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Exploring the socioeconomic disparities of maternal body mass index: a national study in France

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Background: The prevalence of overweight and obesity has increased in various countries. Normal weight before pregnancy is important to protect maternal and newborn health. This study aimed to describe the evolution of body mass index (BMI) before pregnancy in France and explore its association with two measures of socioeconomic status (SES), education and household income. **Methods:** Data were from four national perinatal surveys in France in 1998, 2003, 2010 and 2016 to describe the time evolution of maternal BMI. We explored the links between BMI and women's characteristics in the most recent period (2010–2016 surveys) since income information was not available before. Risk ratios (RRs) of underweight, overweight and obesity for each measure of SES were computed by using multivariable Poisson regression models. **Results:** Overweight and obesity prevalence increased between 1998 and 2016, from 6% to 12% for obesity. Both were inversely associated with SES (higher prevalence among least educated and poorest women), with strong variations for each social indicator, even in multivariable analyses including both. Combining education and income revealed a wide gradient; RR for obesity was 6.01 (95% confidence interval 4.89–7.38) with low education and income $<$2000 euros/month vs. high education and income $\geq$4000 euros/month. **Conclusions:** Public policies must implement programs to limit the increase in overweight and its unequal distribution in the population, alongside other policies to address the societal determinants of the obesogenic environment. Health professionals need to advise women to improve their eating and physical activity to limit weight gain from childhood to early adulthood.

Introduction

The prevalence of overweight and obesity has increased in the general population of most countries. In France, the prevalence of obesity among women increased from 5% in 1981, 6% in 1992 to 10% in 2003[1]; in 2015, the proportions of overweight and obesity were 44% and 17% among women aged 18–74.[2] Trends for pregnant women have shown the same global pattern, with increasing rates of maternal obesity reported from various countries.[3–6]

A normal weight before pregnancy is an important factor to protect maternal and newborn health. When compared with women with normal weight before pregnancy, those with overweight or obesity as well as those with underweight are at increased risk of adverse pregnancy outcomes. Pre-pregnancy overweight and obesity both increase the risk of pregnancy complications, such as gestational diabetes and preeclampsia.[7,8] They also affect maternal outcomes, with increased rates of severe maternal morbidity and maternal death.[9–11] All these maternal risks increase by level of obesity.

Pre-pregnancy overweight and obesity are also associated with adverse perinatal outcomes, including increased rates of congenital anomalies, stillbirth, fetal growth restriction, early preterm birth before 32 weeks of gestation and macrosomia.[12–15] Potential longer-term health and developmental consequences include childhood and adult obesity, metabolic illnesses associated with obesity, asthma and neurodevelopmental delay.[14,16]

Much of public health policy and practice currently focuses on overweight and obesity, but underweight is also associated with increased risk of a preterm or low-birthweight baby.[17,18]

Worldwide, both underweight and overweight seem associated with low socioeconomic status and thus with inequalities in health starting at birth.[3,19] Studies from different countries have described a social gradient of maternal body mass index (BMI) with increased prevalence of both obesity and underweight among the most vulnerable women.[3,20–22] However, such an analysis has not been conducted in France yet. In addition, comparing the results of these studies is difficult because the social indicators explored differ.

Indeed, the social situation is truly multidimensional and requires several indicators to be approached accurately. One way to better understand the mechanisms of these social inequalities is to examine the association of different dimensions of social status with maternal BMI. In this perspective, we postulated that education level is a marker of cultural capital and a proxy for the social background of origin, whereas level of income describes the availability of finances to which women have access and is a proxy for the current social context. The joint analysis of these two social indicators would summarize information on the social situation of women since adolescence.[23–25]

The National Perinatal Survey data, which included various social variables collected from the women's interview, offer the opportunity to explore social disparities in maternal BMI at a national level in France.[26]

The aims were to (i) describe the evolution of maternal BMI at the beginning of pregnancy between 1998 and 2016 and (ii) analyze social determinants of the prevalence of underweight, overweight and obesity in the recent period.

Methods

Study design

The National Perinatal Surveys (NPSs) are repeated national cross-sectional studies conducted since 1972 in France and coordinated by the INSERM Unit of Perinatal Epidemiology (U1153-EPOPé) in collaboration with other institutions.[26] Data collection covered all women aged ≥18 years who delivered in France during 1 week, in public and private maternity units, at gestational age at least 22 weeks or with a baby weighing at least 500 g at birth. Women were interviewed in their postpartum stay to obtain information about their social and demographic characteristics and prenatal care, and data were obtained from medical files about the course and complications of pregnancy and delivery and the child's health status at birth. Women with a stillbirth or termination of pregnancy were not interviewed. The samples obtained in 1998, 2003, 2010 and 2016 were representative of all women who had a live birth in the same year.[26] The NPSs were approved by the ethics committee of the Health Research Institute (Comité d'Evaluation Ethique de l'INSERM, IRB00003888 no.14-191 for 2016), the French Commission on Information Technology and Liberties (CNIL, no. 915197 for 2016) and the National Council on Statistical Information (Comité National de l'Information Statistique, visa no. 2016X703SA for 2016). For this analysis, we included women from the four surveys conducted in 1998, 2003, 2010 and 2016 who gave birth in continental France and had available BMI.

Measures

BMI was calculated by using the height and weight just before pregnancy that was self-reported during the interview. BMI was considered a continuous variable and also a categorical variable according to a classical classification: underweight (<18.5 kg/m^2), normal weight (18.50–24.99 kg/m^2), overweight (25–29.99 kg/m^2), obesity 1 (30–34.99 kg/m^2), obesity 2 (35–39.99 kg/m^2) and obesity 3 (≥40 kg/m^2).[27] In the analysis of social determinants, these last three classes of obesity were combined into one group, 'obese' (BMI ≥ 30 kg/m^2).

Main social exposures and covariates

We considered two main exposure variables characterizing two complementary dimensions of women's social status (according to our hypothesis): (i) women's educational level as a six-class variable (primary school or less; first step of secondary school, second step of secondary school, *Baccalauréat* degree +1 or 2 years, *Baccalauréat* degree +3 or 4 years and *Baccalauréat* degree +≥5 years) and (ii) household monthly income in six classes (<1000, 1000–1499, 1500–1999, 2000–2999, 3000–3999 and ≥4000 euros/month). Whereas education level was available for all four surveys, income was not collected before 2010.

Covariables included age as a continuous variable or in five 5-year classes (<20, 20–24, 25–29, 30–34 and ≥35), women's place of birth (France, other countries in Europe, North Africa, Sub-Saharan Africa and other countries) and parity as the number of children before the current birth (0, 1, 2 and ≥3).

Statistical analysis

First, we described the distribution of maternal BMI as a continuous and categorical variable in each survey year from 1998 to 2016.

Then we explored the links between maternal BMI and women's characteristics in the most recent period (2010 and 2016 surveys) since income information was not available before. We pooled the 2010 and 2016 data because we found no significant interaction between the most recent year surveys and the two main social exposure variables, education and income: the Wald's statistics from generalized estimating equation models showed the interactions year*education and year*income statistically insignificant, with *P*-values about 50%.

On univariate analyses, we examined the distribution of BMI by social and demographic factors. Then on multivariable analyses, we quantified the associations between social exposure variables (educational level and household income) and maternal BMI [outcome variable in four classes: underweight, normal weight (the reference), overweight and obesity]. We estimated risk ratios (RRs) and their 95% confidence intervals (CIs) calculated with Poisson regression models adjusted for maternal place of birth in five classes, parity in four classes, age as continuous variable and survey year (2010/2016).

Finally, to disentangle the role of educational level and household income despite their notable correlation (Spearman rho coefficient 0.57, $P < 0.001$), we performed a stratified analysis describing the variations in BMI by household income in three classes (<2000, 2000–4000, >4000 euros/month) in three subgroups of women defined by education level (low education level, from no schooling to first step of secondary school; intermediate education level, from second step of secondary school to *Baccalauréat* +2 years; high education level, higher level than *Baccalauréat* +2 years).

We built final models including the two social dimensions in a single social index variable with nine categories combining the three household income classes and three education levels. The proportion of women with at least one missing value in the final model was 7.9% (2009/25 566). Multivariable analyses were conducted with complete cases.

Comparisons involved mainly the chi-square test and Mantel–Haenszel trend test for evolution of the prevalence of obesity over the four survey years. All analyses were conducted with SAS v 9.4.

Results

The NPS populations included 13.460 women in 1998, 14.413 in 2003, 14.672 in 2010 and 12.769 in 2016. The proportion of women with missing BMI data varied from 3.6% in 1998 to 4.4% in 2003, 6.1% in 2010 and 7.6% in 2016. This proportion was 6.8% in the combined 2010–2016 data set (i.e. 1875 women with missing BMI, 79% of whom had missing data on both height and weight).

Evolution of maternal BMI from 1998 to 2016

Supplementary figure S1 shows the distribution of BMI as a continuous variable in the 4 years. The statistical mode of the distribution is shifted to the right toward higher BMI values from year to year; the mean BMI ranged from 22.4 kg/m^2 in 1998 to 22.9 kg/m^2 in 2003 and 23.4 kg/m^2 in 2010 to 23.9 in 2016 as shown by the dashed lines on the figure.

The proportion of women with a normal BMI steadily decreased from 1998 to 2016, and that of women in the overweight class and each obesity class increased (table 1). The proportion in the obese 3 group doubled in this period, from 0.5% to 1.0%, and that of the obese 2 group was multiplied by 2.5. Overall, the percentage obesity was 6% in 1998 and 12% in 2016, following a steady increase from year to year. At the same time, the proportion of underweight decreased from 11% to 7%.

Education and income as social determinants of maternal BMI

The rates of obesity and overweight increased in all categories of education level from 1998 to 2016, and in a comparable extent (Supplementary table S1). In the combined 2010 and 2016 dataset, the prevalence of obesity was 11% and that of overweight was 19% (table 2). The prevalence of overweight and obesity varied strongly and regularly by education level: the prevalence was higher among the lowest educated women (28% and 18%, respectively) when compared with the highest educated women (12% and 5%). Similarly, a

Table 1 Maternal body mass index (BMI): distribution from 1998 to 2016

	Year of the National Perinatal Surveys[a]				
	1998 (n = 12 969) %	2003 (n = 13 783) %	2010 (n = 13 773) %	2016 (n = 11 793) %	
Women with BMI information					$P < 0.001$
Underweight (<18.5 kg/m^2)	10.6	9.2	8.1	7.4	
Normal weight (18.5–24.9 kg/m^2)	69.7	68.1	64.6	60.7	
Overweight (25.0–29.9 kg/m^2)	13.6	15.2	17.4	20.0	
Obese 1 (30–34.9 kg/m^2)	4.5	5.1	6.8	8.1	
Obese 2 (35–39.9 kg/m^2)	1.1	1.8	2.1	2.8	
Obese 3 (≥40 kg/m^2)	0.5	0.7	0.9	1.0	
Obese (≥30 kg/m^2)	6.1	7.6	9.8	11.9	$P < 0.001$

Note: Column percentages (number of women).
a: National representative samples of adult women who delivered in continental France.

Table 2 Women's characteristics by BMI class

		Underweight <18.5 kg/m^2 %	Normal weight 18.5–24.9 kg/m^2 %	Overweight 25.0–29.9 kg/m^2 %	Obese ≥30.0 kg/m^2 %	*P* value*
All women	(25 566)	7.8	62.8	18.6	10.8	
Age (years)						
<20	(415)	20.2	57.1	15.4	7.2	
20–24	(3305)	11.2	59.5	18.3	11.0	
25–29	(8354)	7.7	63.6	18.4	10.4	
30–34	(8320)	7.1	64.2	18.2	10.6	
35–39	(4229)	5.8	62.3	19.6	12.2	
≥40	(943)	6.4	60.4	21.8	11.4	*P < 0.001*
Parity						
0	(9792)	8.9	66.0	16.6	8.6	
1	(9010)	7.5	63.4	18.4	10.7	
2	(3617)	6.4	57.9	22.0	13.7	
≥3	(1830)	5.5	48.6	26.5	19.4	*P < 0.001*
Place of birth						
France	(20 982)	8.1	63.5	17.5	10.8	
Other Europe	(972)	8.1	62.4	19.2	10.2	
North Africa	(1781)	3.9	57.9	27.3	11.0	
Other Africa	(1055)	4.4	53.6	28.0	13.9	
Other	(739)	12.6	66.4	15.4	5.6	*P < 0.001*
Education level						
Primary or no schooling	(396)	5.0	48.7	28.5	17.7	
First step of secondary	(5915)	9.6	54.0	20.7	15.6	
Second step of secondary	(5255)	7.2	58.4	20.7	13.6	
Baccalauréat +2 years	(5243)	6.9	63.3	19.5	10.3	
Baccalauréat +3/4 years	(4637)	7.0	69.5	16.8	6.8	
Baccalauréat + ≥5 years	(3932)	8.4	74.6	12.2	4.8	*P < 0.001*
Household income (€/month)						
<1000	(2334)	10.9	54.2	20.5	14.4	
1000–1499	(2320)	9.0	54.9	21.4	14.7	
1500–1999	(3443)	8.3	54.7	21.6	15.4	
2000–2999	(7330)	6.7	60.5	20.8	12.0	
3000–3999	(5565)	6.8	68.6	16.5	8.1	
≥4000	(4005)	8.2	75.7	12.0	4.2	*P < 0.001*

Note: National representative sample of adult women who delivered in continental France, 2010 and 2016.
Row percentages (number of women).
*: Chi square test for differences in the proportions of BMI categories.

steep gradient was observed by household income, from 20% to 12% for overweight and 14% to 4% for obesity. These percentages increased with age and strongly with parity. The proportion of overweight was high for women born in Africa (27%) and that of obesity was especially high for Sub-Saharan African women (14%).

The prevalence of underweight was under 8%. It did not vary regularly by education level, but it was higher with the lowest income, 11% if less than 1000 euros/month and 9% if 1000–1499 instead of 7% if 2000–3999 euros/month. The proportion of underweight decreased with increasing age and parity and was lower for women born in Africa than other women.

After adjustment for income, birthplace, parity and age, education level was associated with both overweight and obesity (table 3): women with the lowest education level (primary or no schooling) had the highest risk of overweight [RR 1.75 (95% CI 1.44–2.11)] and obesity [2.54 (1.94–3.31)] when compared with the highest education level. Also, risk of overweight and obesity differed greatly by household income, the highest risk with income <2000 euros/month. In

Table 3 Risk ratios of maternal BMI classes by educational level and household's income, multivariable analysis[a]

	Body mass classes (kg/m^2)			
	Underweight <18.5 kg/m^2 aRR (95% CI) (*n* = 1831)	**Normal 18.5–24.9 kg/m^2 Reference (*n* = 14 727)**	**Overweight 25.0–29.9 kg/m^2 aRR (95% CI) (*n* = 4412)**	**Obese ≥30.0 kg/m^2 aRR (95% CI) (*n* = 2587)**
Education level				
Primary or no schooling	0.80 (0.51–1.27)	–	1.75 (1.44–2.11)	2.54 (1.94–3.31)
First step of secondary	1.19 (1.00–1.40)	–	1.47 (1.31–1.65)	2.17 (1.82–2.58)
Second step of secondary	0.93 (0.79–1.11)	–	1.45 (1.30–1.63)	2.05 (1.72–2.44)
Baccalauréat +2 years	0.93 (0.79–1.09)	–	1.38 (1.24–1.54)	1.73 (1.46–2.05)
Baccalauréat +3/4 years	0.90 (0.77–1.05)	–	1.24 (1.11–1.39)	1.22 (1.01–1.46)
Baccalauréat +5 years	1	–	1	1
	$P < 0.001$		$P < 0.001$	$P < 0.001$
Household Income (€/month)				
<1000	1.44 (1.19–1.75)	–	1.55 (1.36–1.78)	2.95 (2.41–3.61)
1000–1499	1.31 (1.08–1.58)	–	1.60 (1.40–1.82)	2.83 (2.32–3.45)
1500–1999	1.19 (1.00–1.42)	–	1.68 (1.49–1.89)	3.00 (2.48–3.62)
2000–2999	0.93 (0.80–1.09)	–	1.62 (1.45–1.81)	2.41 (2.01–2.89)
3000–3999	0.89 (0.76–1.03)	–	1.32 (1.18–1.47)	1.81 (1.50–2.17)
≥4000	1	–	1	1
	$P < 0.001$		$P < 0.001$	$P < 0.001$

Note: (Number of women).
Adjusted risk ratios (aRRs) and 95% confidence interval (CIs) by multinomial regression models including education and income and adjusted for maternal place of birth in five classes, parity in four classes, age as a continuous variable and survey year.
a: National representative sample of adult women who delivered in continental France, 2010 and 2016 ($N = 23\,557$ complete cases).

the lowest income group, the RR for overweight was 1.55 (95% CI 1.6–1.78) and for obesity was 2.95 (2.41–3.61) when compared with the highest income, ≥4000 euros per month, after adjusting for education level, birthplace, parity and age (table 3). We found also a dose–response relation, although of milder strength, between household income and risk of underweight: risk of underweight was highest with the lowest vs. highest income (<1000 vs. ≥4000 euros/month): RR 1.44 (95% CI 1.19–1.75).

When stratifying the analysis by education level, we found an association between income and BMI in each category of education, with more than 2-fold higher proportion of obesity for women with low vs. high income in all three strata of education, although the overall BMI shifted toward higher values for women with low education (table 4). The multivariate analysis combining level of education and household income in a single variable with highly educated and high-income women as the reference category showed striking social variations, in particular for obesity: the adjusted RR was 6.01 (95% CI 4.89–7.38) for women with low education and low income, respective absolute rates of 17.1% vs. 3.7% (table 4).

Similar variations were found for overweight, although less strong than for obesity. The risk of underweight was significantly increased in women with low education and low income, the group with also the highest risk of obesity and overweight.

Discussion

This study describes the steady increase in frequency of overweight and obesity at the beginning of pregnancy in continental France over the last two decades. The most recent data show significant social differences in maternal BMI, with greatly increased risks for the most disadvantaged groups, both in terms of education level and household income. In particular, the results underline the continuity of a social gradient of maternal BMI favoring the most educated women in the wealthiest households, with a cumulative effect of these two social dimensions. Our data also draw attention to an increased risk of underweight for women in the poorest households.

The data are from the NPSs, which are generalist surveys designed to measure the state of perinatal health in France.[23] These results are based on large samples that have good representativeness of women who gave birth in maternity wards in the year the survey was carried out. Because the data on BMI, social and demographic characteristics were collected identically in 2010 and 2016, we could combine the two datasets and guarantee the statistical power needed to accurately estimate the relative risks of different body size patterns by education level and household income while adjusting for demographic characteristics such as birthplace, parity and age of women. The absence of statistical interaction between the year and on the one hand the education level and on the other hand the level of household's income makes this combination of the 2 years of surveys possible.

The survey design, with interviews of women, collected more social data than with the routinely collected data usually obtained in a clinical setting. In particular information on household income, more informative than women's wages because it represents a better approximation of women's standard of living (also including partner's income, social assistance, etc.), was collected.

Limitations should be discussed. The study did not include women with stillbirths, and although the total sample is representative of annual live births, there is probably a slight under-representation of immigrant women because of language problems for the interview and, as a result, of women in less favorable social situations. Pre-pregnancy weight and height were collected by self-reporting and retrospectively, with women interviewed in the days following delivery. When compared with anthropometric measurements, the declarative data may be less precise. Various effects can produce imprecision: rounding of values (attraction of tens or half-dozens), responses altered by memory deficits and responses subject to a form of social desirability leading to a probable underestimation of weight and a tendency for women to overestimate height. The latter effect could be mitigated by the fact that the questionnaire was administered by a health professional during hospitalization because the women were aware of the need to be as precise as when seeking medical advice.

Beyond the imprecision, the BMI indicator was unknown for a small part of the sample, which could imply selection bias because this proportion of missing data increased over the surveys. Since missing BMI values were more frequent for women under 25 years, an underestimation of the proportion of underweight women, especially in 2010 and 2016, is possible. We cannot exclude a differential selection bias by social situation. However, because body size was ignored for women who did not participate in the face-to-face

Table 4 Maternal BMI class by household income and education level combined as one social index exposure, rates and multivariable analysis[a]

		Underweight		Normal		Overweight		Obese	
		<18.5 kg/m²		18.5–24.9 kg/m²		25.0–29.9 kg/m²		≥30.0 kg/m²	
	N	%	aRR (95% CI)	%	Reference	%	aRR (95% CI)	%	aRR (95% CI)
All women	(24 851)	7.8		62.8		18.6		10.8	
Low education level									
Income (€/month)									
<2000	(3857)	10.4	1.56 (1.32–1.84)	51.0	–	21.6	2.16 (1.91–2.45)	17.1	6.01 (4.89–7.38)
1999–3999	(2171)	7.7	1.10 (0.91–1.34)	57.2	–	21.4	2.06 (1.80–2.34)	13.6	4.41 (3.54–5.49)
≥4000	(102)	10.8	1.27 (0.73–2.23)	74.5	–	8.8	0.72 (0.37–1.38)	5.9	1.71 (0.79–3.70)
Intermediate education level									
Income (€/month)									
<2000	(3279)	8.1	1.20 (1.01–1.43)	56.2	–	21.6	2.08 (1.83–2.36)	14.1	5.09 (4.13–6.27)
1999–3999	(6198)	6.4	0.88 (0.76–1.04)	61.8	–	20.0	1.91 (1.70–2.15)	11.7	3.86 (3.15–4.72)
≥4000	(815)	7.5	0.93 (0.70–1.22)	72.3	–	14.2	1.24 (1.01–1.52)	6.0	1.74 (1.25–2.41)
High education level									
Income (€/month)									
<2000	(908)	8.9	1.27 (0.99–1.62)	64.1	–	18.1	1.59 (1.34–1.89)	8.9	3.15 (2.38–4.16)
1999–3999	(4461)	6.7	0.85 (0.72–1.00)	70.3	–	16.2	1.49 (1.32–1.68)	6.8	2.13 (1.72–2.65)
≥4000	(3060)	8.3	1	76.6		11.5	1	3.7	1

Note: Income and educational level combined in one social index variable with nine categories; Low education level = primary or no schooling + first step of secondary; Intermediate education level = second step of secondary + *Baccalauréat* +2 years; High education level = >*Baccalauréat* +2 years.
Rates (%) are row percentages.
Adjusted risk ratios (aRRs) and 95% confidence interval (CIs) by multinomial regression models adjusted for maternal place of birth in five classes, parity in four classes, age as a continuous variable and survey year, $N = 23\,557$ complete cases.
a: National representative sample of adult women who delivered in continental France, 2010 and 2016.

interview when social characteristics were collected, we cannot measure the impact of selection by missing data on the measurement of associations with education level or household income.

Women under age 18 years were not included in these samples. Despite a high total fertility rate in this age group, France has few teenage births when compared with English-speaking countries.[28] Since 2010, <2% of mothers had a child before the year they turned 20.[29] The proportion of minor women is too low for their exclusion to invalidate our results, but this selection by age may have led to an underestimation of the proportion of underweight women and a very slight overestimation of the overall proportion of overweight and obesity, preferentially for women with low education level.

We describe an increase in maternal BMI overtime in France, with a doubling of maternal obesity rate between 1998 and 2016. We observed a general shift in maternal body size toward high values, leading to an increase even in frequency of severe obesity. This result is consistent with the increase in obesity described in the general population in France since 1981, with an acceleration in the 1990s and up to the mid-2000s.[1,30,31] An increase in maternal overweight and obesity prevalence over time has been reported in all countries with data on this aspect, although with a variety of baseline BMI level in the late 90's- much higher maternal obesity rates around 20% in the USA,[6] Australia[20] and Mexico,[4] and closer to the 6% rate in France in 1998 in Spain and Greece[21] for example-, France being a country where the frequency of obesity in the general population is rather lower than for other countries in Europe.[32] This development of BMI in pregnant women is a concern for the maternal and perinatal health of the population worldwide. Changes over time among pregnant women in the prevalence of some characteristics that are risk factors for high BMI may account for the increase in maternal BMI: this is the case for increasing maternal age and higher prevalence of foreign-born mothers, as described in France.[26] However, other contemporary trends, such as the increase in the educational level[26] may act in the opposite way. Therefore, future specific analyses are necessary to characterize the share of each factor in the evolution of maternal BMI over time, and the differences between countries in that matter. A recent paper commissioned by European Board and College of Obstetrics and Gynaecology (EBCOG) stated that 'While most European countries do not systematically report obesity figures in their pregnant population, the prevalence of maternal obesity varies from 7% to 25% and seems strongly related to social and educational inequalities'.[22]

In order to characterize social inequalities in maternal BMI in France on recent data, we used the level of education and household income as complementary indicators of women's social situation, and found high BMI strongly related to each of these indicators separately, even after adjusting for the other, and related to their combination. We highlight a continuous social gradient across the entire population. Differences in overweight or obesity by education level are documented among pregnant women in Sweden,[3] Australia[20] and Spain and Greece,[2] with a rather consistent 2- 3-fold relative difference in maternal obesity rates between the lowest and highest levels of education. Results related to financial income are far less numerous. In the general population, data from nine European countries showed a negative association between body size and income, especially work income, for women.[33] The originality of our findings is to suggest the cumulative impact on high maternal BMI of the two social indicators explored, and the importance of considering each social dimension in a conceptual framework with clear hypotheses on causal relationships.

These high-amplitude associations may be the result of a two-way effect. On one hand, the social determination of behaviors in terms of diet, sedentary lifestyle or physical activity can be initiated from childhood, and facilitated by current economic position.[34,35] This determination is the result of not only individual decisions but is also subject to collective phenomena (e.g. work environment, family or community habits) and constraints on access, because of the price of products or accessibility, depending on where people live.[36,37] On the other hand, social selection by overweight discriminates against such people during their schooling or their access to employment or better-paid jobs with the

same level of training.[33,38] Our study does not allow for distinguishing between the contribution of one or other of these effects given the cross-sectional nature of the data, but it does note and quantify the situation in France on the basis of good-quality and recent data.

Obesity and overweight, which are becoming increasingly common, are a major concern for maternal and perinatal health. Reducing these risk factors in women of childbearing age requires a holistic approach to population health before and during pregnancy. Particular attention must be paid to the significant social inequality of this risk. Public policies must implement programs to limit the increase in obesity as well as its unequal distribution in the population. Such action needs to take place alongside other policies to address the structural, societal, determinants of the obesogenic environment. Health professionals and clinicians from different fields urgently need to inform and advise women to improve their eating and physical activity practices to limit weight gain during childhood, adolescence and early adulthood.

Supplementary data

Supplementary data are available at *EURPUB* online.

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Keypoints

- The results describe a steady increase in frequency of overweight and obesity at the beginning of pregnancy in France over the last two decades, overall and in all categories of maternal education level.
- This study underlines strong social disparities in maternal BMI, both in terms of education level and household income, and the continuity of a social gradient favoring the most educated women in the wealthiest households, supporting the combined implication of social background and current social position in these socioeconomic disparities.
- Women with low education and low income had both the highest risk of obesity and overweight, and the highest risk of underweight.
- Public policies must implement programs to limit the increase in obesity and to advise women to improve their eating and physical activity practices to limit weight gain during childhood, adolescence and adulthood. Such action needs to take place alongside other policies to address the structural, societal, determinants of the obesogenic environment.

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