **4. Discussion**

247 **Principal Findings.** We studied two large cohorts of women with self-reported pregnancy status,  
248 symptoms and COVID-19 outcomes through participative surveillance. Pregnant women reported  
249 more frequent testing for SARS-CoV-2, but generally did not experience more severe disease.  
250 Disease trajectories were similar, and the time from onset to peak of symptoms was only slightly  
251 longer in pregnant than non-pregnant women (2.8 vs. 2.2 days).

252 Gastrointestinal symptoms were different in pregnant and non-pregnant women with poor  
253 outcomes, with decreased *skipped meals* in the discovery cohort and increased *nausea or vomiting*  
254 in the replication cohort. Neurologic symptoms (only surveyed in the discovery cohort) were  
255 decreased in pregnant women while *nasal congestion* (only surveyed in the replication cohort) was  
256 increased.

257 The current epidemiologic literature is largely based on pregnant women admitted to the hospital,  
258 which provides a narrow view of the spectrum of SARS-CoV-2 infection in all pregnant women.  
259 Our data show the preponderance of test positive and even suspected positive pregnant women were  
260 not seen at or admitted to the hospital for their illness; most pregnant women reported they recover  
261 in the community, as was observed by Lokken et al.<sup>22</sup>. Cardiopulmonary symptoms were more  
262 frequently reported by pregnant women who were hospitalised. Notably, pre-existing lung disease  
263 was confirmed as the major risk factor to develop more severe COVID-19 in pregnancy, as it is  
264 outside of pregnancy. Heart disease, kidney disease and diabetes were also risk factors.

265 Contextually, we developed a symptom-based prediction method to identify suspected COVID-19  
266 cases among women 18-44 years of age, and validated this in an independent cohort with different  
267 symptom sets and reporting methodology.

268 **Results in the context of what is known.** Pregnant women are considered a high-risk group in UK  
269 and were considered high risk in the USA early in the pandemic. This likely contributed to the  
270 higher testing proportion but lower positives results among pregnant women vs. non-pregnant.  
271 Hospitalized pregnant women presented lower frequency of neurologic symptoms, especially  
272 *delirium*, which were only measured in the discovery cohort. The replication cohort showed higher  
273 frequency of *gastrointestinal* symptoms among pregnant women with more severe outcomes,  
274 especially *nausea or vomiting* in pregnancy, which may be a feature of pregnancy itself (e.g.  
275 hyperemesis gravidum). Diarrhoea in positive pregnant women has been previously reported (rates  
276 between 8.8% and 14%)<sup>23,24</sup>.

277 Disease severity did not differ between pregnant and non-pregnant women in both datasets. This  
278 posits an equivalent manifestation of SARS-CoV-2 infection in pregnant and non-pregnant, as  
279 already reported by Chen and others<sup>9,12</sup>.

280 Pre-existing lung disease is the comorbidity with strongest impact on the SARS-CoV-2 infection  
281 severity in pregnant women in both cohorts. Lokken et al.<sup>22</sup> similarly reported asthma as a primary  
282 risk factor for severe COVID-19 in pregnancy. Heart disease, kidney diseases and diabetes were  
283 also associated with severity in the replication cohort which had high enough prevalence of these  
284 conditions (related to survey-sampling to the general population) to detect an effect. These  
285 comorbidities are consistent with risk factors in the general, non-pregnant population; Li et al.  
286 observed chronic obstructive pulmonary disease, diabetes, hypertension, coronary heart disease and  
287 cerebrovascular diseases had the highest odd ratio for SARS-CoV-2 and admission to the intensive

288 care unit (ICU) <sup>25</sup>, while Kumar et al. found diabetes increased SARS-CoV-2 severity and mortality  
289 two-fold <sup>26</sup>.

290 Cough, chest pain and dyspnea showed much higher incidence in the hospitalized pregnant women,  
291 indicating that cardiopulmonary symptoms are the major discriminant for hospitalization. Similarly,  
292 Ellington et al <sup>27</sup>, found increased ICU admissions and need of mechanical ventilation in pregnant  
293 women, although the cohort studied had higher frequency of underlying medical conditions, and  
294 might be less representative of the general pregnant population.

295 **Clinical implications.** Pregnant women with pre-existing lung disease or prominent  
296 cardiopulmonary symptoms may need special attention during the COVID-19 pandemic; lung  
297 disease had strongest impact on disease severity while cardiopulmonary symptoms were the major  
298 discriminant for hospitalization in pregnancy. Indeed, in pregnancy, cardiopulmonary reserve is  
299 limited which increases morbidity and complicates management when there are added physiologic  
300 stressors (e.g. asthma exacerbation) <sup>28-30 31</sup>. Diabetes was more common in the pregnant women in  
301 our cohorts, likely related to gestational diabetes. We confirmed diabetes is associated to increased  
302 severity of SARS-CoV-2 presentation <sup>32</sup>.

303 **Research implications.** This study leveraged two cohorts followed through remote, participatory  
304 epidemiology, enabling rapid assessment of COVID-19 in pregnancy. The longitudinal nature of the  
305 discovery dataset enabled the comparison of disease duration, time from onset to peak of symptoms,  
306 and hospitalization between pregnant and non-pregnant women, prospectively. Broadly, pregnancy  
307 does not substantially contribute to morbidity. Clinicians should be more vigilant with pregnant  
308 who have pre-existing health conditions, prominent respiratory symptoms or a higher severity index  
309 -- as is the case in the general population. Further studies specifically targeting high-risk  
310 pregnancies and outcomes across the three trimesters may be warranted, to better define outcomes  
311 in this population. Also, we point out the need to interpret hospitalization rates and severity results  
312 in light of the policy changes, which can be dependent on the context or country.

313 **Strengths and limitations.** Participatory surveillance tools are crucial to epidemiological research  
314 and citizen science, as they increase population's awareness of urgent public health risks, promote  
315 public participation into science and enable inclusion in studies of large samples from the  
316 community within short time periods. Real-time public health data has been crucial in decision-  
317 making during the COVID-19 pandemic. However, user of smartphone applications and web-based  
318 surveys may not be representative of the general population, potentially limiting generalizability.  
319 Self-reported events may suffer from misclassification bias, which may be differential. The  
320 replication cohort was designed to be representative of the social media site user-base (the vast  
321 majority of US population), and it showed similar results to the detailed longitudinal discovery  
322 cohort of technology-aware smartphone users. Additionally, we applied age-standardization to  
323 account for demographic structure inherent to pregnancy. Despite the differences in the UK,  
324 Sweden and USA testing guidelines and healthcare systems, morbidity with COVID-19 in  
325 pregnancy were comparable. While the timing and symptoms profiled varied across platforms, we  
326 were able to develop and validate a prediction score for suspected positive, as well as a severity  
327 score for use in women of childbearing age. This may be useful for obstetricians in the context of  
328 limited access to SARS-CoV-2 testing during this pandemic.

329 **Conclusions.** Our findings from two large real-time syndromic surveillance technologies provide  
330 no evidence that pregnant women positive for SARS-CoV-2 are at higher risk of developing either  
331 increased morbidity or complex symptomatology compared with non-pregnant women. However,  
332 pre-existing lung disease or prominent cardiopulmonary symptoms may exacerbate  
333 cardiopulmonary stress of pregnancy. Pregnant women with comorbidities appear to be at increased  
334 risk for severe disease, consistent with evidence from COVID-19 infection in the general  
335 population.

336

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457 Table 1. Characteristics of the two cohorts, presented as percentages and means (standard  
 458 deviations) in the cohorts. Except for group age, percentages and means are age standardized to the  
 459 pregnant population age distribution in each cohort. Adjustment for survey weights was applied to  
 460 the replication cohort. Self-report of being seen at a hospital was used as a proxy for hospitalization  
 461 in the replication cohort.

	Discovery Cohort			Replication Cohort		
	All (N=400, 750)	Non- pregnant (N=386,70 1)	Pregnant (N=14,04 9)	All (N=1,34 4,966)	Non- pregnant (N=1,303,1 70)	Pregnant (N=41,796)
Age (years) (not age- standardized)	32.1 (7.2)	32.1 (7.3)	32.4 (4.9)	29.0 (0.02)	29.0 (0.01)	29.0 (0.05)
Tested	7.0%	6.1%	8.0%	2.5%	2.4%	2.7%
Positive	0.6%	0.7%	0.6%	0.4%	0.4%	0.4%
Negative	5.5%	4.9%	6.2%	2.2%	2.1%	2.2%
Suspected	5.6%	6.7%	4.5%	3.5%	4.0%	3.0%
Comorbidities						
Diabetes	1.8%	1.2%	2.3%	3.9%	3.5%	4.3%
Lung	12.9%	12.8%	11.3%	19.3%	19.8%	18.8%
Heart	0.6%	0.5%	0.6%	0.8%	0.9%	0.7%
Kidney	0.3%	0.4%	0.3%	0.6%	0.7%	0.5%
Cancer	0.1%	0.2%	0.1%	0.9%	1.1%	0.8%
Symptom Severity	0.07 (0.11)	0.07 (0.11)	0.04 (0.09)	0.08 (0.0005)	0.08 (0.0003)	0.07 (0.001)
Test positive and hospitalized*	0.09%	0.07%	0.1%	0.06 %	0.03%	0.09%
Suspected positive and Hospitalized*	0.16%	0.16%	0.15%	0.17 %	0.12%	0.23%

462 \* Hospitalization not queried in replication cohort. Proportion of who tested positive or were  
463 suspected positive and who reported seeking care at a hospital for symptoms in the prior 24 hours  
464 provided as a proxy.

Table 2. Frequencies and percentage values of presentation of each symptom among hospitalized in the discovery cohort, and among all women who self-reported being seen at a hospital for their illness in the replication cohort (as hospitalization data were not available). Data are reported by pregnancy status and further subdivided by SARS-CoV-2 test positive or suspected COVID-19 status. Data are reported as N (%) in the discovery cohort, and N surveys (survey-weight adjusted %) in the replication cohort. *Fatigue* was mapped to *tiredness/exhaustion* and *unusual muscle pain* to *pain in muscle and joints* in the replication cohort. Symptoms not ascertained or mapped in either cohort are marked as not available (NA).

Cluster (body system)	Symptom	Discovery Cohort				Replication Cohort			
		Hospitalised non pregnant positive (N=229)	Hospitalised non pregnant suspected positive (N=591)	Hospitalised pregnant positive (N=15)	Hospitalised pregnant suspected positive (N=21)	Seen at hospital, non-pregnant positive (N=300-)	Seen at hospital, non-pregnant suspected positive (N=1395-)	Seen at hospital, pregnant positive (N=29)	Seen at hospital, pregnant suspected positive (N= 75-)
Inflammation	Fever	151 (65.9)	359 (60.7)	8 (53.3)	12 (57.1)	135 (48.1)	514 (39.0)	12 (50.6)	19 (29.9)
	Unusual muscle pain	121 (52.8)	338 (57.2)	9 (60.0)	9 (42.9)	199 (69.0)	1,048(77.0)	19 (76.2)	52 (71.8)
	Fatigue	125 (54.6)	345 (58.4)	10 (66.7)	8 (38.1)	207 (65.9)	1,142(79.8)	24 (87.5)	161 (84.0)
Neurologic	Headache	185 (80.8)	516 (87.3)	12 (80.0)	17 (81.0)	NA	NA	NA	NA

	Delirium	88 (38.4)	253 (42.8)	4 (26.7)	1 (4.8)	NA	NA	NA	NA
Cardiopulmonary	Dyspnea	113 (49.3)	316 (53.5)	9 (60.0)	11 (52.4)	166 (54.8)	913(65.1)	20 (73.6)	47 (66.9)
	Persistent cough	178 (77.7)	438 (74.1)	12 (80.0)	19 (90.5)	202 (68.2)	1,161 82.3	24(84.6)	61 (81.0)
	Chest pain	170 (74.2)	463 (78.3)	11 (73.3)	14 (66.7)	156 (53.2)	787(56.8)	17 (62.3)	34 (51.9)
	Difficulty breathing	NA	NA	NA	NA	144 (47.7)	710 (51.6)	16 (56.0)	36 (55.1)
Oropharyngeal	Hoarse voice	117 (51.1)	309 (52.3)	6 (40.0)	11 (52.4)	NA	NA	NA	NA
	Sore throat	148 (64.6)	371 (62.8)	10 (66.7)	14 (66.7)	118 (38.3)	552(39.1)	15 (59.0)	29 (46.7)
	Nasal congestion	NA	NA	NA	NA	146 (48.4)	719 (51.5)	19 (61.5)	45 (56.2)
	Runny nose	NA	NA	NA	NA	116 (35.9)	636 (48.5)	14 (57.0)	33 (51.4)
Anosmia/ageusia	Anosmia	177 (77.3)	481 (81.4)	12 (80.0)	19 (90.5)	182 (63.1)	786 (56.7)	20 (75.2)	47 (70.4_)
Gastrointestinal	Skipped meals	153 (66.8)	400 (67.7)	7 (46.7)	11 (52.4)	NA	NA	NA	NA
	Abdominal pain	115 (50.2)	274 (46.4)	9 (60.0)	10 (47.6)	NA	NA	NA	NA
	Diarrhoea	126 (55.0)	275 (46.5)	7 (46.7)	11 (52.4)	137 (49.2)	611(44.4)	17 (59.8)	39 (56.1)

	Nausea or vomiting	NA	NA	NA	NA	138 (49.4)	633 (49.8)	21 (78.2)	51 (79.4)
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Table 3. Frequencies and percentages of comorbidities and pre-existing conditions in the discovery and replication cohorts. Columns refer to pregnant women tested and suspected positive for SARS-CoV-2 infection. Data are reported as N (%). Data from the replication cohort are reported as N surveys (survey-weight adjusted %). Conditions not ascertained or mapped in either cohort are marked as not available (NA).

Comorbidity or pre-existing condition	Discovery Cohort		Replication Cohort	
	Pregnant test positive (N=79)	Pregnant suspected positive (N=629)	Pregnant test positive (N=134)	Pregnant suspected positive (N=1076)
Diabetes	3 (3.8)	15 (2.4)	11 (8.9)	76 (7.4)
Lung disease	8 (10.1)	80 (12.7)	37 (31)	376 (34.2)
Heart disease	1 (1.3)	5 (0.8)	5 (6.3)	41 (4.8)
Kidney disease	0 (0.0)	2 (0.3)	8 (7.8)	30 (43.3)
Hypertension	NA	NA	17 (13.9)	170 (15.4)
Autoimmune	0 (0.0)	8 (1.3)	14 (11.5)	106 (9.3)
Cancer	0 (0.0)	1 (0.2)	5 (4.7)	29 (3.2)
Smoking / Past smoker	6 (7.6) 13 (16.5)	36 (5.7) 121 (19.2)	NA	NA

Figure 1. Receiver Operating Characteristics curve showing validation of the imputation of SARS-CoV-2 test status using the mapped symptom score probability in the replication cohort. Area under the curve is 74%.

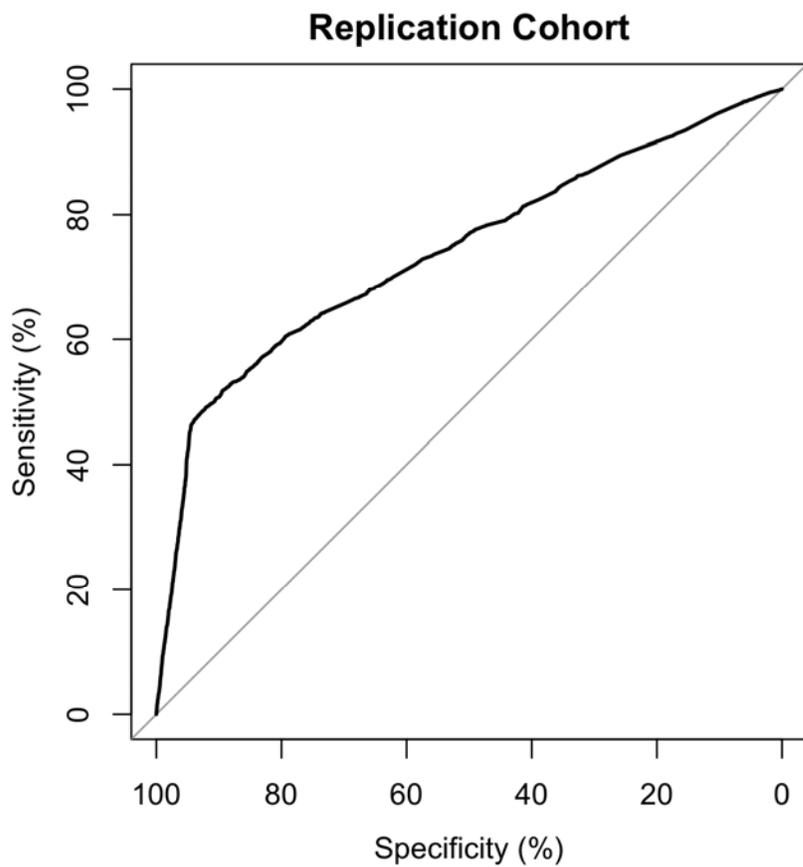


Figure 2. Comparison of symptoms presentation in the discovery (DC) and replication (RC) cohorts. Results refer to non-pregnant (orange) and pregnant (blue) women tested positive and suspected positive for SARS-CoV-2 and who required hospitalization (in DC, darker shade) or were seen at the hospital (RC, lighter shade). Results are reported as age-standardized percentage of women reporting each symptom in each subcohort.

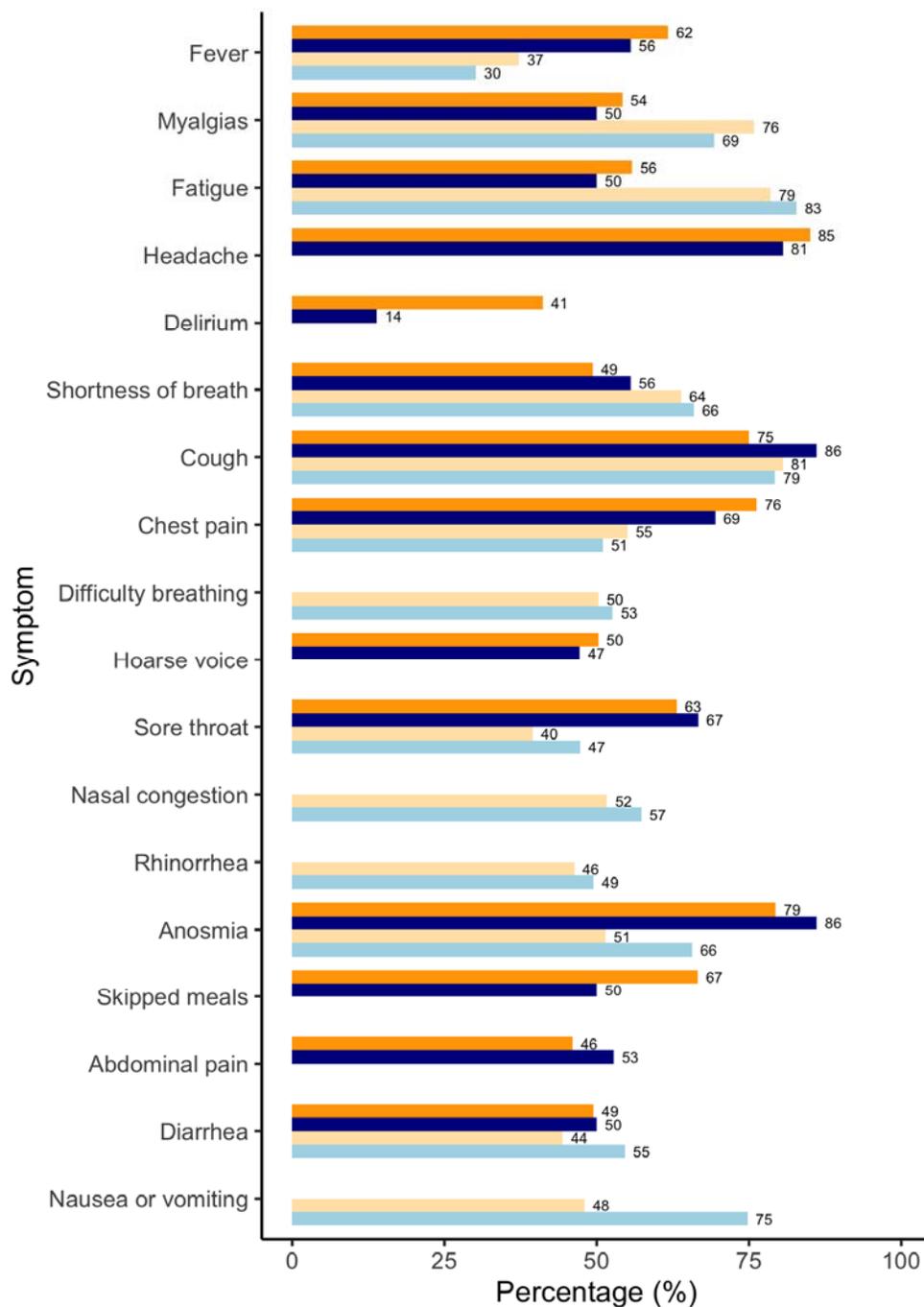


Figure 3. Symptom profile of hospitalized and non-hospitalized pregnant and non-pregnant women positive and suspected positive to SARS-CoV-2 in the discovery cohort. Results are reported in percentage of women reporting each symptom in each group.

