Antenatal care services and pregnancy outcomes during the COVID-19 pandemic in Milan, Lombardy, Italy

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Abstract

Background. During the COVID-19 pandemic maternity healthcare seeking and provision reduced worldwide. We explored the indirect effects of the pandemic on key pregnancy outcomes and access to antenatal care services.

Methods. Observational cross-sectional study on all pregnancies between years 2019-2020 in Milan metropolitan area (Lombardy, Italy). Multiple logistic regression analysis was used to assess the access to antenatal care (ANC) services (timing of first contact, ultrasound examinations (US) and ANC contacts) and pregnancy outcomes (preterm births, perinatal deaths and surgically treated ectopic pregnancies). Data were retrieved from both administrative (public healthcare) and self-reported sources (public and private services).

Results. The first antenatal contact was slightly delayed in pandemic year 2020. Adequate levels of antenatal care were maintained according to self-reported data, though a decrease in public healthcare was noted (administrative data). Perinatal death and preterm birth risk did not worsen, while it increased for surgically managed ectopic pregnancies.

BACKGROUND

Italy was one the European country most affected by the COVID-19 pandemic in 2020, especially in the study area located in Milan metropolitan area, Lombardy [1]. On 8th March 2020, the Lombardy region issued severe containment measures which were later extended to a nationwide lockdown until 18th May 2020. A second outbreak, with ensuing restrictions, took place between October 2020 and January 2021. Indeed, restrictions due to the pandemic took place in many nations, with different starting date and durations, on a global scale. The two pandemic waves had profound impact on the national health service, with staff reorganization and pause or postponement of all elective surgical activities and outpatient clinics. The extraordinary burden on the healthcare system concerned the delivery of all services, including women's health services. For example, it is known that decreased or delayed surgical procedures, cancer screening tests and outpatient appointments led to a significant decline in cancer diagnosis and overall poorer outcomes for oncologic patients [2]. Being pregnancy essentially time-sensitive, pregnant women were particularly vulnerable to altered or delayed access to care. With childbirth representing the first reason for hospital admission [3], maternity services are known to be a key index in healthcare system policies. During the COVID outbreak maternity care was regarded as non-deferrable both by national [4-6] and international recommendations [7, 8]. However, the modifications in social and healthcare policies inevitably influenced access to care with consequences on perinatal outcomes [9, 10]. Reduced maternity healthcare-seeking and provision were reported in the majority of studies [11-15]. Several changes in key maternal and perinatal outcomes were noted worldwide. Overall, maternal mortality, stillbirths and ruptured ectopic pregnancies increased, with substantial differences between high income (HIC) and low or middle income countries (LMIC) [16]. In HIC stillbirth figures were found to be either increased [17-19] or unchanged [20], while several reports pointed towards a decrease in preterm births (PTB) [16, 18, 20]. Alongside pregnancy care, also abortion care was deemed essential both by major societies [21, 22] and national authorities [5]. However, in Italy no details were provided on how to maintain access to voluntary termination of pregnancy (TOP), leading to unequal abortion care in the country [23]. Furthermore, the pandemic increased social disparities and highlighted

- Key words
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- COVID-19
- prenatal care
- maternal health services
- public health

the difference in access to care between autochthonous pregnant women and immigrants [24, 25]. Overall, the indirect effects of the restrictions brought by the pandemic waves were manyfold, sometimes even conflicting.

Therefore, the aim of the study was to explore how the COVID-19 pandemic and ensuing lockdown impacted on pregnancy outcome and access to care in Milan metropolitan area.

MATERIALS AND METHODS

An observational cross-sectional study was conducted. The population included in the study is the female population residing in the provinces of Milan and Lodi and served by the Health Protection Agency of Milan (Agenzia per la Tutela della Salute, ATS). Eligible women had an admission to hospital either for birth, spontaneous abortion or voluntary TOP between January 2019 and December 2020. Information regarding maternal access to care and pregnancy outcomes was retrieved combining data from the datawarehouse (DWH) which structures all healthcare administrative data sources and from birth certificates ("Certificato di assistenza al parto", CedAP [26]) filled out at delivery based on self-reported information. The information coming from the Civil Registry (Nuova anagrafe regionale, NAR) of women was integrated with the information from the permanent georeference system, developed and maintained by the Epidemiology Unit of the ATS of Milan. Thus, it was possible to integrate the information from the Population and Home Census of 2011 and, in particular, the deprivation index, based on census tract. The deprivation index is a composite measure on aggregate data considered a proxy of social disadvantage. It incorporates five socioeconomic indicators such as low level of education, being unemployed, living in rent, overcrowding, single-parent family. It is categorized into five quintiles, from the least (first quintile) to the most (fifth quintile) deprived [27, 28].

An information system was created for the current evaluation integrating all the described sources, with deterministic record linkage using the anonymized individual code present in the data warehouse systems of the ATS of Milan.

Data retrieved comprised access to routine antenatal care (timing of first antenatal contact, number of ANC contacts, ultrasound examinations and invasive procedures), pregnancy outcomes (birthweight, gestational age at birth, livebirth, stillbirth or neonatal death, mode of conception), spontaneous abortion, TOP and associated modality (medical *vs* surgical) and management of ectopic pregnancy (medical *vs* surgical). Stillbirth was defined as the absence of fetal cardiac activity on ultrasound examination after 24 weeks of gestation. Neonatal death (NND) was defined as death among livebirths during the first 28 completed days of life. Perinatal death comprised both stillbirths and NND.

First, data were analyzed using descriptive statistics, computing mean and standard deviation for continuous variables, frequency distribution for categorical variables. Categorical variables were compared between pre-pandemic year 2019 and pandemic year 2020 us-

ing the chi-square test, continuous variables using the Mann-Whitney U test. Then the change in access to ANC between the two years (pre-pandemic vs pandemic) was modelled using logistic regression, considering thresholds aligned with national guidelines [3], that identify at least four ANC contacts and two ultrasound (US) examinations in normal pregnancy. Therefore, poor antenatal care was defined as less than four appointments and less than two US examinations in pregnancies ended with delivery of a liveborn or stillborn. Inadequate timing of first ANC contact was defined as first booking after the 14th week of gestation. Considered covariates were: year (pre-pandemic vs pandemic), maternal country of birth (foreigner vs Italian), place of residence (Milan vs hinterland), index of deprivation (ID), pregnancy from assisted reproductive technology (ART) vs spontaneous pregnancy, age subgroup (less or equal to 25, 26-30, 31-35, more than 35). The censusbased ID was categorized in quintiles, with the fifth quintile representing the most deprived municipalities [28]. Italian citizenship, Milan residence, an ID of 1, spontaneous pregnancy, pre-pandemic year 2019 and age subgroup of 30-34 were considered as reference. Analyses were carried out on three different datasets: the whole two-years cohort (n=55,590 pregnancies) for timing of first ANC contact; a sub-cohort of all ectopic pregnancies (n=363) for surgically managed ones; a sub-cohort of all pregnancies ended in the delivery of a liveborn/stillborn (n=43,638 pregnancies) for preterm births, perinatal deaths, appropriate levels of ANC contacts and US examinations. Missing data were assumed to be missing at random and not included in the analyses. All analyses were done using SAS Enterprise version 9.4. Ethics committee approval was not required as the data were collected as part of the service and pseudonymized data were included.

RESULTS

A total of 55,590 conceptions were analyzed in the study period, 43,638 births and 11,952 abortions respectively. Population characteristics are shown in *Table 1*. The population is slightly younger in the prepandemic period (p<0.001), with a slightly higher proportion of unemployed (p<0.001), low-education mothers (p<0.001), low-education father (p<0.05) and mother with foreign citizenship (p<0.05), while the figures of father work status, women living in Milan and deprivation indices were comparable (p-values 0.3, 0.3 and 0.4).

There was a decreasing trend in conceptions, ranging from 30,007 pregnancies in 2019 to 25,583 in 2020 (*Table 1*). Abortion figures decreased accordingly (*Supplementary Table 1 available online as Supplementary Materials*): from 3,504 (50.4%) TOP in 2019 to 2,428 (48.6%) in 2020 and from 3,268 (47%) spontaneous abortions in 2019 to 2,389 (47.8%) in 2020. No change in TOP modality was noted, for medical and surgical treatment did not significantly differ over the two years (p-value 0.6). Ectopic pregnancies in need of surgical treatment increased in 2020: 126 (69.2%) as opposed to 113 (62.5%) in 2019, though the change in management did not reach significance (p-value 0.2) (*Supplementary Table 1 available online as Supplementary Materials*).

Table 1

Distribution of population characteristics over the study period

Population characteristics	2019 (n=30,007)	2020 (n=25,583)	p value
Maternal age class			
25 years	3,401 (11.4%)	2,599 (10.2%)	<0.001
26-30 years	5,678 (19%)	4,800 (18.8%)	
31-35 years	9,539 (31.9%)	8,455 (33.1%)	
>35 years	11,316 (37.8%)	9,686 (37.9%)	
Mother, work status			
Employed	14,364 (47.9%)	13,172 (51.5%)	<0.001
Unemployed	6,864 (22.9%)	5,789 (22.6%)	
Unknown	8,779 (29.2%)	6,622 (25.9%)	
Mother, education level			
Low	3,881 (12.9%)	3,129 (12.2%)	<0.001
Middle	8,259 (27.6%)	7,284 (28.5%)	
High	9,078 (30.3%)	8,542 (33.4%)	
Unknown	8,789 (29.2%)	6,628 (25.9%)	
Father, work status			
Employed	19,939 (66.4%)	17,762 (69.4%)	0.3
Unemployed	1,289 (4.3%)	1,199 (4.7%)	
Unknown	8,779 (29.3%)	6,622 (25.9%)	
Father, education level			
Low	5,034 (16.8%)	4,334 (16.9%)	0.04
Middle	8,787 (29.3%)	7,846 (30.7%)	
High	7,047 (23.5%)	6,489 (25.4%)	
Unknown	9,139 (30.4%)	6,914 (27%)	
Town of residence			
Milan	13,091 (43.7%)	11,046 (43.2%)	0.3
Outside Milan	16,916 (56.3%)	14,537 (56.8%)	
Citizenship			
Italian	19,804 (66%)	17,274 (67.5%)	<0.001
Foreign	10,203 (34%)	8,309 (32.5%)	
Deprivation Index			
Very affluent	3,184 (10.6%)	2,824 (11%)	0.4
Affluent	5,271 (17.6%)	4,449 (17.4%)	
Average	7,086 (23.6%)	5,963 (23.3%)	
Deprived	7,139 (23.8%)	6,098 (23.8%)	
Severely deprived	5,716 (19%)	4,786 (18.8%)	
Unknown	1,611 (5.4%)	1,463 (5.7%)	

Data are presented as number of cases and percentages. Chi-square test for categorical variables.

Birth figures also mirrored the decrease in conceptions, from 23,115 in 2019 to 20,616 in 2020 (Supplementary Table 1 available online as Supplementary Materials). Of all births, preterm deliveries significantly decreased in the study period: from 1,370 (5.9%) in 2019 to 1,120 (5.5%) in 2020. Stillbirth figures also reduced in 2020 (15 deaths, 0.07%), unlike year 2019 in which there were 38 (0.16%) stillbirths. There were 4 neonatal deaths (0.02%) in 2019 and 6 (0.03%) in 2020 (Supplementary Table 1 available online as Supplementary

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Materials). Though decreased, there was no significant change in trend for ART vs spontaneous conceptions (p-value 0.8).

Supplementary Table 2 available online as Supplementary Materials shows outpatient access to care, according to administrative and self-reported data. There were less US examinations in 2020 according to administrative data (mean 3.5 vs 3.7 in 2019), while women reported an increase from a mean of 5.8 US examinations in 2019 to 5.9 in 2020. Information regarding the week of first US examination came from administrative data only and showed a significant delay from 15.8 weeks' gestation in 2019 to 16.2 in 2020. ANC contacts mirrored the same trends: there was a decrease according to administrative data (mean 4.7 in 2019 vs 4.6 in 2020), while according to self-reported data ANC contacts did not decrease (mean 7.2 ANC contacts both in 2019 and 2020). Similarly, a delayed first ANC contact was noted only according to administrative data (mean 17.1 weeks' gestation in 2019 vs

17.6 weeks in 2020) and not by self-reported data (7.9 weeks' gestation both in 2019 and 2020). Finally, all invasives procedure decreased altogether with the decrease in conceptions. Chorionic villous sampling figures maintained from 2019 to 2020, while there was an increase (though not significant) in amniocentesis: from 1.9% in 2019 to 2.1% in 2020.

Results indicated that pandemic year 2020 resulted into higher odds of delayed first antenatal booking (aOR 1.08: 95% CI 1.04-1.13 and aOR 1.19: 95% CI 1.05-1.34 respectively) according to both administrative and self-reported data sources (Table 2). There was increased risk of inadequate antenatal care contacts according to administrative data only: at multiple analysis, year 2020 showed an aOR of 1.09 (95% CI 1.04-1.14) for less than four ANC contacts. Results are shown in Table 2. The recommended number of ANC contacts was associated with foreign citizenship (aOR 0.31; 95% CI 0.30-0.33), younger age (aOR 0.83; 95% CI 0.75-0.91) and growing deprivation in-

Table 2

Logistic regression analysis for antenatal care services (timing of 1st contact, number of ANC contacts and US examinations) in pregnancy and associated covariates, both administrative and self-reported data

	1st ANC contact >14 weeks		<4 ANC contacts		<2 US examinations	
	Administrative OR (95% CI)	Self-reported OR (95% CI)	Administrative OR (95% CI)	Self-reported OR (95% CI)	Administrative OR (95% CI)	Self-reported OR (95% CI)
Year						
2019	1#	1#	1#	1#	1#	1#
2020	1.08 (1.04-1.13)	1.19 (1.05-1.34)	1.09 (1.04-1.14)	0.82 (0.74-0.91)	1.36 (1.27-1.45)	0.71 (0.57-0.88)
Residence						
Municipality of Milan	1#	1#	1#	1#	1#	1#
Outside	1.28 (1.23-1.34)	1.16 (1.02-1.32)	1.44 (1.36-1.52)	0.80 (0.72-0.89)	0.89 (0.83-0.96)	1.26 (1.00-1.59)
Citizenship						
Italian	1#	1#	1#	1#	1#	1#
Foreign	0.72 (0.68-0.75)	5.03 (4.35-5.81)	0.31 (0.30-0.33)	2.07 (1.85-2.30)	0.54 (0.50-0.59)	1.95 (1.55-2.45)
Age class						
<25 years	0.94 (0.87-1.02)	3.02 (2.53-3.60)	0.83 (0.75-0.91)	1.64 (1.39-1.93)	0.75 (0.65-0.87)	1.97 (1.44-2.69)
26-30 years	0.91 (0.86-0.97)	1.40 (1.17-1.68)	0.84 (0.79-0.91)	1.14 (0.99-1.32)	0.79 (0.71-0.87)	1.01 (0.74-1.37)
31-35 years	1#	1#	1#	1#	1#	1#
>35 years	0.94 (0.90-0.98)	1.28 (1.08-1.53)	1.05 (0.99-1.11)	1.13 (0.99-1.29)	1.12 (1.04-1.21)	0.93 (0.70-1.24)
Deprivation index						
Very affluent	1#	1#	1#	1#	1#	1#
Affluent	0.93 (0.87-1.01)	1.39 (1.01-1.92)	0.84 (0.76-0.92)	1.19 (0.96-1.47)	0.81 (0.73-0.91)	1.22 (0.76-1.96)
Average	0.95 (0.88-1.02)	1.53 (1.12-2.08)	0.86 (0.78-0.94)	1.04 (0.84-1.28)	0.76 (0.68-0.85)	0.91 (0.57-1.46)
Deprived	0.81 (0.75-0.87)	2.24 (1.66-3.02)	0.76 (0.69-0.83)	1.09 (0.89-1.35)	0.63 (0.56-0.70)	1.02 (0.64-1.63)
Severely deprived	0.75 (0.69-0.81)	0.75 (0.69-0.81)	0.59 (0.53-0.65)	1.37 (1.18-1.69)	0.53 (0.46-0.60)	1.33 (0.84-2.11)
Pregnancy						
Spontaneous	1#	1#	1#	1#	1#	1#
ART	0.88 (0.81-0.97)	0.23 (0.11-0.45)	1.01 (0.90-1.13)	0.98 (0.74-1.29)	0.91 (0.78-1.07)	0.61 (0.29-1.30)

ANC: antenatal care; US: ultrasound; #reference category; ART: assisted reproductive technology

dices (for class 5, aOR 0.59; 95% CI 0.53-0.65). On the contrary, self-reported data showed that pandemic year 2020 was not associated with less than the recommended number of ANC contacts (aOR 0.82; 95% CI 0.74-0.91), while it were the foreign (aOR 2.07; 95% CI 1.85-2.30), the younger (aOR 1.64; 95% CI 1.39-1.93) and the more deprived women (aOR 1.37; 95% CI 1.18-1.69) at higher risk of not meeting recommended standards (Table 2). Pandemic year 2020 was associated with increased figures for less than two US examinations in pregnancy (aOR 1.36; 95% CI 1.27-1.45) according to administrative data, a result not confirmed by self-reported data (aOR 0.71; 95% CI 0.57-0.88) (Table 2). Women living outside Milan, of younger age and foreign citizenship showed significantly reduced figures for ultrasound examinations according to self-reported data (aOR 1.26; 95% CI 1.00-1.59, aOR 1.97; 95% CI 1.44-2.69, aOR 1.95; 95% CI 1.55-2.45, respectively) (Table 2). Supplementary Table 2 available online as Supplementary Materials shows numerosity of outcome measures (first antenatal booking, ANC contacts and US examination).

Pandemic year 2020 was not significantly associated with preterm births (aOR 0.91; 95% CI 0.83-0.98), while foreign citizenship (aOR 1.38; 95% CI 1.26-151) and ART pregnancies (aOR 2.66; 95% CI 2.32-3.06) significantly increased the risks of preterm delivery (*Table 3*). Moreover, pandemic year 2020 was not significantly associated with perinatal deaths (aOR 0.52; 95% CI 0.30-0.91). Results are shown in *Table 3. Supplementary Table 1 available online as Supplementary Materials* shows numerosity of outcome measures (preterm births, perinatal deaths, surgical treatment of ectopic pregnancy).

The only significant factor associated with surgically managed ectopic pregnancy was indeed the pandemic year with an aOR of 2.55 (95% CI 1.16-5.63), as shown in *Table 3*. The pandemic period as covariate with associated aOR across all logistic regression analyses is shown in *Figure 1* (administrative data only).

Table 3

Multiple logistic regression analysis for key pregnancy outcomes (preterm births, perinatal deaths and need of surgical treatment of ectopic pregnancy) and associated covariates

	Preterm birth	Perinatal death	Surgical treatment of ectopic pregnancy
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Year			
2019	1#	1#	1#
2020	0.91 (0.83-0.99)	0.52 (0.30-0.91)	2.55 (1.16-5.63)
Residence			
Municipality of Milan	1#	1#	1#
Outside	0.99 (0.91-1.08)	1.67 (0.94-2.96)	1.24 (0.53-2.86)
Citizenship			
Italian	1#	1#	1#
Foreign	1.38 (1.26-1.52)	1.74 (1.00-3.05)	1.10 (0.44-2.76)
Ageclass			
<25 years	1.03 (0.88-1.22)	1.12 (0.43-2.91)	0.65 (1.00-4.38)
26-30 years	0.88 (0.78-1.00)	0.64 (0.27-1.56)	0.84 (0.31-2.28)
31-35 years	1#	1#	1#
>35 years	1.20 (1.09-1.33)	1.62 (0.88-2.99)	1.22 (0.48-3.09)
Deprivation index			
Very affluent	1#	1#	1#
Affluent	1.26 (1.07-1.48)	1.79 (0.58-5.53)	3.04 (0.64-14.4)
Average	1.12 (0.95-1.31)	1.32 (0.42-4.14)	1.48 (0.31-7.13)
Deprived	1.32 (1.12-1.55)	1.21 (0.38-3.85)	1.54 (0.31-7.54)
Severely deprived	1.17 (0.98-1.38)	1.59 (0.50-5.07)	1.96 (0.42-9.10)
Pregnancy			
Spontaneous	1#	1#	1#
ART	2.67 (2.32-3.06)	0.61 (0.15-2.54)	1.00 (0.38-2.64)

#reference category; ART: assisted reproductive technology.





Figure 1

The pandemic period as covariate and associated adjuster odds ratios across all logistic regression analyses (only administrative data results for antenatal care services). Results are shown as adjusted odds ratios (aOR) with corresponding 95% confidence intervals. ANC: antenatal care; US: ultrasound.

DISCUSSION

In this study covering all pregnancies in Milan and Lodi metropolitan areas, we found that in pandemic year 2020 there was a small delay in the first antenatal contact according to both administrative and selfreported data. Furthermore, pandemic year 2020 was associated with less than the recommended numbers of both ANC contacts and US examinations according to administrative data, while this result did not maintain for self-reported data. Finally, year 2020 showed a rise in surgically managed ectopic pregnancies, while preterm births and perinatal deaths were not increased compared with pre-pandemic year 2019.

Administrative data results concerning reduced access to antenatal services agree with a previous report in UK where more than two-thirds of units reported a reduction in antenatal appointments [29]. There is also the systematic review and meta-analysis by Townsend et al. that confirmed reduced antenatal care contacts during the pandemic: quantitative data from seven studies showed that overall there was a 38.6% drop in care appointments during the pandemic period, with moderate heterogeneity (I²=54.6%) [13]. Accordingly, there were reports of diminished maternity contacts also in Italy: from March to May 2020, only 28.4% of facilities all over the country continued to provide outpatient routine visits and examinations as usual, while 59.4% reduced the number of visits and 12.2% ceased all activities [11]. Data were collected via a national survey, with most of healthcare facilities that responded located in Lombardy or Veneto (the most affected Italian regions). However, there was a low response rate (5.4%)and most of the facilities in which visits were ceased were community-based. In contrast to these previous reports, our study provides quantitative data coming from administrative datasets and self-reported data collected for birth certificates.

Our results point towards reduced referral to ANC services and US examinations in the pandemic period according to administrative data, a finding not confirmed by self-reported data. While administrative data mainly cover national health service usage, self-reported data likely reflect usage of both national health and private services. Results show that the younger, of foreign citizenship and more deprived women were more likely to meet recommended standards according to administrative data; on the contrary, the same women were more likely to unmeet the standards according to self-reported data. A plausible explanation is that the less wealthy subgroups mostly refer to hospital based public health services, as evidenced by administrative data results, while the wealthier refer also to private health services. Self-reported data showed that overall the more disadvantages subgroups were indeed more likely to fail recommended standards of antenatal care. Anyhow, self-reported data prove that on the whole pandemic year 2020 was not significantly associated with inadequate levels of antenatal care, with most women attending more than 4 ANC contacts and 2 US examinations in pregnancy.

These findings agree with the ones of a cross-sectional survey conducted at 3 maternity care centers in Italy where, overall, there was a good compliance to prenatal care services [25]. Still, also in the study of Vilca *et al.* immigrants were less likely than Italians to comply with prenatal services [25].

In the present study, key indicators of maternal and fetal outcomes such as perinatal deaths and preterm births were significantly reduced in pandemic year 2020. The majority of perinatal deaths was driven by stillbirths. Stillbirths are known to be closely associated with poor access to adequate antenatal and obstetric care. Our data of not increased stillbirth rates are concordant with the systematic review and meta-analysis by Yang et al. [20], and with national data published by Rusconi et al. [30], Esposito et al. [9] and Salerno et al. [31]. However, reports of stillbirth rates during the COVID-19 pandemic remain contradictory: whether these variations reflect real differences due to national lockdowns, or perhaps differences in stillbirth rates and/ or study designs is still unclear [18]. Reports of higher stillbirth rates come from both LMIC [32, 33] and HIC

[17, 19, 34, 35]. The Authors suggested the rise in stillbirth may have resulted from reduced access to hospital care, as mirrored by the fall in triage attendance [12, 19]. Though we did not evaluate emergency hospital attendance, we found that women reported to have met the recommended standards of routine antenatal care during pandemic year 2020 with ensuing lockdowns. This is a plausible explanation for unchanged stillbirth rates, though larger studies are needed to evaluate rare outcomes such as stillbirth.

We also found a significant reduction in preterm birth: pandemic year 2020 was associated with an aOR 0.91 (0.83-0.99, 95% CI) for PTB. The reduction of preterm births during the COVID-19 pandemic has been described before [34, 36, 37]. Preterm births are closely related to neonatal mortality, which also did not differ significantly in our cohort. Again, there is conflicting evidence which highlights important differences between LMIC and HIC. Overall, a systematic review and metaanalysis reported increased neonatal death in LMICs and decreased in HICs, consistently with the observed trends in preterm birth. This reduction in HICs appears to be driven by a reduction in spontaneous preterm birth [16]. The interrupted time series and meta-analyses by Calvert et al. used harmonized data from 52 million births in 26 countries and showed small reductions in preterm birth during the first three months of lockdown [18]. The study by Rusconi et al., covering 84.3% of the births in Italy, demonstrated a decrease in PTB [30]. Our data fit accordingly. However, the effect of the pandemic on PTB is difficult to evaluate, given the multiple possible causal pathways. A first distinction should be drawn between spontaneous and iatrogenic preterm birth. Though the former seems reduced, maybe due to lifestyle changes [38], the latter is known to be increased in COVID infected women [39]. Nonetheless, the evidence of an overall reduction of PTB is notable given that only a small fraction of women experienced CO-VID infection while lockdown measures were essentially universal at the early stages of the pandemic. Finally, we found that the OR for preterm birth were significantly increased by foreign citizenship and ART conceptions. This is in accordance with previous findings of ethnic disparities [40] and pregnancy by ART [41] as established risk factors for preterm delivery.

Lockdown restrictions likely impacted most on access to emergency services. The systematic review and metaanalysis by Chmielewska *et al.* that found increased ruptured ectopic pregnancies during the pandemic included three studies [16], of which two were from Italy [19, 42]. Possible explanations could be women's hesitance to seek medical attention or the reduction of early firsttrimester scans. In accordance with previous reports, our data showed both a significant increase of surgically managed ectopic pregnancies (aOR 2.55; 1.16-5.62 95% CI) and increased odds for later referrals (aOR 1.08, 1.04-1.13 95% CI and aOR 1.19, 1.05-1.34 95% CI for administrative and self-reported data respectively).

The number of abortion requests and procedures across the study period was generally reduced, together with the decrease in conceptions. These findings are consistent with previous ones [43]. Notably, the decrease in conceptions was already noted in the years before the study period, as mentioned in yearly birth reports [44]. Whether attributable to the decrease in conceptions and/or an indirect effect of the pandemic, the drop of TOP procedures was noted also in France [45, 46] and Sweden [47]. Abortion figures in other countries like Belgium [48], Israel [49] and the United States [50] were unchanged. Overall, evidence points towards an adequate response by healthcare services in HIC. Our data fit accordingly. Furthermore, we did not observe a change in abortion modality between pre-pandemic year 2019 and pandemic year 2020. This agrees with the findings of Guzzetti *et al.*, who found the procedures used (medical or surgical) were equally distributed among the considered timespans [51].

This study has several strengths and limitations. On one hand, there is the large sample size and the coverage of the entire period affected by the restrictions brought by the COVID-19 pandemic in Milan metropolitan area, Lombardy, one of the most populous and affected Italian regions. Moreover, the study covers both administrative data derived from the datawarehouse database and self-reported data filled out at delivery (birth certificates).

On the other hand, limitations are brought by the retrospective nature of the study and the lack of information regarding COVID-infected women and its direct impact on perinatal outcomes (especially preterm birth and stillbirth). Another important limitation concerns information regarding obstetric care outside the one offered by the national health system, a common reality in Italy especially for gynecologic and obstetric services [25]. Such information can only be indirectly inferred from self-reported data. For example, the fact that higher figures of ANC contacts were mostly seen in foreign and deprived women (administrative data results) led to the speculation that the wealthier population continued to use private health services. However, these must be regarded as indirect conclusions and need external validation.

CONCLUSIONS

In conclusion, both livebirths and legal terminations of pregnancy were decreased in pandemic year 2020, mirroring a decrease in conceptions. During the pandemic there was a delay in the first antenatal contact. However, adequate levels of routine antenatal care were maintained throughout 2020 according to self-reported data, though a decrease in national health system utilization was noted. There was no increase in perinatal deaths or preterm births, but there was a rise in surgically managed ectopic pregnancies. Overall, our results align with previous findings of the effects of the CO-VID-19 pandemic on maternal and perinatal outcomes.

Conflict of interest statement

The Authors declare that they have no conflict of interests.

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