Rosa Bertha Gutarra-Vilchez
ᵃ⁾ Universidad de San Martín de
   Porres, Facultad de Medicina,
   Lima, Perú
ᵇ⁾ Vitarte Hospital, Health
   Ministry, Lima, Peru

Joselyne Gutarra-Samán
Hospital II Vitarte Essalud, Lima,
Perú

Teodardo Campos-Solórzano
Gynecology and Obstetrics
Department, Hospital Complex
Guillermo Kaelin, Lima, Peru

Cilia Mejia-Lancheros
MAP Centre for Urban Health
Solutions, St. Michael's Hospital,
Li Ka Shing Knowledge Institute,
Toronto, Canada

Association between the pre-pregnancy body mass index and risk of cesarean section: A case-control study

Rosa Bertha Gutarra-Vilchez, Joselyne Gutarra-Samán, Teodardo Campos-Solórzano and Cilia Mejia-Lancheros

Abstract
Objective: To estimate the association between the pre-pregnancy Body Mass Index (BMI) and the weight categories with the risk of cesarean section in Peruvian women.
Methods: A Case-control study was conducted. The present study included 13 734 pregnant women (cases=4578 and controls=9156). The pre-pregnancy BMI and overweight and obesity status were the main risk factors. Logistic regression was used to assess the association between the main exposures and cesarean section.
Results: Higher BMI values were associated with cesarean delivery (adjusted Odds Ratio (aOR): 1.081, 95% CI 1.067-1.095, $P<0.001$). When bodyweight status was considered, women with overweight (aOR: 1.461, 95% IC 1.172-1.823, P: 0.001) and obesity (OR: 1.810, 95% IC 1.578-2.076, $P<0.001$) during the pre-pregnancy had a higher likelihood of cesarean section compared to those with normal weight.
Conclusion: Pre-pregnancy higher BMI values, particularly those of overweight and obesity status were independent risks for cesarean delivery in Peruvian women.

Keywords: Body mass index, obesity, overweight, cesarean delivery, pregnancy, vaginal delivery

Introduction
The World Health Organization and the Pan American Health Organization emphasize that rates of deliveries by cesarean over 15% are not justified, even in the context of high rates of maternal and fetal morbimortality [1]. However; current figures indicate that cesarean deliveries can contribute to over 50% of the childbirths in some Latin American and Caribbean jurisdictions [2-4]. This is a situation of great concern, as rates of cesareans over 16% do not seem to be associated with the reduction on maternal and neonatal morbimortality [5-6]. Furthermore, the child and maternal morbimortality associated with cesarean delivery is higher than that related to vaginal childbirth [7, 8]. Thus, it is important to identify factors that contribute to childbirth via cesarean in order to inform evidence-based interventions to reduce the number of cesarean deliveries that are preventable or unnecessary.
On the other hand, the overweight and obesity status are current global public health concerns that have negatives effects on the individuals' health [9]. It has been estimated that the prevalence rates of overweight and obesity status in the general population are around 39% and 13%, respectively [10]. These figures can arrive at up to 50% among pregnant women [11]. Existing evidence has shown that the maternal and fetal mortality and morbidity rates are greater among pregnant women with higher BMI values than in those with lower BMI figures. For example, pregnant women with overweight and obesity tended to have more prolonged gestational and delivery periods, instrumental deliveries, and macrosomic babies (Birthweight: >4000 gr) [12-16]. Yet, the association between BMI and the risk of delivery via cesarean is still unclear. For instance, in a systematic review of the exiting evidence up to 2016, it was found that the cesarean childbirths were significantly higher among women with greater BMI values [13]. However, recent primary studies have reported contradicting findings [14-17].
In the present study, we analyzed the predictor role of the pre-pregnancy BMI on the risk of cesarean section in Peruvian women. We also examined the association between overweight and obesity status with the childbirth via urgent and elective cesarean delivery.

Methods
We carried out an observational and retrospective study with a case control design embedded within a cohort of pregnant women (N=28 943) aged 18 years or more who had a birth delivery

Corresponding Author:
Rosa Bertha Gutarra-Vilchez
ᵃ⁾ Universidad de San Martín de
   Porres, Facultad de Medicina,
   Lima, Perú
ᵇ⁾ Vitarte Hospital, Health
   Ministry, Lima, Peru

during January 2010 and December 2017 in the Vitarte Hospital in Lima, Peru. The Vitarte Hospital is a public healthcare facility that provides secondary health care, including Gynecology, Obstetrics, and Pediatrics services. This hospital mainly provides services for people from low-income backgrounds, especially individuals residing in the ATE, Santa Anita, El Agustino and Lurigancho districts of Lima the capital of Peru. The percentage of people living with less than ten dollars per day in these areas ranges from 8.9% to 40.6%.

The pregnant women who give birth in the Vitarte Hospital are registered in the Hospital Perinatal Information System (HPIS), which is daily completed by the medical and nursing professionals of the Gynecology and Obstetrics Department. In this registry, information related to the clinical history, anthropometric measures, biomarkers as well as the maternal and fetal-related diagnostics and associated treatments is recorded. This perinatal register has been previously used to study the macrosomia and the associated factors [18].

Of the 28 943 pregnant women who were attended during January 2010 and December 2017 in the Hospital Vitarte, 8 872 (30.65%) had childbirth via cesarean, while 20 071 (69.35%) had vaginal child delivery. For the selection of the cases and control for the present study, we considered pregnant women who had attended the Hospital Vitarte during January 2010 and December 2017 as the main selection criteria (Figure 1).
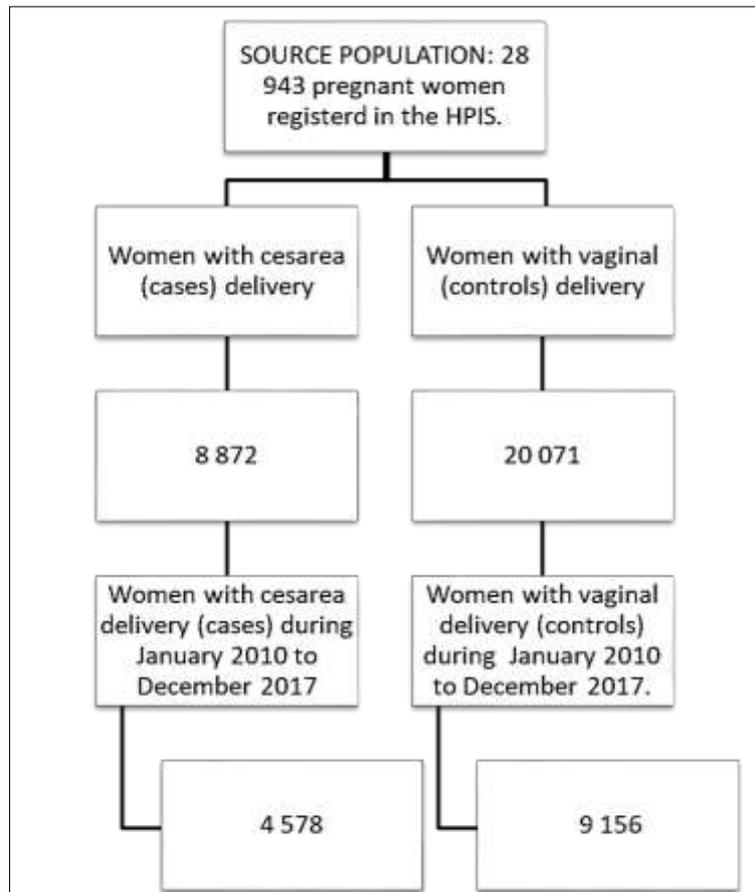

Fig 1: Selection of cases (Cesarean deliveries) and control (Vaginal deliveries) in the study population of Peruvian women from 2010 to 2017

Pregnant women with multiple gestations (more than one fetus) were excluded. We considered the women with childbirth deliveries via a cesarean as cases and those women with childbirth deliveries via vaginal as controls. Using the simple random sampling and the data available in the HPIS, we selected 4 578 cases and 9 156 controls from the 8 872 childbirth via cesarean and 20 071 childbirth via vaginal respectively. This study sample size was calculated based on 0.05 Alpha risk level and on 0.2 Beta risk level in a bilateral statistical contrast to detected a minimum OR of 1.111 in the cases by assuming an exposure rate of 0.396 (39.6%) in the controls. The sample calculation was performed using the software GRANMO.

The present study received ethical approval from the Research Ethical Board at the Hospital Vitarte.

Written informed consent is obtained from the patients to access and use their anonymized clinical data recorded in the Hospital Vitarte's Perinatal Information System for health research activities.

Patients were not involved in conceiving, carrying out or interpreting the present study findings.

The pre-gestational BMI (Kg/m2) derived from self-reported weight and height during the first antenatal visit (at 12 weeks of gestational age) that participants attended in the hospital was considered the main exposure. To better understand the role of body weight on the risk of cesarean delivery, the following body weight categories were also analyzed: underweight (BMI: <18.5), overweight (BMI: >25 to < 30), obesity (BMI: ≥ 30), and normal weight (BMI: 18.5 to < 25). The overweight and obesity status were considered as secondary exposures, while normal weight was the reference category.

A cesarean (cases) and vaginal (controls) delivery was the primary outcome. The type of cesarean section (urgent and elective) was also examined.

Based on the existing literature and in the clinical relationship with cesarean delivery, we also included the following binary factors in our analyses. Maternal factors: mother's age (<35/≥35

years of age), history of previous cesarean, parity (nulliparous/multiparous), short inter-cesarean interval (less than two years between two cesareans), mother's height (140 cm/ ≥140cm), risk of placental abruption, placenta previa, premature rupture of membranes, eclampsia, and preeclampsia. Fetus's factors: Breech presentation, biological sex (female/male), premature birth (22 to 36 week of gestational age), postterm birth (≥42 weeks of gestational age), macrosomia (birthweight: ≥ 4000 gr), and acute fetal distress based on the CIE-10 CM criteria.

The characteristics of the cases and controls were described using frequency and percentages, or measures of central tendency and dispersion. The statistical comparisons between the cases and control were assessed using the Chi-Squared test or F de Fisher test for categorical variables, and the t-test for comparing the continuous variables. For the statistical analyses, we first identified the factors that were associated with both the cesarean and a high BMI. Secondly, we assessed the association between the BMI and weight categories with the cases of cesarean using the logistic regression. The adjustment process was performed by introducing into the model all the potential confusing factors identified in the first step and based on the existing literature. The "backwards-stepwise" method was used to identify the factors that contributed to the best predictive models. We re-evaluated the final models by entering and removing each of the variables. Thirdly, we assessed the potential moderator effect of the macrosomia for the relationship between BMI and a cesarean delivery using an interaction term between BMI and macrosomia; however, the interaction was not statistically significant. Fourth, as an exploratory analysis, we assessed the association between BMI, obesity and overweight with the likelihood of urgent and elective cesarean deliveries compared with vaginal childbirth.

All the analyses were two-tailed tested at 0.05 statistical significance level with 95% confidence intervals. All the analyses were carried out using the IBM SPSS software, version 25.

Results
The study participants were on average 26 ($\pm$ 6.6) years old and had a BMI mean of 24.8 ($\pm$ 4.0). When comparing the distribution of the maternal BMI values among cases (cesareans deliveries) and controls (vaginal deliveries), it was found that the cases tended to have higher BMI values (BMI: 25.4 ($\pm$ 4.3)) than controls (BMI: 24.3 ($\pm$ 3.8)). Related to the type of cesareans within the cases, we found that 88.1% (n=4031) were urgent cesareans compared with 21.9% (n=547) of elective cesareans. In addition, the percentage of the urgent cesareans were higher among participants with overweight (36.3%, n=885/2440) and obesity (45.6%, n=838/1839) status than those with normal weight (30.6%, 2598/8468) status.

The comparison of the maternal and fetal characteristics among cases (cesareans sections) and controls (vaginal deliveries) are presented in Table 1. Women who had cesarean delivery were more aged, had higher percentages of history of previous cesareans, short inter-cesarean interval, placenta previa, premature rupture of membranes, and eclampsia and preeclampsia if compared with those who gave birth via vaginal delivery. The cases also had a higher percentage of babies in breech presentation, with birth weight higher than 4000 gr, and acute fetal distress than the controls. Conversely, participants with a vaginal delivery were nulliparous, with lower height, and had higher percentage of obesity and overweight. In addition, the controls had higher percentage of suffering preeclampsia, had female and premature babies than women with cesarean delivered (Table 1).

Table 1: A descriptive comparison of the maternal and fetal characteristics across cases (cesarean deliveries) and control (vaginal deliveries) in a large sample of Peruvian women from 2010 to 2017

	Overall sample N=13734 N (%)	Cases (Cesarean deliveries) n=4 578 n (%)	Controls (Vaginal deliveries) n=9156 n (%)	p-value[a]
Maternal characteristics				
Age (years)				
≥ 35 years	1405 (10.2%)	857 (61.0%)	548 (39.0%)	<0.001
< 35 years	12329 (89.8%)	8299 (67.0%)	4030 (33.0%)	
Parity				
Nulliparous	4500 (32.8%)	1624 (36.1%)	2876 (63.9%)	<0.001
Multiparous	9234 (67.2%)	2954 (32.0%)	6280 (68.0%)	
Short inter-cesarean interval				
Yes	994 (7.2%)	991 (99.7%)	3 (0.3%)	<0.001
No	12724 (92.8%)	3587 (28.2%)	9153 (71.8%)	
Height				
<140cm	306 (2.2%)	137 (44.8%)	169 (55.2%)	<0.001
≥140cm	13428 (97.8%)	4441 (33.1%)	8987 (66.9%)	
BMI (Kg/m^2) Mean ±SD	25.9 (2.5)	25.4 (4.3)	24.3 (3.8)	<0.001[b]
Body weight categories				
Low weight (BMI: <18.5)	987 (7.2%)	257 (26.0%)	730 (74.0%)	<0.001
Normal weight (BMI: 18.5 to <25)	8468 (61.7%)	2598 (30.6%)	5870 (69.4%)	<0.001
Overweight (BMI: 25 - 29.9)	2440 (17.8%)	885 (36.3%)	1555 (63.7%)	<0.001
Obesity (BMI: ≥30)	1839 (13.3%)	838 (45.6%)	1001 (54.4%)	<0.001
History of previous cesarean				
Yes	1039 (7.6%)	1039 (99.6%)	4 (0.4%)	<0.001
No	12695 (82.4%)	3539 (27.8%)	9152 (72.1%)	
Placental abruption				
Yes	13 (0.1%)	13 (100.0%)	0 (0.0%)	<0.001
No	13721 (98.9%)	4565 (33.3%)	9156 (66.7%)	
Placenta previa				
Yes	34 (0.2%)	34 (100.0%)	0 (0.0%)	<0.001

No	13700 (99.8%)	4544 (32.2%)	9156 (66.8%)	
Premature rupture of membranes				
Yes	157 (1.1%)	138 (87.9%)	19 (12.1%)	<0.001
No	13577 (98.9%)	4440 (32.7%)	9137 (67.3%)	
Eclampsia				
Yes	6 (0.1%)	6 (100.0%)	0 (0.0%)	0.001[c]
No	13728 (99.9%)	4572 (33.3%)	9156 (66.7%)	
Preeclampsia				
Yes	55 (0.4%)	11 (20.0%)	44 (80.0%)	<0.001
No	13679 (96.6%)	4534 (33.1%)	9145 (66.9%)	
Fetal characteristics				
Breech presentation				
Yes	425 (3.1%)	425 (100%)	0 (0%)	<0.001
No	13 309(96.9%)	4153 (31.2%)	9156 (68.8%)	
Biological sex				
Female	6827 (49.7%)	2171 (31.8%)	4656 (68.2%)	<0.001
Male	6901 (50.3%)	2404 (34.8%)	4497 (65.2%)	
Premature birth				
Yes	409 (2.9%)	143 (35.0%)	266 (65.0%)	0.476
No	13 325 (97.1%)	4435 (33.3%)	8890 (66.7%)	
Postterm birth				
Yes	207 (1.5%)	97 (46.9%)	110 (53.1%)	<0.001
No	13 527 (98.5%)	4481 (33.1%)	9046 (66.9%)	
Macrosomia				
Yes (birthweight ≥ 4000 gr)	1110 (8.1%)	652 (58.7%)	458 (41.3%)	<0.001
No (birthweight <4000 gr)	12694 (91.9%)	3926 (31.1%)	8698 (68.9%)	
Acute fetal distress				
Yes	548 (3.9%)	548 (100%)	0 (0%)	<0.001
No	13188 (96.1%)	4030 (30.6%)	9156 (69.4%)	

a = *p*-value: Chi squared test, b = t-test. c = F de Fisher test

The comparisons of the maternal and fetal characteristics among the pre-gestational body weight status are presented in Table 2. We found that pregnant women with overweight and obesity prior to the pregnancy were those older, and with greater percentages of previous cesarean, multiparous, shorter, placenta previa and macrosomic babies than pregnant women with normal weight status. There were no observed differences in the distribution of the other maternal and fetal characteristics across body weight categories (Table 2).

Table 2: A descriptive comparison of the maternal and fetal characteristics across pre-pregnancy maternal body weight categories in a large sample of Peruvian women from 2010 to 2017

	Pre-pregnancy maternal body weight categories (N=13734)				
	Low weight (BM:<18) n=987 (7.2%)	**Normal weight (BMI: ≥ 18 to <25)** n=8468 (61.7%)	**Overweight (BMI: >25 to 29.9)** n=2440 (17.8%)	**Obesity (BMI: >25 to 29.9)** n=1839 (13.4%)	*p*-value [a]
	N (%)	N (%)	N (%)	N (%)	
Maternal characteristics					
Age (years)					
≥ 35 years	20(2.0%)	625 (7.4%)	380 (15.6%)	380 (20.7%)	<0.001
< 35 years	967 (98.0%)	7843 (92.6%)	2060 (84.4%)	1459 (79.3%)	
Parity					
Nulliparous	519 (52.6%)	3242 (38.3%)	496 (20.3%)	243 (13.2%)	<0.001
Multiparous	468 (47.4%)	5226 (61.7%)	1944 (79.7%)	1596 (86.8%)	
Short inter-cesarean interval					
Yes	69 (70.0%)	602 (7.1%)	170 (7.0%)	153 (8.3%)	0.075
No	918 (93.0%)	7866 (92.9%)	2440 (93.0%)	1839 (91.7%)	
Height					
<140cm	13 (1.3%)	161 (1.9%)	59 (2.4%)	73 (4.0%)	<0.001
≥140cm	974 (98.7%)	8307(98.1%)	2381 (97.6%)	1788 (96.0%)	
History of previous cesarean					
Yes	257 (26.0%)	2598 (30.7%)	885 (36.3%)	838 (45.6%)	<0.001
No	730 (74.0%)	5870 (69.3%)	1555 (63.7%)	1001 (54.4%)	
Placental abruption					
Yes	1 (0.1%)	8 (0.1%)	2 (0.1%)	2 (0.1%)	0.534[b]
No	986 (99.9%)	8460 (99.9%)	2438 (99.9%)	1837 (99.9%)	
Placenta previa					
Yes	2 (0.2%)	13 (0.2%)	12 (0.5%)	7 (0.4%)	0.013[b]
No	985 (99.8%)	8455 (99.8%)	2428 (99.5%)	1832 (99.6%)	
Premature rupture of membranes					
Yes	17 (1.7%)	96 (1.1%)	26 (1.1%)	18 (1.0%)	0.173[b]
No	970 (98.3%)	8372 (98.9%)	2414 (98.9%)	1821 (99.0%)	

Eclampsia				
Yes	0 (0.0%)	4 (0.1%)	2 (0.1%)	0 (0.0%)	0.575[b]
No	987 (100.0%)	8464 (99.9%)	2438 (99.9%)	1839 (100.0%)	
Preeclampsia				
Yes	3 (0.3%)	32 (0.4%)	9 (0.4%)	11 (0.6%)	0.122[b]
No	984 (99.7)%	8436 (99.6%)	2431 (99.6%)	1828 (99.4%)	
Fetal characteristics				
Breech presentation				
Yes	29 (2.9%)	272 (3.2%)	64 (2.6%)	60 (3.3%)	0.423[b]
No	958 (97.1%)	8196 (96.8%)	2440 (97.4%)	1839 (96.7%)	
Biological sex				
Female	487 (49.3%)	4234 (50.0%)	1230 (49.5%)	941 (48.8%)	0.951[b]
Male	500 (50.7%)	4230 (50.0%)	1230 (50.4%)	941 (51.2%)	
Premature birth				
Yes	44 (4.5%)	239 (2.8%)	66 (2.7%)	60 (3.3%)	0.500
No	943 (95.5%)	8229 (97.2%)	2374 (97.3%)	1779 (96.7%)	
Post-term birth				
Yes	8 (0.8%)	123 (1.5%)	47 (1.9%)	29 (1.6%)	0.087
No	979 (99.2%)	8345 (98.5%)	2393 (98.1%)	1810 (98.4%)	
Macrosomia				
Yes (birthweight ≥ 4000 gr)	31 (3.1%)	511 (6.0%)	266 (10.9%)	302 (16.4%)	<0.001
No (birthweight <4000 gr)	956 (96.9%)	7957 (94.0%)	2174 (89.1%)	1537 (83.6%)	
Acute fetal distress				
Yes	39 (4.0%)	346 (4.1%)	99 (4.1%)	64 (3.5%)	0.364
No	948 (96.0%)	8122 (95.9%)	2341 (95.9%)	1775 (96.5%)	

a = *p*-value: Chi squared test, b = t-test. c = F de Fisher test

Table 3 shows the unadjusted and adjusted association between the BMI values and bodyweight categories with the cesarean deliveries compared with the vaginal deliveries. After adjusting for potential maternal and fetal characteristics, it was found that higher BMI values were associated with a higher likelihood of cesarean deliveries (adjusted OR: 1.068, IC 95% 1.059-1.077, *P*<0.001). When the bodyweight status was considered, it was observed that women with pre-pregnancy overweight (adjusted OR (aOR): 1.461, IC 95% 1.172-1.823, *P*=0.001) and obesity (aOR: 1.810, IC 95% 1.578-2.076, *P*<0.001) status were more likely to have cesarean childbirth than those with normal weight status after control for potential confounding factors. These associations were greater with urgent cesareans than elective cesarean sections (Table 3).

Table 3: Association between pre-pregnancy maternal BMI and body weight categories with deliveries via cesarean (cases) in a large sample of Peruvian women from 2010 to 2017

	Cases and control			**Type of cesarean**					
	Cesarean delivery vs vaginal delivery			**Urgent cesarean vs vaginal delivery**			**Elective cesarean vs vaginal delivery**		
	OR	**CI 95%**	***p*-value**	**OR**	**CI 95%**	***p*-value**	**OR**	**CI 95%**	***p*-value**
Unadjusted models									
Pre-pregnancy maternal BMI (kg/m²)	1.068	1.059-1.077	<0.001	1.055	1.049-1.064	<0.001	1.041	1.021-1.062	<0.001
Pre-pregnancy maternal body weight categories									
Low weight vs Normal weight	0.687	0.593-0.795	<0.001	0.806	0.690-0.941	0.006	0.972	0.640-1.475	0.893
Overweight vs Normal weight	1.257	1.083-1.460	0.003	1.219	1.105-1.344	<0.001	1.261	1.001-1.588	0.049
Obesity vs Normal weight	1.892	1.707-2.096	<0.001	1.688	1.519-1.875	<0.001	1.424	1.134-1.789	0.002
Adjusted models [a]									
Pre-pregnancy maternal BMI (kg/m²)	1.081	1.067-1.095	<0.001	1.069	1.056-1.082	<0.001	1.080	1.067-1.094	<0.001
Pre-pregnancy maternal body weight categories									
Low weight vs Normal weight	0.626	0.518-0.757	<0.001	0.617	0.505-0.754	<0.001	0.630	0.521.0.672	<0.001
Overweight vs Normal weight	1.461	1.172-1.823	0.001	1.551	1.220-1972	<0.001	1.398	1.153-1.694	<0.001
Obesity vs Normal weight	1.810	1.578-2.076	<0.001	1.833	1.587-2.117	<0.001	1.807	1.576-2.073	<0.001

a = Adjusted for maternal characteristics (age, parity, short inter-cesarean interval, height, history of the previous cesarean, placental abruption, placenta previa, premature rupture of membranes, eclampsia and preeclampsia) and fetal characteristics (Sex, premature birth, post term birth, breech presentation, and acute fetal distress)

Discussion
In the present study carried out in a large sample of Peruvian pregnant women, we found that women with higher values of pre-pregnancy BMI values, and especially those within the overweight and obesity status had a higher likelihood of a birth delivery via cesarean than via vaginal after control for maternal and fetus related factors.
The present study included a large population sample of Peruvian women who gave birth during 2010-2017. Peru has experienced a significant increase in overall cesareans rates over this period (from 22.9% in 2011 to 31.6% in 2016), with an estimated 35.5% of those cesareans considered unjustified.19 Thus, the study sample and the period provided a unique opportunity to better understand the potential role of overweigh and obesity on contributing to the alarming increase of cesarean section in Peruvian women, and therefore inform practice and policy. In addition, in the present analyses, we considered a large set of maternal and fetal characteristics that may have

acted as potential confounders to better estimate the independent effect of BMI, overweight and obesity on cesarean deliveries. The present study also has the following limitations that should be considered. Firstly, the retrospective design of the study and the used of medical records may affect the quality of the observed findings. Yet, the data used in our study are gathered by experienced health professionals working in the Genecology and Obstetrics services and overseen by expert data scientists. Secondly, self-reported pre-pregnancy weight and height may be affected by misreporting and recall issues. However, the self-reported anthropometric values pre-pregnancy are considered valid and reliable indicators [20]. Finally, we were unable to use maternal BMI during the pregnancy period which potential increased values may have contributed to the observed results. However, is highly unlikely that women who were obese during the pregnancy would have achieved better weight status during the pregnancy, period during which women tended to gain weight associated with their pregnancy state.

Despite that a cesarean procedure could cause serious health complication for the patient as other medical surgeries, and that pregnant women who have undergone an emergency cesarean tend to experience a level of distress [6, 7, 21], this medical procedure is becoming more frequent, even in countries with lower socioeconomic status and health resources [2-5].

In our study, it was found that having higher BMI values, and specifically being overweight or obese during the pre-pregnancy period, increased the likelihood of delivery via cesarean, independent of the demographic and clinical characteristic of the participants and their babies. For instance, in an umbrella review of the existing meta-analysis carried out by Kalliala et al., it was found that obesity increased the risk of having delivery via emergency cesarean (OR: 1.63; IC: 1.15-2.31) [13].

Despite the pregnant women in our studies were in the majority multiparous and young (26 years of age on average), the observed associations between overweight and obesity with cesarean childbirths differ from findings reported in other studies. For example, Volumenie et al. found that in pregnant women of African descent resident in Caribbean Martinique Island, overweight and obesity status were not associated with cesarean deliveries [17]. However, our findings support what observed by authors in other contexts. For instance, in a recent study, Harvey et al., carried out in nulliparous women, found that those participants with pre-pregnancy obesity had 2.03 more odds of having cesarean deliveries than women with normal weight status. Killiala et al. and Ellekjaer et al., also observed that obesity was a risk factor for cesarean childbirth [13, 14]. In addition, Maged et al. found that the incidence rates of cesareans after the delivery labor began, were greater in the obese primigravidae than in non-obese pregnant women [15]. It is possible that the ambiguity in the association between high BMI values and deliveries via cesarean across studies is due to ethno-racial and sociocultural differences, dissimilar lifestyles and behaviors, and differences in approaches to delivering healthcare on a domestic basis.

Several mechanisms have been hypothesized for explaining the potential association between higher BMI values and cesarean deliveries. One of those mechanisms can be the existence of chronic metabolic comorbidities such as diabetes and hypertension, which if not controlled could constitute a medical indication of cesarean [8, 10, 11]. The overweight and obesity status may also be leading factors for obstetric complications such as dysfunctional delivery labor, cephalo-pelvic disproportion with or without macrosomia fetal and prolonged deliveries, therefore requiring a cesarean section [6, 11].

The findings from the present study have the following practical implications. Firstly, overweight and obesity status is a current public health concern expanding from the highly developed countries to those less economically advanced such as Peru. Thus, effective interventions aimed to prevent and reduce overweight and obesity during the pre-pregnancy period is required. This is critical as maternal obesity can have adverse effects not only for the health of pregnant women but also for the health status of their progeny [22, 23]. A Cesarean section is a medical intervention that can have serious medical complication for the pregnant women, the newborn and increases the cost burden for the health system. Thus, it is essential to conduct further studies to identify which other factors at an individual level, contextual level, and at a higher structural level are contributing to the increasing rate of cesareans, including those jurisdictions where the childbirths via vaginal were traditionally frequent.

In conclusion, in a large Peruvian population sample, having higher BMI values, and particularly having overweight and obesity during the pre-pregnancy period were independent risks factors for cesarean section. Effective intervention and policies are required to curb overweight and obesity during the pre-pregnancy period and reduce the cesarean deliveries that are preventable.

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