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Retrospective cohort study on weight gain among pregnant women of the Italian Province of Trento during the 2020 lockdown due to COVID-19

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ABSTRACT

Objective. The lockdown due to COVID-19 has been associated with a reduction of physical activity and a change in eating behaviors, with consequent weight gain, in general and specific populations. The objective of this study was to assess whether women whose pregnancies encompassed the lockdown due to COVID-19 in 2020 had an excess gestational weight gain as compared with those who were pregnant in the same periods of previous years.
Materials and Methods. This was a retrospective cohort study based on anonymous data from the Birth Attendance Certificate (CedAP) information flow which is mandatorily collected in all Italian Regions. In the Autonomous Province of Trento, North-Eastern Italy, more information than those required as a minimum data set are collected, including maternal weight at the first gestational obstetric visit, initial body mass index (BMI), and maternal weight at delivery. We calculated mean gestational weight gain for women whose pregnancy encompassed the 2-month lockdown in 2020 and for those who were pregnant in corresponding periods of the years 2016-2019. Linear and logistic regression models were built to assess the association between lockdown and weight gain or excess weight gain, respectively, adjusting for the potential confounding effect of gestational month at the beginning of lockdown or corresponding period and pre-pregnancy body mass index.
Results. In 2020, mean gestational weight gain was not significantly different from the previous years, nor was the likelihood of gaining excess weight.
Conclusions. Unlike other populations that increased weight during the COVID-19 lockdown, the Italian population of pregnant women described in this study has a gestational weight gain comparable with that of the previous years. Public health and environmental interventions, as well as dedicated programs taking care of women from conception to post-partum may have a role in the health of future mothers and should be promoted.

INTRODUCTION

In Europe, Italy was the first country to be heavily affected by the SARS-CoV-2 outbreak in 2020, to the point that, as of March 20, 2020, Italy had the second largest number of confirmed cases worldwide, second only to China where the outbreak was described for the first time at the end of 2019 [1]. The Italian health system, as many others, was not prepared for a pandemic like COVID-19 and the intensive care units did not have sufficient capacity to face it. Thus, from March 9, 2020, the

Italian Government introduced progressive mitigation measurements to prevent viral diffusion. The country entered a 3-month lockdown, during which most people were confined in their homes. The limitation of movements, the increase of sedentary behaviors, anxiety, the increase of snacks and reduced consumption of fresh foods induced by the lockdown have been associated with weigh gain in a large proportion of people [2]. A Spanish cross-sectional study found that more than 40% of responders experienced weigh gain [3]. Another survey among active adult subjects in Israel reported that 55% of responders gained weight, with an average increase of 1.2 kg [4]. In an Italian survey, too, almost half responders had the perception of a weight gain during the lockdown [5]. A meta-analysis of 6 studies reported a significantly higher body weight after the lockdown as compared with the pre-lockdown period, with a weighted mean difference of 1.57 kg [6].

Weight increase was described also in large proportions of people with particular characteristics, *e.g.*, overweight and obese persons [7, 8] or college students [9].

Little is known about weight gain among pregnant women. A survey of 640 Chinese women who experienced the lockdown during the third trimester of pregnancy described the phenomenon of emotional eating, increased consumption of cereals and oil, and consequent excess gestational weight gain [10]. Another Chinese study showed that newborns whose mothers were in their third trimester during the lockdown were heavier than those who were delivered earlier, although there was no difference in the rate of Cesarean delivery [11].

To our knowledge, there are no data on gestational weight gain during lockdown in Italy. Thus, we conducted this study to assess whether women living in the North-Eastern Italian Autonomous Province of Trento had an excess gestational weight gain during lockdown as compared with previous analogous periods (2016-2019).

MATERIALS AND METHODS

This was a retrospective cohort study using data from the Birth Attendance Certificate (CedAP) information flow of the Autonomous Province of Trento, which includes a minimum dataset required by the Italian Ministry of Health from all the Italian Regions and Autonomous Provinces that annually transmit the data [12, 13], containing basic information on gestational history, delivery characteristics, and newborn's characteristics, and additional information collected in the Province of Trento, including maternal weight at the first gestational obstetric visit, initial body mass index (BMI), and maternal weight at delivery.

The CedAP data used in this study include all deliveries occurring within the area of the Province of Trento plus those occurring at the neighboring hospital of Feltre (in the region of Veneto) among mothers living in the Province of Trento. Data on deliveries at other locations were not available.

We analyzed CedAP data from 2016 to 2020. For 2020, when the lockdown was enforced, we extracted data of women who experienced the whole lockdown period (March 9th, 2020 to May 3rd, 2020) during their pregnancies (exposed cohort), based on delivery date and gestational age at delivery, information that are both included in the minimum ministerial dataset. For the previous years, we extracted data on women who had pregnancies encompassing the corresponding dates of each year (unexposed cohorts). Then, women of each cohort were divided into 7 subgroups, based on the gestational month they were in at the beginning of the lockdown or corresponding period (1st to 7th month).

Women were also classified, according to their initial BMI, into 4 groups: underweight (BMI < 18.5), normal weight (BMI 18.5-25), overweight (BMI 25-30), and obese (BMI ≥ 30). Gestational weight gain was defined as the difference between final and initial weight, and it was considered adequate, low or excessive according to the Institute of Medicine (IOM) recommendations [14]: the minimum and maximum recommended weight gains were respectively 12.5 and 18 kg for underweight women, 11.5 and 16 kg for normal weight women, 7 and 11.5 kg for overweight women, and 5 and 9 kg for obese women.

We evaluated the distribution (mean, standard deviation, quartiles, minimum and maximum) of gestational weight gain in the lockdown and non-lockdown cohorts, also stratified by gestational month and BMI category. The statistical significance of differences among groups were assessed through the ANOVA. We also assessed whether there was an association between compliance with the IOM recommended weight gain and exposure to lockdown, gestational month,

and BMI category. The statistical significance of differences was assessed through the chi-square test. Then, we compared the distribution of birth weights of newborns from each cohort and the statistical significance of differences was assessed through the ANOVA. P-values < 0.05 were considered statistically significant.
Linear and logistic regression models were built to evaluated the association of respectively gestational weight gain and excess weight gain (*vs* low/adequate gain) according to IOM with initial weight, initial BMI, gestational month at the start of lockdown or corresponding period in previous years, maternal age, citizenship (Italian *vs* other), educational level (ordinal), parity (first pregnancy *vs* other), smoking status in pregnancy (yes *vs* no), twin delivery, gestational diabetes, and exposure to lockdown, adjusting for the potential confounding effect of each covariate on the others. In linear regression, the association was expressed though the Beta coefficient; in logistic regression by the Odds Ratio (OR).
All the analyses were conducted using SAS v9.4 (SAS Institute Inc., Cary, NC, USA).

Ethical statement

This analysis was based on an anonymized version of the CedAP information flow which was established by the Italian Ministry of Health and is mandatory for all Italian Regions and autonomous Provinces. No Ethics Committee approval was needed. *Ad-hoc* consent was not necessary because the authors used data already collected at the beginning of the study.

RESULTS

From 2016 to 2020, the number of births of mothers whose pregnancy encompassed the period from March 9th to May 3rd progressively declined (**Table 1**). For the 12724 women, the distribution of gestational months at the beginning of each observation period was very similar (**Figure 1**; P-value of chi-square test 0.4727). Mean maternal age did not significantly differ across years (range 32.2-32.4 years; P-value of ANOVA 0.6468), nor did median educational level (always 3). The frequency of categorical characteristics of mothers and pregnancies in the study years is shown in **Table 2**.
The distribution of gestational weight gain was also analogous in the various periods (**Table 1**; P-value of ANOVA test 0.2667). The distribution of gestational weight gains was very similar in the various years in each of the categories of initial BMI (mean gain range 12.5-13.2 in underweight women, 12.7-13.2 in normal weight women, 11.4-11.7 in overweight women, and 8.0-9.3 in obese women), with neither a clear trend nor an evident difference between the exposed and unexposed cohorts (detailed data not shown). Even after stratifying for gestational month, no trends nor evident difference between the exposed and unexposed cohorts were observed (data not shown). **Figure 2** shows the frequency of excess, normal and low weight gain in the exposed and unexposed cohorts (P-value of chi-square test 0.0995). When the analysis was repeated stratifying by gestational month at the beginning of the period March 9th – May 3rd, no clear trend was observed and the proportions in the exposed cohort (year 2020) were never the highest or the lowest (data not shown). When stratifying by initial BMI, no significant differences were observed across cohorts either.
In linear regression analysis, when adjusting for the confounding effect of each covariate on the others, weight gain increased significantly with increasing initial weight and gestational month, decreasing initial BMI, lower maternal educational level, smoking habit, delivery of twins, being at first pregnancy, and not having gestational di-

Table 1. *Distribution of gestational weight gain of women who encompassed the period March 9th- May 3rd during their pregnancy from 2016 to 2020. Autonomous Province of Trento, Italy.*

			Gestational weight gain (kg)						
Year	**N births**	**N mothers**	**Mean**	**Standard dev**	**Minimum**	**25th percentile**	**Median**	**75th percentile**	**Maximum**
2016	2748	2700	12.3	5.2	- 22	10	12	15	39
2017	2600	2556	12.1	4.9	- 19	10	12	15	30
2018	2581	2545	12.1	5.0	- 7	10	12	15	39
2019	2531	2493	12.3	5.0	- 7	10	12	15	44
2020	2452	2430	12.1	5.0	- 11	9	12	15	35

Table 2. *Frequency of maternal and pregnancy characteristics in women who encompassed the period March 9th- May 3rd during their pregnancy from 2016 to 2020. Autonomous Province of Trento, Italy.*

	Year					
	2016 (N = 2700)	2017 (N = 2556)	2018 (N = 2545)	2019 (N = 2493)	2020 (N = 2430)	P-value of chi-square test
Citizenship (% Italian)	72.6	72.7	73.9	74.4	76.1	0.0304
Parity (% first pregnancy)	38.3	36.9	37.0	37.4	38.3	0.7297
Smoking status (% smoker)	6.2	5.2	6.4	5.8	6.1	0.4104
Delivery of twins (% yes)	1.7	1.7	1.4	1.5	039	0.1011
Gestational diabetes (% yes)	6.2	6.3	6.8	8.1	8.4	0.0034

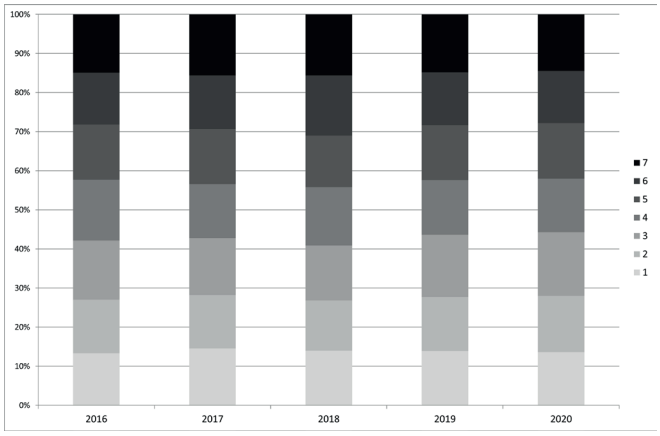

Figure 1. *Distribution of gestational months at the beginning of each observation period (March 9th – May 3rd 2016 to 2020). Autonomous Province of Trento, Italy.*

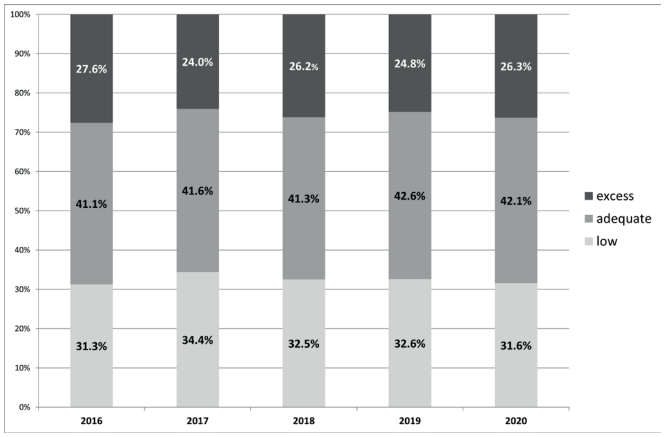

Figure 2. *Frequency of excess, adequate and low gestational weight gain according to IOM recommendations in the cohorts of pregnant women exposed (year 2020) and unexposed (years 2016-2019) to lockdown. Autonomous Province of Trento, Italy.*

abetes (**Table 3**). On the other hand, no difference emerged between the exposed and unexposed cohort (P-value 0.8214).

Table 4 shows results of logistic regression; when adjusting for the potentially confounding effect of each covariate on the others, the likelihood of an excess gestational weight gain was not increased in the 2020 cohort (P-value 0.3767). The other factors that were associated with gestational weight gain in linear regression were also consistently associated with the likelihood of excess weight gain. In logistic analysis, citizenship was also significantly associated with excess weight gain (Italian women had a reduced risk), although in linear regression analysis it was not.

Table 5 shows the distribution of birth weights of the newborns from each cohort. No significant difference was observed (P-value of ANOVA 0.2740).

Table 3. *Linear regression analysis: association between woman's initial weight and BMI, gestational month as of March 9th, mother's age, citizenship, educational level, parity, smoking status in pregnancy, delivery of twins, gestational diabetes, exposure to lockdown and gestational weight gain (outcome variable). Autonomous Province of Trento, Italy.*

	Beta coefficient	P-value
Initial weigh (per kg)	0.0534	< 0.0001
Initial BMI (per unit)	- 0.3786	< 0.0001
Gestational month as of March 9th (per month)	0.0828	< 0.0001
Mother's age (years)	- 0.0192	0.0269
Mother's citizenship (Italian *vs* other)	0.0309	0.7590
Educational level (ordinal, 1: university degree, 5: elementary school degree)	0.1145	0.0074
Parity (first pregnancy *vs* other)	0.2258	0.0125
Smoking status in pregnancy (smoker *vs* non-smoker)	0.7345	< 0.0001
Delivery of twins (yes *vs* no)	2.4437	< 0.0001
Gestational diabetes (yes *vs* no)	- 1.3305	< 0.0001
Exposure to lockdown (2020 *vs* 2016-2019)	0.0236	0.8214

Table 4. *Logistic regression analysis: association between woman's initial weight and BMI, gestational month as of March 9th, mother's age, citizenship, educational level, parity, smoking status in pregnancy, delivery of twins, gestational diabetes, exposure to lockdown and gestational weight gain (outcome variable). Autonomous Province of Trento, Italy.*

	OR	95% CI	P-value
Initial weigh (per kg)	1.03	1.02-1.04	< 0.0001
Initial BMI (per unit)	1.04	1.02-1.07	0.0005
Gestational month as of March 9th (per month)	1.05	1.03-1.07	< 0.0001
Mother's age (years)	0.99	0.98-1.00	0.1900
Mother's citizenship (Italian *vs* other)	0.88	0.79-0.97	0.0111
Educational level (ordinal, 1: university degree, 5: elementary school degree)	1.12	1.07-1.17	< 0.0001
Parity (first pregnancy *vs* other)	1.18	1.07-1.29	0.0007
Smoking status in pregnancy (smoker *vs* non-smoker)	1.47	1.25-1.74	< 0.0001
Delivery of twins (yes *vs* no)	2.90	2.14-3.94	< 0.0001
Gestational diabetes (yes *vs* no)	0.70	0.59-0.82	< 0.0001
Exposure to lockdown (2020 *vs* 2016-2019)	1.05	0.94-1.17	0.3767

95% CI: 95%: Confidence Interval.

Table 5. *Distribution of birth weight of newborns from mothers who encompassed the period March 9th- May 3rd during their pregnancy from 2016 to 2020. Autonomous Province of Trento, Italy.*

		Birth weight (g)						
Year	**N newborns**	**Mean**	**Standard dev**	**Minimum**	**25th percentile**	**Median**	**75th percentile**	**Maximum**
2016	2748	3259	519	415	2990	3300	3580	4800
2017	2600	3272	519	580	2980	3300	3590	5085
2018	2581	3271	530	410	2995	3300	3610	4915
2019	2531	3263	506	350	2965	3300	3590	4980
2020	2452	3289	493	415	3015	3310	3600	4870

DISCUSSION

This retrospective cohort study showed that in the Italian Province of Trento women who were pregnant during the 2-month lockdown due to COVID-19 in 2020 did not gain more weight than those who were pregnant in the corresponding period of the previous four years. This result was unexpected, since in China excess gestational weight gain and increased newborn's weight were described during the COVID-19 lockdown [10, 11] and even in the general population large proportions of persons experiencing the lockdown increased their weight, both in Italy [5] and in other countries [2-4, 6].

There were no differences, either, in the proportion of pregnant women who complied with the IOM gestational weight gain recommendations. In fact, approximately one fourth of women gained excess weight in all the five periods of analysis. Pregnancy outcome, in terms of newborn's birth weight, did not significantly change as compared with the previous years. This does not mean that COVID-19 and lockdown did not have any impact on pregnancies and on the health care of pregnant women: in fact, in 2020 we observed an increase in the proportion of Italian women delivering in the Province of Trento, which may be a consequence of travel limitations and of foreign women returning to their countries of origin; in addition, we report a decrease in the proportion of deliveries of twins in the Province, due to the fact that in 2020 some women with twin pregnancy were referred to hospitals out of the Province for delivery, because of COVID-related organizational issues. Other researchers studied the potential impact of COVID-19 on pregnant women: the World Association of Perinatal Medicine Working Group on COVID-19 showed that pregnant women infected with SARS-CoV-2 might be exposed to a higher risk of respiratory morbidity [15]; an Italian study monitored the mental health aspect of pregnant women, highlighting an increased rate of depressive symptoms and anxiety in this population, after a COVID-19 diagnosis [16]. As concerns the health effects on the newborn, early gestational age at infection, maternal ventilator supports, and low birthweight are the main determinants of adverse perinatal outcomes in fetuses with maternal COVID-19 infection [17].Our finding that gestational weight gain was not substantially different from past years has several possible explanations. First, pregnant women in the Autono-

mous Province of Trento are offered to be followed up in a dedicated care program named "Percorso Nascita" which takes care of them throughout the pregnancy and covers multiple aspects of it. The implementation of such program might have the beneficial effect of engaging pregnant women in virtuous behaviors. The hypothesis that providing comprehensive support to pregnant women improves behaviors and outcomes is strengthened by the observation of reduced likelihood of gaining excess weight among women with gestational diabetes. In fact, they are monitored more strictly than the others because of their condition and have better performances in terms of weight control.

Second, the adult population of the Province of Trento is on average more active than the Italian average: according to the PASSI surveillance system: 35.1% of the population 18-69 years of age is physically active (*vs* 31.1% in Italy) and 44.1% is partially active (*vs* 33.8% in Italy) [18]; 52.1% declared they commute on foot (*vs* 40.9% in Italy) [19]; 56.6% reported an intake of ≥ 3 servings of fruit per day (*vs* 48.8% in Italy) [20]. Thus, healthy habits of the general population might have contributed to avoid excess weight gain in pregnant women during lockdown.

In addition, 63% of the soil of the Autonomous Province of Trento is made of forests, one fourth of which is represented by private properties [21]. Cities are also green. As an example, Trento, the main city of the Province, is the Italian city with the highest urban green areas per capita (401.5 m^2) [22]. Even during the lockdown, when the population was forced to remain confined within one's own property, green areas around home might have facilitated physical activity of people, including pregnant women.

Finally, pregnant women, because of their special condition and perceived responsibility on the well-being of their future child, may be more health-oriented and focused on the care of their own bodies than the general population, although responses to stress from COVID-19 among pregnant women have been shown to be different from individual to individual and that depression was more common among those who were pregnant during the pandemic than among those who had been pregnant earlier [23].

The main limitation of this study was the lack of data on eating habits and physical activity in our source of information, not allowing an assessment of possible changes during the COVID-19 lockdown.

This study was made possible by the availability of information on weights at the beginning and at the end of the pregnancy in the enhanced CedAP version of the Autonomous Province of Trento, however, we believe the study findings may be generalized to the other Italian and even European contexts.

CONCLUSIONS

Our study results were reassuring, since the lockdown due to COVID-19 did not have a significant negative impact on either gestational weight gain or on the newborns' birth weight. We cannot specifically identify the main determinants of such sort of "resilience", differentiating pregnant women of the Province of Trento from other populations described in the international literature. It is likely that a mix of the above-mentioned factors played a role. Thus, we encourage the maintenance and support of the existing integrated care program that takes care of future mothers from the beginning of pregnancy to the post-partum, the reinforcement of the public health messages promoting physical activity and healthy eating habits in the population, and environmental protection to allow people finding green spaces around home.

COMPLIANCE WITH ETHICAL STANDARDS

Authors contribution

F.V.: Design of the study, statistical analyses conduction, manuscript writing. R.P.: study design contribution, statistical analyses, critical review of the manuscript. M.P.: study design contribution, management of the data, critical review of the manuscript.

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Study registration

N/A.

Disclosure of interests

The authors declare that they have no conflict of interests.

Ethical approval

This analysis was based on an anonymized version of the CedAP information flow which was established by the Italian Ministry of Health and is mandatory for all Italian Regions and autonomous Provinces. No Ethics Committee approval was needed.

Informed consent

Ad-hoc consent was not necessary because the authors used data already collected at the beginning of the study.

Data sharing

Data are available under reasonable request to the corresponding author.

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