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ABSTRACT

Background: The incidence of maternal obesity at the start of pregnancy was increasing. But it turns out the data in the scientific literature about the obesity epidemic stabilization or slowing down of BMI trend increases in general population.

Objective: To estimate the prevalence of overweight and obesity in selective Caucasian reproductive age women population in Lithuanian urban region in three decades.

Methods: This is observational retrospective study with the final sample size of 2827 women who gave birth in 1987-1989, 1996 and 2007-2010: 861 (30.5%), 995 (35.2%), 971 (34.3%) respectively. All women were sub-grouped into BMI groups. We also analyzed data on women's age. The results were considered statistically significant at $p<0.05$.

Results: We have observed the increasing BMI for elder women ($r=0.234$, $p<0.05$/ $r=0.254$, $p<0.05$). Correlation between BMI and conceptional age: 1987-1989 $r=0.275$ ($p<0.01$)/ $r=0,325$ ($p<0.01$); 1996-1997 $r=0.212$ ($p<0.01$)/ $r=0.266$ ($p<0.01$); 2007-2010 $r=0.199$ ($p<0.01$)/ $r=0.210$ ($p<0.01$). The prevalence of overweight and obesity among women aged 18 to 24 years decreased from 20.9% in 1987-1989 to 9.5% in 1996, and to 15.7% in 2007-2010; aged 25 to 34 years decreased from 35.5% in 1987-1989 to 23% in 1996, and to 22.4% in 2007-2010; aged 35 to 44 years decreased from 64.9% in 1987-1989 to 34% in 1996, and to 44.9% in 2007-2010.

Conclusion: The conceptional age has increased. Elder pregnant women have higher BMI. The prevalence of overweight and obesity in pregnancy tends to decrease comparing with 1987-1989, but is slightly increasing comparing with 1996 most likely due to elder maternal age.

KEY WORDS: pregnancy, outcome, obesity, body mass index

Strengths and limitations of this study

The main strenght of our research is the evaluation of pregnant women body mass index in three decades. Three decades is a long enough period for the measurement of changes. Our comparative groups size were greatly similar in all decades.

Interpretation of data is limited as pre-pregnancy BMI was self-reported, but not detailed measurements of pre-pregnancy body composition. Second limitation of our study is the diverse distribution of age in study subjects in different decades, since it was not a random sample size, but retrospective study of medical data of all pregnant women who were monitored in the largest outpatient clinics in Kaunas – Lithuanian urban region. To assess the potential modifying effects of BMI and age, women were attributed to various age groups, to analyze interactions between age and body weight.

INTRODUCTION

Rates of overweight and obesity have increased worldwide, therefore World Health Organisation identified obesity as a significant global health problem [1]. The incidence of overweight and obesity increased progressively over the last 5 decades, suggesting that the rising trend in prevalence is not a recent phenomenon [2]. Overweight and obesity is increasing not only in high-income countries, but in low-income as well [3]. This number of people exceeds the number of people who lack food and have lower than normal body mass [4, 5]. It is known that the rate of overweight and obesity is rising over decades in the United States and European countries. 33% of pregnant women are overweight or obese in the United Kingdom [6]. The increasing prevalence of obesity amongst females of reproductive age is of particular concern with epidemiological data describing an overall incidence of 32,4 in the United States. The prevalence of obesity in reproductive age women has doubled since 1979 [7]. It turns out the data in the scientific literature about the obesity epidemic stabilization or slowing down of BMI trend increases, but, in any case, prevalence remain high [8] [9] [10].

Obese persons are more likely to develop potentially serious health problems: dyslipidemia, type 2 diabetes, high blood pressure, metabolic syndrome, stroke, cancer, etc. Obesity negatively affects both contraception and fertility as well. [11] [12]. Relative to normal weight, obesity is associated with significantly higher all-cause mortality [13].

The incidence of maternal obesity at the start of pregnancy it is also increasing and accelerating and obesity among pregnant women is becoming one of the most important women's health issues for this decade [6]. International data shown that the prevalence of maternal obesity (BMI of at least 30kg/m^2) is ranging from 1.8% to 25.3% across countries [14]. Maternal obesity can result in various negative outcomes for both – the mother and the offspring. It is associated with an increased risk of gestational diabetes, hypertension, preeclampsia, stillbirth, fetal macrosomia, Caesarean section [15] [16] [17] [18] [19]. Increasing obesity rates in population it is becoming one of the most commonly occuring risk factors in obstetric practice. [20, 21].

The epidemiological Lithuanian health behaviour monitoring project of adult population was carried-out every two-four years in 1994-2012. In this monitoring project, the rate of overweight (BMI>25kg/m^2) in adult women population ranged from 44% to 50%. The prevalence of obesity in 20-64 aged women reached 18-20 %. In this observational period (1994-2012) the prevalence of overweight and obesity among women aged 20-64 has not change [22] [23] [24]. Sorting through the

epidemiological Lithuanian health behaviour monitoring project data from 1994 to 2012, we can see that percent of overweight and obesity in reproductive age women is dithering, but in recent years (2010-2012) we can see the declining trend (Table No 1). This data contradicts to various literature data indicating the increasing prevalence of overweight and obesity and is encouraging. Therefore, we conducted a study to further analyze body weight changes in reproductive age women and possible trends of body mass in Lithuanian urban region.

Table No 1. Frequency of overweight and obesity in reproductive age women in 1994-2012.
(according Health Behaviour among Lithuanian Adult Population monitoring Project 1994-2012).

Age groups		Year	BMI (kg/m2)						
			<20	20-29.99	20-24.99	25-29.99	≥30	Total No.	Total (%)
20-24 years	% of total	1994	34.8	65.2			0.0	89	100
		1998	16.2	79.2			4.6	130	100
		2000	31.2		58.7	10.1	0.0	109	100
		2002	39.3		47.9	10.3	2.6	117	100
		2006	30.6		55.1	10.2	4.1	98	100
		2010	43.8		38.4	14.3	3.6	112	100
		2012	41.5		45.7	10.6	2.1	94	100
25-34 years		1994	8.8	79.5			11.7	238	100
		1998	7.0	83.9			9	243	100
		2000	17.8		60.4	13.8	8.0	275	100
		2002	27.4		53.5	14.2	4.9	226	100
		2006	21.5		52.9	17.9	7.6	223	100
		2010	26.4		48.6	20.4	4.6	216	100
		2012	27.1		52.1	16.7	4.2	192	100
35-44 years		1994	5.4	79.6			15	240	100
		1998	1.5	78.2			20.3	266	100
		2000	5.4		51.1	28.3	15.2	315	100
		2002	10.3		57.4	24.4	7.9	242	100
		2006	6.7		54.6	21.4	17.2	238	100
		2010	9.2		44.0	28.3	18.4	293	100
		2012	11.3		51.5	23.4	13.8	239	100

OBJECTIVE

To estimate the prevalence of overweight and obesity in selective Caucasian reproductive age women population in Lithuanian urban region in three decades.

MATERIALS AND METHODS

The study has been approved by Kaunas Regional Bioethics Committee, Lithuania (Nr. BE-2-49).
This is part of GESTAD study, wich surveys the influence of gestational diabetes and obesity during pregnancy on health of women and their offspring. We overviewed 2896 medical records of pregnant women who gave birth in 1987-1989, 1996 and 2007-2010, and were seeking for maternity care in 2 outpatient departments of Kaunas city (Lithuania) with the population of 348 000. We excluded data of women who were younger than 18 years and elder than 44 years of age and where the information on height and weight was lacking or obviously wrong. The final sample size in the analyses included 2827 women: 861 (30.5%) for group of 1987-1989 years, 995 (35.2%) for group of 1996 years and 971 (34.3%) for group of 2007-2010.
Information of body weight and height was registrated from medical notes, collected at the first antenatal visit. We evaluated body mass index (BMI) from self-reported pre-pregnancy data (weight and height). BMI was calculated as the weight in kilograms divided by the square of the height in meters (kg/m^2). All women, according to World Health Organisation (WHO) classifications, were sub-grouped into the following groups: underweight women (BMI <18.5 kg/m^2), women with normal BMI (18.5–24.9 kg/m^2), overweight women (BMI correspond 25–29.9 kg/m^2), obese women (BMI ≥30 kg/m^2). There are three different classes of obesity: BMI 30.0–34.9 (Class 1); BMI 35.0–39.9 (Class 2); and BMI 40 and over (Class 3 or morbid obesity). We also analyzed data on women's age. To assess the potential modifying effects of BMI and age, women were attributed to various age groups, to analyze interactions between age and body weight within these subgroups. Tests for differences by age in subjects were evaluated with the following comparisons: aged 18 to 24 vs 25 to 34 years, 18 to 24 vs 35 to 44 years, and 25 to 34 vs 35 to 44 years.
A database was created using Microsoft Office Excel. For the statistical analysis, data was exported to the statistical package IBM SPSS Statistics version 21. Quantitative parametric variables presented as mean and standard deviation, qualitative variables – as absolute numbers (n) and percentage (%). For parametric data, analysis of variance (ANOVA) was used, for the comparison between three or more groups. The results were compared interdependently using Student t-test. Correlation analysis of parametrical data was performed by Pearson's correlation. The results were considered statistically significant at $p<0.05$.

RESULTS

A total of 2827 pregnant women were included in the study population. The final sample size in the analyses included 861 for group 1987-1989 (30.5%), 995 for group 1996 (35.2%) and 971 for group 2007-2010 (34.3%).
Characteristics of women within reproductive age for decades is described in **Table 2**.

Table No 2. Characteristics of women within reproductive age for different year groups.

Characteristic	1987-1989	1996	2007-2010	p value
n (%)	861 (30.5)	995 (35.2)	971 (34.3)	
Age (years), mean ±SD	25.6 ± 5.16	25.26 ± 4.88	28.37 ± 5.51	p<0.05
Age group≤24 years, n (%)	429 (49.8)	504 (50.7)	255 (26.3)	p<0.05
Age group 25-34 years, n (%)	375 (43.6)	435 (43.7)	580 (59.7)	p<0.05
Age group≥35 years, n (%)	57 (6.6)	56 (5.6)	136 (14.0)	p<0.05
Height (cm), mean ±SD	1.65 ± 0.05	1.66 ± 0.05	1.67 ± 0.06	p>0.05
Weight (kg), mean ±SD (min-max)	65.28 ± 10.79 (44-123,9)	61.68 ± 9.88 (40-117)	64.87 ± 12.90 (42-127)	p<0.05
BMI (kg/m²), mean ±SD	23.9 ± 3.68	22.14 ± 3.36	23.05 ± 4.32	p<0.05
BMI <18.5kg/m² n (%)	21 (2.4)	82 (8.2)	81 (8.3)	p<0.05
BMI 18.5 – 24.9kg/m² n (%)	580 (67.4)	746 (75)	659 (67.9)	p<0.05
BMI 25 – 29.9 kg/m² n (%)	200 (23.2)	136 (13.7)	156 (16.1)	p<0.05
BMI 30 – 34.9 kg/m² n (%)	52 (6.0)	26 (2.6)	53 (5.5)	p<0.05
BMI 35 – 39.9 kg/m² n (%)	6 (0.7)	3 (0.3)	19 (2.0)	p<0.05
BMI ≥40 kg/m² n (%)	2 (0.2)	2 (0.2)	3 (0.3)	p>0.05

We have observed the increasing body mass/BMI for elder women (r=0.234, p<0.05/ r=0.254, p<0.05), therefore, analyzing the data, women were assigned to different age groups, seeing that nowadays more often elder women are getting pregnant. Correlation between body weight/BMI and conceptional age according to decades are listed below: 1987-1989 r=0.275 (p<0.01)/ r=0,325 (p<0.01); 1996-1997 r=0.212 (p<0.01)/ r=0.266 (p<0.01); 2007-2010 r=0.199 (p<0.01)/ r=0.210 (p<0.01). Younger women had significantly lower BMI compared to elder women (p<0.01) (**Table No 3)**. Overweight and obesity was more prevalent in older age women (p<0.01) **(Table No 4)**.

Table No 3. BMI values for study subjects according to year and age groups.

Age groups	Year groups		
	1987-1989	1996	2007-2010
	BMI mean±SD (95%CI)		
18-24 years	22,89±3,084 (22,60-23,19)	21,34±2,78 (21,10-21,59)	22,03±3,65 (21,57-22,48)
25-34 years	24,63±3,91 (24,23-25,03)	22,83±3,75 (22,48-23,19)	23,02±4,26 (22,67-23,37)
35-44 years	26,60±3,83 (25,59-27,62)	23,86±3,24 (22,99-24,73)	25,10±4,97 (24,26-25,95)

Table No 4. BMI distribution for study subjects according to year and age groups

Decades				Body mass index groups (kg/m²)						Total (n; %)
				<18,5	18,5-24,9	25-29,9	30-35	35-40	>40	
1987-1989	Age groups	18-24	n	18	321	80	7	3	0	429
			(%)	4,2%	74,8%	18,6%	1,6%	0,7%	0,0%	100,0%
		25-34	n	3	239	94	34	3	2	375
			(%)	0,8%	63,7%	25,1%	9,1%	0,8%	0,5%	100,0%
		35-44	n	0	20	26	11	0	0	57
			(%)	0,0%	35,1%	45,6%	19,3%	0,0%	0,0%	100,0%
	Total		n	21	580	200	52	6	2	861
			(%)	2,4%	67,4%	23,2%	6,0%	0,7%	0,2%	100,0%
1996	Age groups	18-24	n	55	401	39	9	0	0	504
			(%)	10,9%	79,6%	7,7%	1,8%	0,0%	0,0%	100,0%
		25-34	n	26	309	80	15	3	2	435
			(%)	6,0%	71,0%	18,4%	3,4%	0,7%	0,5%	100,0%
		35-44	n	1	36	17	2	0	0	56
			(%)	1,8%	64,3%	30,4%	3,6%	0,0%	0,0%	100,0%
	Total		n	82	746	136	26	3	2	995
			(%)	8,2%	75,0%	13,7%	2,6%	0,3%	0,2%	100,0%
2007-2010	Age groups	18-24	n	36	179	29	8	3	0	255
			(%)	14,1%	70,2%	11,4%	3,1%	1,2%	0,0%	100,0%
		25-34	n	40	410	84	32	13	1	580
			(%)	6,9%	70,7%	14,5%	5,5%	2,2%	0,2%	100,0%
		35-44	n	5	70	43	13	3	2	136
			(%)	3,7%	51,5%	31,6%	9,6%	2,2%	1,5%	100,0%
	Total		n	81	659	156	53	19	3	971
			(%)	8,3%	67,9%	16,1%	5,5%	2,0%	0,3%	100,0%

In subgroup analyses, the prevalence of overweight and obesity among women aged 18 to 24 years decreased from 20.9% in 1987-1989 to 9.5% in 1996, and to 15.7% in 2007-2010. The prevalence among women aged 25 to 34 years decreased from 35.5% in 1987-1989 to 23% in 1996, and to 22.4% in 2007-2010. The prevalence of BMI over 30 kg/m² among women aged 35 to 44 years decreased from 64.9% in 1987-1989 to 34% in 1996, and to 44.9% in 2007-2010. Overall, overweight and obesity according the decades, the prevalence rate has decreased from 30,1% in 1987-1989 to 16,8% in 1996, and 23,9% in 2007-2010.

DISCUSSION

The rapid growth in obesity represents a major public concern. There has been a significant increase in obesity in the last 40 years in developed areas of the world and in developing countries [25]. The rate of overweight and obesity is increasing between reproductive age women as well [25]. Data from some countries have shown a decline or stabilization of obesity levels, especially in children [10]. Recent decreases in the prevalence of obesity have been reported in some populations of youth in the United States. The rate of increase in adult BMI has decreased In England [9].

We chose to analyze the sample of pregnant (reproductive age) female body weight, whereas is very important not only for their own health, but also for their offspring – the future generation. The

mechanisms that link maternal obesity to obesity in offspring and the level of gene-environment interactions are not well understood, but gestational programming could play a very important role [26] [27] [28]. Among women of childbearing age, it is of paramount importance because of its association with multiple adverse health out-comes for the mother and fetus once a woman becomes pregnant [15].

Obesity is an issue of particular concern in the Baltic Countries, where data from multinational surveys have found rates that are among the highest in the world. Data from the WHO MONICA study, collected between 1983 and 1988, placed the 5 centers in the former Soviet Union among the top six positions of 48 centers world-wide in terms of female obesity, with Kaunas in Lithuania occupying the highest position [29]. Considering the surveys, which were conducted in Lithuania, Latvia and Estonia in 1997, obesity is a major health problem in the Baltic Countries, particularly among Lithuanian and Latvian women. In this survey, the proportion of women in Lithuania who were obese was lower than in the earlier MONICA sample [30]. 51% of female respondents from Lithuania had an excess weight (either overweight or obesity). The proportion of women who are obese in Latvia and Lithuania was almost three times higher than in Estonia. The difference is especially marked in women aged under 35, with over four times as many women in Lithuania being obese compared with those in Estonia [30]. Pomerleau et al. evaluated BMI in different age groups in Baltic countries in 1997. We extracted data only of reproductive age women in Lithuanian population. According Pomerleau et al., women at the age of 19-34 years and 35-49 years BMI was 23.2±4.6 and 25.7±4.6 respectively.

According to our results, reproductive age women (≤34 years/ ≥35 years), BMI trend is decreasing: from 23.76±3.49 / 26,60±3,83 in 1987-1989 to 22.52±3.95 / 25,10±4,97 in 2007-2010 respectively. Considering Pomerleau et al. results, normal BMI had 61.75%, overweight - 27.45%, obese - 10.85% of Lithuanian women (No=751) in 1997. Sorting through the epidemiological Lithuanian health behaviour monitoring project data from 1994 to 2012, we see that percent of overweight and obesity in reproductive age women is dithering, but in recent years (2010-2012) the declining trend is observed **(Table No. 1)** [22] [23] [24]. Analyzing our results, the prevalence of obesity among women aged 18 to 44 years decreased from 6.9% in 1987-1989 to just over 3% in 1996, and the prevalence increased to 7.8% in 2007-2010. While in our study sample, the prevalence of overweight and obesity rate has decreased from 30,1% in 1987-1989 to 16,8% in 1996, and to 23,9% in 2007-2010.

According to the literature, the prevalence rate of overweight and obesity is higher in elder women population [31, 32]. We have also observed the increasing body mass/BMI for elder women. The rate of elder pregnant women nowadays is also higher. During the 2001-2010 period in Kaunas (Lithuania), the prevalence of pregnant women of up to 25 years old decreased from 35% to 16% while the rate of pregnant women aged 25-39 years old increased from 56% to 72% [33]. Therefore, it can lead to higher obesity prevalence recently, comparing to 1996.

Several limitations should be considered when interpreting the results of our study. First, interpretation of data is limited as pre-pregnancy BMI was self-reported, but not detailed measurements of pre-pregnancy body composition. Most women, come for their first antenatal visit early in their pregnancy, that is, before the 12th week. In a normal pregnancy, woman could already gain some weight, but in cases of hyperemesis her weight will be lower. This means that some women will exceed a BMI > 30 due to the few kilos of weight gain, and some other women who have lost weight will not be registered as obese. In assessing possible deviations, self-reported pre-

pregnancy BMI was evaluated. Although some investigators have observed that self-reported pre-pregnancy weight and measured weight at first prenatal visit results in identical classification of pre-pregnancy BMI status [34] [35-37].

Second limitation of our study is the diverse distribution of age in study subjects in different decades, since it was not a random sample size, but retrospective study of medical data of all pregnant women who were monitored in the largest outpatient clinics in Kaunas – Lithuanian urban region. Analyzing the data we have observed that recently women are giving birth being elder than previously. To assess the potential modifying effects of BMI and age, women were attributed to various age groups, to analyze interactions between age and body weight.

Comparing Pomerleau et al., the epidemiological Lithuanian health behaviour monitoring project and our results of Lithuanian women's BMI changes, we have observed a downward trend of overweight and obesity. This data contradicts to various literature data indicating the increasing prevalence of overweight and obesity and is encouraging. But it may be only a temporary phenomenon, mainly due to the recent media which promotes very lean body. It is therefore necessary for monitoring the tendency of women's BMI in the future.

In summary, it is very important for obese reproductive age women to plan pregnancy, whereas the early life environment may represent a critical period for which intervention strategies could be developed to enchain the current obesity epidemic. Overweight and obese women should receive preconception assessment and counselling with the provision of specific information concerning the maternal and fetal risks of obesity in pregnancy, they might benefit from regular visits to a dietician for dietary and physical activity recommendations. Urgent global activity is needed for more effective obesity prevention.

CONCLUSION

The conceptional age has increased during three decades. Elder pregnant women have higher BMI. The prevalence of overweight and obesity in pregnancy tends to decrease comparing with 1987-1989, but is slightly increasing comparing with 1996 most likely due to elder maternal age.

Competing interests: the authors declare that they have no competing interests.

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Authors' contributions: MFD researched data, contributed to discussion, made statistical analysis, wrote manuscript. PV researched data, contributed to discussion. DB researched data, contributed to discussion. DV designed the study, contributed to discussion, reviewed/edited manuscript.

Data Sharing Statement: glucose and glucose tolerance tests are available.

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract: **Page 1.**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found: **Page 2.**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported: **Page 3-4.**
Objectives	3	State specific objectives, including any prespecified hypotheses: **Page 4.**
Methods		
Study design	4	Present key elements of study design early in the paper: **Page 5.**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection : **Page 5.**
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up: **Page 5.**
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable. **Page 5.**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group: **Page 5.**
Bias	9	Describe any efforts to address potential sources of bias **Page 3.**
Study size	10	Explain how the study size was arrived at: **Page 5.**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding: **Page 5.**
		(*b*) Describe any methods used to examine subgroups and interactions **Page 5.**
		(*c*) Explain how missing data were addressed: **Page 5.**
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed **Page 5.**
		(*e*) Describe any sensitivity analyses **Page 5.**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed: **Page 5-6.**
		(b) Give reasons for non-participation at each stage: **Page 5.**
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders: **Page 5.**
		(b) Indicate number of participants with missing data for each variable of interest: **Page 5.**

		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount): **Page 5.**
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time: **Page 7.**
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **Page 6-7.**
		(*b*) Report category boundaries when continuous variables were categorized: **Page 5.**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **Page 5.**
Discussion		
Key results	18	Summarise key results with reference to study objectives: **Page 9.**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias: **Page 8.**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence: **Page 8-9.**
Generalisability	21	Discuss the generalisability (external validity) of the study results **Page 8-9.**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based: **Page 9.**

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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RETROSPECTIVE AGE-ADJUSTED BODY MASS INDEX ANALYSIS OF CAUCASIAN PRE-PREGNANT WOMEN POPULATION OVER THREE DECADES IN LITHUANIAN URBAN REGION

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KEY WORDS: pregnancy, obesity, body mass index.

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ABSTRACT

Background: The incidence of maternal obesity at the start of pregnancy is increasing. But it turns out the data in the scientific literature about the obesity epidemic stabilization or downward trend in general population.

Objective: To estimate the prevalence of overweight/obesity in Caucasian pre-pregnant women population in three decades.

Methods: This is observational retrospective study with the final sample size of 2827 women who gave birth in 1987-1989, 1996-1997 and 2007-2010: 861 (30.5%), 995 (35.2%), 971 (34.3%) respectively. All women were sub-grouped into BMI and age groups. For the statistical analysis, MS Excel and SPSS Statistics v.21 were used. Quantitative parametric variables presented as mean and SD, qualitative variables – as absolute numbers (n) and percentage (%). For parametric data, analysis of variance was used. Comparison between two groups χ^2 test was used. Correlation analysis of parametrical data was performed by Pearson's correlation. The results were compared interdependently using Student t-test. The results were considered statistically significant at $p<0.05$.

Results: We have observed the increasing BMI for elder women ($r=0.254$, $p<0.05$). Correlation between BMI and conceptional age: 1987-1989 r=0,325 ($p<0.01$); 1996-1997 $r=0.266$ ($p<0.01$); 2007-2010 $r=0.210$ ($p<0.01$). The prevalence of overweight/obesity among women aged 18 to 24 years decreased from 20.9% in 1987-1989 to 9.5% in 1996-1997, and to 15.7% in 2007-2010; aged 25 to 34 years decreased from 35.5% in 1987-1989 to 23% in 1996-1997, and to 22.4% in 2007-2010; aged 35 to 44 years decreased from 64.9% in 1987-1989 to 34% in 1996-1997, and to 45.3% in 2007-2010.

Conclusion: The conceptional age has increased during three decades. Elder pregnant women have higher BMI. The prevalence of overweight and obesity in pregnancy tends to decrease in Lithuanian urban region in three decades. The slight increase in overweight/obesity is seen in 2007-2011 comparing to 1996-1997 most likely due to elder maternal age.

KEY WORDS: pregnancy, outcome, obesity, body mass index

Strengths and limitations of this study

The main strenght of our research is the evaluation of pre-pregnant women body mass index in three decades. Three decades is a long enough period for the measurement of changes. Our comparative groups size were greatly similar in all decades. To our knowledge this is the first publication that presents the downward and stabilizing trend of pre-pregnancy BMI.

Interpretation of data is limited as pre-pregnancy BMI was self-reported, but not detailed measurements of pre-pregnancy body composition. But it is practically impossible to measure the young women's pre-pregnancy BMI, whereas young women rarely visits the clinic for well-being, as well as the possible unplanned pregnancies - so the only option to evaluate pre-pregnancy BMI is self-reported.

The diverse distribution of age in our study subjects in different decades, limited the opportunities for more accurate assessment of obesity prevalence, because elder age women monitored to have higher BMI. We could not influence the data as it was not a random sample size, but retrospective study of medical data of all pregnant women who were observed in the largest outpatient clinics in Kaunas – Lithuanian urban region. To assess the potential modifying effects of BMI and age, women were attributed to various age groups, to analyze interactions between age and body weight.

INTRODUCTION

The incidence of overweight and obesity increased worldwide progressively over the last 5 decades, suggesting that the rising trend in prevalence is not a recent phenomenon [1, 2]. The prevalence of obesity in reproductive age women has doubled since 1979 [3]. Overweight and obesity is increasing not only in high-income countries, but in low-income as well [4]. Recently, it turns out a little data in the scientific literature about the obesity epidemic stabilization or slowing down of BMI trend increase, but, in any case, prevalence remain high [5] [6] [7] [8]. Obesity downward trend nowadays is more common in children [8, 9] [7, 10], but the stabilization of excess weight prevalence is predicted in adults as well [6, 11]. The data says, that pre-pregnancy obesity prevalence continues to increase and varies by race–ethnicity and maternal age, unfortunately. [12] [13]. The incidence of maternal obesity at the start of pregnancy it is also increasing and accelerating and obesity among pregnant women is becoming one of the most important women's health issues for this decade [14]. International data shown that the prevalence of maternal obesity (BMI of at least 30kg/m^2) is ranging from 1.8% to 25.3% across the countries [15].

Maternal obesity can result in various negative outcomes for both – the mother and the offspring. It is associated with an increased risk of gestational diabetes, hypertension, preeclampsia, stillbirth, fetal macrosomia, Caesarean section [16] [17-20].

The epidemiological Lithuanian health behaviour monitoring project of adult population was carried-out every two-four years in 1994-2012. In this monitoring project, the rate of overweight (BMI>25kg/m^2) in adult women population ranged from 44% to 50%. The prevalence of obesity in 20-64 aged women reached 18-20 %. In this observational period (1994-2012) the prevalence of overweight and obesity among women aged 20-64 has not change [21-23]. Sorting through the epidemiological Lithuanian health behaviour monitoring project data from 1994 to 2012, we can see that percent of overweight and obesity in reproductive age women is dithering, but in recent years

(2010-2012) the trend is declining. This data of Lithuanian women population contradicts to various literature data indicating the increasing prevalence of overweight and obesity in pre-pregnancy and is encouraging. Therefore, we conducted a study to further analyze body weight changes in reproductive age women and possible trends of body mass in pre-pregnancy in Lithuanian urban region.

OBJECTIVE

To estimate the prevalence of overweight and obesity in Caucasian pre-pregnant women population in Lithuanian urban region in three decades.

MATERIALS AND METHODS

The study has been approved by Kaunas Regional Bioethics Committee, Lithuania (Nr. BE-2-49).

This is a part of GESTAD study, wich surveys the influence of gestational diabetes and obesity during pregnancy on health of women and their offspring. We overviewed 2896 medical records of pregnant women who gave birth in 1987-1989, 1996-1997 and 2007-2010, and were seeking for maternity care in 2 outpatient departments of Kaunas city (Lithuania) with the population of 348 000. We excluded data of women who were younger than 18 years and elder than 44 years of age and where the information on height and weight was lacking or obviously wrong. The final sample size in the analyses included 2827 women: 861 (30.5%) in the group of 1987-1989 years, 995 (35.2%) in the group of 1996-1997 years and 971 (34.3%) in the group of 2007-2010.

Information of age, body weight and height was registrated from medical notes, collected at the first antenatal visit. Body mass index (BMI) was evaluated from self-reported pre-pregnancy data (weight and height). BMI was calculated as the weight in kilograms divided by the square of the height in meters (kg/m^2). All women, according the World Health Organisation (WHO) classifications, were sub-grouped into the following groups: underweight women (BMI <18.5 kg/m^2), women with normal BMI (18.5–24.9 kg/m^2), overweight (BMI correspond 25–29.9 kg/m^2) and obese women (BMI ≥30 kg/m^2). There are three different classes of obesity: BMI 30.0–34.9 (Class 1); BMI 35.0–39.9 (Class 2); and BMI 40 and over (Class 3 or morbid obesity). To assess the potential modifying effects of BMI and age, women were attributed to various age groups, to analyze interactions between age and body weight within these subgroups. Tests for differences by age in subjects were evaluated with the following comparisons: aged 18 to 24 vs 25 to 34 years, 18 to 24 vs 35 to 44 years, and 25 to 34 vs 35 to 44 years.

A database was created using Microsoft Office Excel. For the statistical analysis, data was exported to the statistical package IBM SPSS Statistics version 21. Quantitative parametric variables presented as mean and standard deviation, qualitative variables – as absolute numbers (n) and percentage (%). For parametric data, analysis of variance (ANOVA) was used, for the comparison between three or more groups. Comparison between two groups χ^2 test was used. Correlation analysis of parametrical data was performed by Pearson's correlation. To assess the potentianl effect of age to BMI, odds ratio was evaluated. The results were considered statistically significant at $p<0.05$.

RESULTS

A total of 2827 pregnant women were included in the study population. The final sample size in the analyses included 861 for group 1987-1989 (30.5%), 995 for group 1996-1997 (35.2%) and 971 for group 2007-2010 (34.3%). Characteristics of women within reproductive age for decades is described in **Table 1**.

Table No 1. Characteristics of women within reproductive age for different year groups.

Characteristic	1987-1989	1996-1997	2007-2010	p value
n (%)	861 (30.5)	995 (35.2)	971 (34.3)	
Age (years), mean ±SD	25.6 ± 5.16	25.26 ± 4.88	28.37 ± 5.51	p<0.001
Age group≤24 years, n (%)	429 (49.8)	504 (50.7)	255 (26.3)	p<0.05
Age group 25-34 years, n (%)	375 (43.6)	435 (43.7)	580 (59.7)	p<0.05
Age group≥35 years, n (%)	57 (6.6)	56 (5.6)	136 (14.0)	p<0.05
Height (cm), mean ±SD	1.65 ± 0.05	1.66 ± 0.05	1.67 ± 0.06	p<0.001
Weight (kg), mean ±SD (min-max)	65.28 ± 10.79 (44-123,9)	61.68 ± 9.88 (40-117)	64.87 ± 12.90 (42-127)	p<0.001
BMI (kg/m²), mean ±SD	23.9 ± 3.68	22.14 ± 3.36	23.05 ± 4.32	p<0.001
BMI <18.5kg/m² n (%)	21 (2.4)	82 (8.2)	81 (8.3)	p<0.05
BMI 18.5 – 24.9kg/m² n (%)	580 (67.4)	746 (75)	659 (67.9)	p<0.05
BMI 25 – 29.9 kg/m² n (%)	200 (23.2)	136 (13.7)	156 (16.1)	p<0.05
BMI 30 – 34.9 kg/m² n (%)	52 (6.0)	26 (2.6)	53 (5.5)	p<0.05
BMI 35 – 39.9 kg/m² n (%)	6 (0.7)	3 (0.3)	19 (2.0)	p<0.05
BMI ≥40 kg/m² n (%)	2 (0.2)	2 (0.2)	3 (0.3)	p>0.05

We have observed the increasing BMI for elder women (r=0.254, p<0.05), therefore, analyzing the data, women were assigned to different age groups, seeing that recently more often women are getting pregnant elder than previously. Correlation between BMI and conceptional age according to decades are listed below: 1987-1989 r=0.325 (p<0.001); 1996-1997 r=0.266 (p<0.001); 2007-2010

r=0.210 (p<0.001). The odds ratio of being overweight for women at the age of 25, is 2.34 (CI 95% 1.93-2.83), but at the age of 35 the odds ratio of being overweight is even 3.39 (CI 95% 2.59-4.42).

Table No 2 represents BMI values for study subjects according to age indicating that elder women had significantly higher BMI compared to younger women (p<0.001). The table below also indicates the mean of BMI trend in surveyed decades. BMI downward trend is best reflected in the largest group of subjects, that is in women aged 25-34, where we have observed statistically significant difference between 1987-1989 versus 1996-1997 and 1987-1989 versus 2007-2011. But no statistical significant difference of BMI mean was observed between 1996-1997 and 2007-2011. This indicates the declining and stabilizing trend in pre-pregnancy in Lithuanian urban region.
Evaluating BMI in elder than 35 years old women is complicated whereas there were twice less pregnant women in 1987-1989 and 1996-1997 comparing to 2007-2011. The data implies an overall decrease, but the mean of BMI not siniffically increased in 2007-2011 comparing to 1996-1997.

Table No 2. BMI values for study subjects according to year and age groups.

Age groups	Year groups			p value
	1987-1989	1996-1997	2007-2010	
	BMI mean±SD (95%CI)			
18-24 years	22,89±3,084 (22,60-23,19)	21,34±2,78 (21,10-21,59)	22,03±3,65 (21,57-22,48)	1987-1989vs1996-1997 p<0.001 1987-1989vs2007-2010 p<0.001 1996-1997vs2007-2010 p=0.004
25-34 years	24,63±3,91 (24,23-25,03)	22,83±3,75 (22,48-23,19)	23,02±4,26 (22,67-23,37)	1987-1989vs1996-1997 p<0.001 1987-1989vs2007-2010 p<0.001 1996-1997vs2007-2010 p=0.450
35-44 years	26,60±3,83 (25,59-27,62)	23,86±3,24 (22,99-24,73)	25,10±4,97 (24,26-25,95)	1987-1989vs1996-1997 p=0.002 1987-1989vs2007-2010 p=0.068 1996-1997vs2007-2010 p=0.055

Table No 3 indicates BMI distribution for study subjects according to different decades and age groups. In subgrouped analyses, the prevalence of overweight and obesity among women aged 18 to 24 years decreased from 20.9% in 1987-1989 to 9.5% in 1996-1997, and to 15.7% in 2007-2010 (p<0.05). The prevalence of BMI over 25 kg/m² among women aged 25 to 34 years decreased from 35.5% in 1987-1989 to 23% in 1996-1997, and to 22.4% in 2007-2010. The prevalence of overweight and obesity among women aged 35 to 44 years decreased from 64.9% in 1987-1989 to 34% in 1996-1997, and to 45.3% in 2007-2010. The slight increase in overweight/obesity is seen in 2007-2011 comparing to 1996-1997 in elder women, but is not statistically significant and this is most likely due to elder maternal age. Therefore, further monitoring of this data should be performed.
Overall, overweight and obesity according the decades, the prevalence rate has decreased from 30.1% in 1987-1989 to 16.8% in 1996-1997, and 23.8% in 2007-2010.

Table No 3. BMI distribution for study subjects according to different decades and age groups

BMI_gr (kg/m²)	Decades											
	1987-1989			Total	1996-1997			Total	2007-2011			Total
	Age_groups				Age_groups				Age_groups			
	18-24	25-34	35-44	18-44	18-24	25-34	35-44	18-44	18-24	25-34	35-44	18-44
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
<18.5	18 (4.2)	3 (0.8)	0 (0)	21 (2.4)*/**	55 (10.9)	26 (6.0)	1 (1.8)	82 (8.2)*	36 (14.1)	39 (6.7)	5 (3.6)	80 (8.2)**
18.5-24.9	321 (74.8)	239 (63.7)	20 (35.1)	580 (67.4)*	401 (79.6)	309 (71.0)	36 (64.3)	746 (75.0)*/**	179 (70.2)	410 (70.8)	70 (51.1)	659 (67.9)**
25-29.9	80 (18.6)	94 (25.1)	26 (45.6)	200 (23.2)*/**	39 (7.7)	80 (18.4)	17 (30.4)	136 (13.7)*	29 (11.4)	84 (14.5)	43 (31.4)	156 (16.1)**
30-35	7 (1.6)	34 (9.1)	11 (19.3)	52 (6.0)*	9 (1.8)	15 (3.4)	2 (3.6)	26 (2.6)*	8 (3.1)	32 (5.5)	13 (9.5)	53 (5.4)
35-40	3 (0.7)	3 (0.8)	0 (0)	6 (0.7)	0 (0)	3 (0.7)	0 (0)	3 (0.3)	3 (1.2)	13 (2.2)	3 (2.2)	19 (1.9)
>40	0 (0)	2 (0.5)	0 (0)	2 (0.2)	0 (0)	2 (0.5)	0 (0)	2 (0.2)	0 (0)	1 (0.2)	3 (2.2)	4 (0.4)
Total (within group)	429 (100)	375 (100)	57 (100)		504 (100)	435 (100)	56 (100)		255 (100)	579 (100)	137 (100)	
Total	861 (100)				995 (100)				971 (100)			

*/** show statistical significant difference between the column relevant values ($p<0.05$)

DISCUSSION

The rapid growth in obesity represents a major public concern. There has been a significant increase in obesity in the last 40 years in developed areas of the world and in developing countries [24]. The rate of overweight and obesity is increasing between reproductive age women as well [24]. Data from some countries have shown a decline or stabilization of obesity levels, especially in children [7]. Recent decreases in the prevalence of obesity have been reported in some populations of youth in Europe and in the United States. The rate of increase in adult BMI has decreased In England [6]. Unfortunately, pre-pregnancy obesity prevalence continues to increase and varies by race–ethnicity and maternal age [12] [13].

We choose to analyze the sample of pregnant (reproductive age) female body weight, whereas is very important not only for their own health, but also for their offspring – the future generation. The mechanisms that link maternal obesity to obesity in offspring are not well understood, but gestational programming could play an important role [25] [26] [27]. Among women of childbearing age, it is of paramount importance because of its association with multiple adverse health outcomes for the mother and fetus once a woman becomes pregnant [16].

Obesity is an issue of particular concern in the Baltic Countries, where data from multinational surveys have found rates that are among the highest in the world. Data from the WHO MONICA study, collected between 1983 and 1988, placed the 5 centers in the former Soviet Union among the top six positions of 48 centers world-wide in terms of female obesity, with Kaunas in Lithuania occupying the highest position [28]. Considering the surveys, which were conducted in Lithuania, Latvia and Estonia in 1997, obesity is a major health problem in the Baltic Countries, particularly among Lithuanian and Latvian women. In this survey, the proportion of women in Lithuania who were obese was lower than in the earlier MONICA sample [29]. 51% of female respondents from Lithuania had an excess weight (either overweight or obesity). The proportion of women who are obese in Latvia and Lithuania was almost three times higher than in Estonia. The difference is especially marked in women aged under 35, with over four times as many women in Lithuania being obese compared with those in Estonia [29]. Pomerleau et al. evaluated BMI in different age groups in Baltic countries in 1997. We extracted data only of reproductive age women in Lithuanian population. According Pomerleau et al., women at the age of 19-34 years and 35-49 years BMI was 23.2±4.6 and 25.7±4.6 respectively. According to our results, reproductive age women (≤34 years/ ≥35 years), BMI trend is decreasing: from 23.76±3.49 / 26,60±3,83 in 1987-1989 to 22.52±3.95 / 25,10±4,97 in 2007-2010 respectively. Considering Pomerleau et al. results, normal BMI had 61.75%, overweight - 27.45%, obese - 10.85% of Lithuanian women (No=751) in 1997. Sorting through the epidemiological Lithuanian health behaviour monitoring project data from 1994 to 2012, we see that percent of overweight and obesity in reproductive age women is dithering, but in recent years (2010-2012) the declining trend is observed [21] [22] [23]. Analyzing our results, the prevalence of obesity among women aged 18 to 44 years decreased from 6.9% in 1987-1989 to just over 3% in 1996-1997, and the prevalence increased to 7.8% in 2007-2010. While in our study sample, the prevalence of overweight and obesity rate has decreased from 30.1% in 1987-1989 to 16.8% in 1996-1997, and to 23.8% in 2007-2010.

Several limitations should be considered when interpreting the results of our study. First, interpretation of data is limited as pre-pregnancy BMI was self-reported, but not detailed measurements of pre-pregnancy body composition. On the other hand, some investigators have observed that self-reported pre-pregnancy weight and measured weight at first prenatal visit results in identical classification of pre-pregnancy BMI status [30] [30-32]. It is common to evaluate self-reported pre-pregnancy data to avoid possible weight changes in the first trimester of pregnancy. Most women, come for their first antenatal visit early in their pregnancy, that is, before the 12th week. In normal pregnancy, woman could already gain some weight, but in cases of hyperemesis the weight would be lower. This means that some women will exceed a BMI > 30 due to the few kilos of weight gain, and some other women who have lost weight will not be registered as obese. In assessing possible deviations, self-reported pre-pregnancy BMI was evaluated. It is practically impossible to measure the young women's pre-pregnancy BMI, whereas young women rarely visits the clinic for well-being, as well as the possible unplanned pregnancies - so the only option to evaluate pre-pregnancy BMI is self-reported.

The diverse distribution of age in our study subjects in different decades, limited the opportunities for more accurate assessment of obesity prevalence, because elder age women monitored to have higher BMI [33] [34]. Slightly higher pre-pregnancy BMI in 2007-2010 compared to 1996-1997 is likely to be determined by elder age entailed decreased physical activity, sedentary lifestyle, changes in hormones, but not the term period. We could not influence the data as it was not a random sample

size, but retrospective study of medical data of all pregnant women who were observed in the largest outpatient clinics in Kaunas – Lithuanian urban region. Only analyzing the data, we have observed that recently women are giving birth being rather elder than previously. Literature data confirms that during the 2001-2010 period in Kaunas (Lithuania), the prevalence of pregnant women of up to 25 years old decreased from 35% to 16% while the rate of pregnant women aged 25-39 years old increased from 56% to 72% [35]. To assess the potential modifying effects of BMI and age, women were attributed to various age groups, to analyze interactions between age and body weight.

Comparing Pomerleau et al., the epidemiological Lithuanian health behaviour monitoring project and our results of Lithuanian women's BMI changes, we have observed a downward trend of overweight and obesity. This data contradicts to various literature data indicating the increasing prevalence of overweight and obesity in pre-pregnancy and is encouraging. To our knowledge this is the first publication that presents the downward and stabilizing trend of pre-pregnancy BMI. This promising data could be determined by public health promotion, social health improvement, organizing physical activity campaigns, improving access to physical activity, providing more information about obesity damages to the body. This could mean effective prevention of obesity. But also it may be only a temporary phenomenon, mainly due to the recent media which promotes very lean body. It is therefore necessary for monitoring the tendency of women's BMI in the future.

In summary, global activity is needed for more effective obesity prevention. The results are encouraging to futher implement preventive strategies, disseminate information about the principles of healthy nutrition, promote physical activity. Talking about future generations, the early life environment may represent a critical period for which intervention strategies could be developed to enchain the current obesity epidemic, therefore it is very important for obese reproductive age women to plan pregnancy. Overweight and obese women should receive preconception assessment and counselling with the attitude of specific information regarding the maternal and fetal risks of obesity in pregnancy, they might benefit from regular visits to a dietician for dietary and physical activity recommendations. Our goal should be vicious circle of obesity closing.

CONCLUSION

The conceptional age has increased during three decades. Elder pregnant women have higher BMI. The prevalence of overweight and obesity in pregnancy tends to decrease in Lithuanian urban region in three decades. The slight increase in overweight/obesity is seen in 2007-2011 comparing to 1996-1997 most likely due to elder maternal age.

Competing interests: the authors declare that they have no competing interests.

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Authors' contributions: MFD researched data, contributed to discussion, made statistical analysis, wrote manuscript. PV researched data, contributed to discussion. DB researched data, contributed to discussion. DV designed the study, contributed to discussion, reviewed/edited manuscript.

Data Sharing Statement: No additional data available.

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract: **Page 1.**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found: **Page 2.**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported: **Page 3-4.**
Objectives	3	State specific objectives, including any prespecified hypotheses: **Page 4.**
Methods		
Study design	4	Present key elements of study design early in the paper: **Page 5.**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection : **Page 5.**
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up: **Page 5.**
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable. **Page 5.**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group: **Page 5.**
Bias	9	Describe any efforts to address potential sources of bias **Page 3.**
Study size	10	Explain how the study size was arrived at: **Page 5.**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding: **Page 5.**
		(*b*) Describe any methods used to examine subgroups and interactions **Page 5.**
		(*c*) Explain how missing data were addressed: **Page 5.**
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed **Page 5.**
		(*e*) Describe any sensitivity analyses **Page 5.**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed: **Page 5-6.**
		(b) Give reasons for non-participation at each stage: **Page 5.**
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders: **Page 5.**
		(b) Indicate number of participants with missing data for each variable of interest: **Page 5.**

		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount): **Page 5.**
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time: **Page 7.**
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **Page 6-7.**
		(*b*) Report category boundaries when continuous variables were categorized: **Page 5.**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **Page 5.**
Discussion		
Key results	18	Summarise key results with reference to study objectives: **Page 9.**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias: **Page 8.**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence: **Page 8-9.**
Generalisability	21	Discuss the generalisability (external validity) of the study results **Page 8-9.**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based: **Page 9.**

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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RETROSPECTIVE ANALYSIS OF AGE-ADJUSTED BODY MASS INDEX AMONG PRE-PREGNANT WOMEN IN THE LITHUANIAN URBAN AREA DURING THREE DECADES

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KEY WORDS: pregnancy, obesity, body mass index.

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Authors: Francaite-Daugeliene M., Baliutaviciene D., Petrenko V., Velickiene D.

ABSTRACT

Background: The prevalence of maternal obesity at the beginning of pregnancy is increasing. However, there are some studies reporting the stabilization of obesity epidemic or even the downward trend in the general population.

Objective: To determine the prevalence of overweight and obesity in Lithuanian pre-pregnant female population during three decades.

Methods: This observational retrospective study included a sample of 2827 18–44-year-old women who gave birth in 1987–1989, 1996–1997 and 2007–2010: 861(30.5%), 995(35.2%) and 971(34.3%) respectively. All women were divided into groups by body mass index (BMI) calculated from self-reported weight and height, and age reported during the first antenatal visit. Quantitative parametric variables were expressed as mean and standard deviation; qualitative variables, as absolute numbers(n) and percentage(%). For parametric data, analysis of variance was used. Differences were considered statistically significant at $P<0.05$.

Results: The prevalence of overweight and obesity among women aged 18 to 24 years decreased from 20.9% in 1987–1989 to 9.5% in 1996–1997 and to 15.7% in 2007–2010; among women aged 25 to 34 years, decreased from 35.5% in 1987–1989 to 23% in 1996–1997 and to 22.4% in 2007–2010; and among women aged 35 to 44 years decreased from 64.9% in 1987–1989 to 34% in 1996–1997 and to 45.3% in 2007–2010. BMI increased with an increasing age($r=0.254$, $P<0.05$). Analysis by separate periods(1987–1989, 1996–1997 and 2007–2010) revealed a positive correlation between BMI and age at the first antenatal visit in all periods($r=0.325$, $P<0.01$; $r=0.266$, $P<0.01$; and $r=0.210$, $P<0.01$, respectively).

Conclusion: The prevalence of overweight and obesity among pre-pregnant women tended to decrease in the Lithuanian urban area during three decades. A slight increase in overweight and obesity documented in 2007–2010 compared with 1996–1997 most likely was caused by older maternal age.

KEY WORDS: pregnancy, outcome, obesity, body mass index

Strengths and limitations of this study

The evaluation of body mass index (BMI) among pre-pregnant women during three decades is a long enough period to identify the changes and draw conclusions about trends.

The size of groups in our study across different decades was greatly similar, and this allowed intercomparison of groups.

To our knowledge, this is the first publication that presents the downward and stabilizing trend in pre-pregnancy BMI.

The interpretation of data is limited as pre-pregnancy BMI was calculated from self-reported weight and height, and no detailed measurements of pre-pregnancy weight and height were taken. It is practically impossible to measure pre-pregnancy weight and height among young healthy women as they rarely visit a clinic, and this leaves the only option to evaluate pre-pregnancy BMI from self-reported data.

The diverse distribution of our study subjects by age across different periods limited the opportunities for more accurate assessment of obesity prevalence, because older women have been shown to have a higher BMI; however, we could not influence the data as our study was not a randomised study, but a retrospective study of antenatal data of all pregnant women who were observed in the largest outpatient clinics in Kaunas, a Lithuanian urban area.

INTRODUCTION

The incidence of overweight and obesity increased worldwide progressively over the last 5 decades, suggesting that a rising trend in prevalence is not a recent phenomenon [1, 2]. The prevalence of obesity among women of reproductive age has doubled since 1979 [3]. Overweight and obesity is increasing not only in high-income, but also in low-income countries [4]. Recently, there is a growing body of evidence about the stabilization of obesity epidemic or slowing down of body mass index (BMI) trend increases; however, in any case, the prevalence of obesity remains high [5] [6] [7] [8]. A declining trend in obesity prevalence is documented more commonly among children [7, 8, 9, 10], but stabilization in the prevalence of excess weight is predicted in adults as well [6, 11]. Unfortunately, evidence shows that the prevalence of pre-pregnancy obesity continues to increase and varies by race–ethnicity and maternal age [12] [13]. There are studies reporting that the incidence of maternal obesity at the beginning of pregnancy is also increasing and accelerating and that obesity among pregnant women is becoming one of the most important women's health issues for this decade [14]. World-wide data show that the prevalence of maternal obesity (BMI of at least 30 kg/m^2) varies from 1.8% to 25.3% across the countries [15].

Maternal obesity can lead to various negative outcomes for both mother and their offspring. It has been reported to be associated with an increased risk of gestational diabetes, hypertension, preeclampsia, stillbirth, foetal macrosomia and Caesarean section [16] [17-20].

Since 1994, several health behaviour surveys have been carried out every 2–4 years during the period of 1994–2012 within the framework of FINBALT HEALTH MONITOR, a collaborative system for monitoring health behaviour in Estonia, Finland, Latvia and Lithuania. The results of this project showed that the prevalence of overweight (BMI 25–29.9 kg/m^2) and obesity (BMI

>30 kg/m^2) in the adult female population aged 20–64 years ranged from 44% to 50% and from 16% to 20%, respectively. However, no changes in the prevalence of overweight and obesity among 20–64-year-old women during the period of 1994–2012 were observed [21-23]. The analysis of epidemiological data gathered during this project from 1994 to 2012 revealed a varying prevalence of overweight and obesity among women of reproductive age, but during last years of the project (2010–2012), a declining trend was observed. These data of the Lithuanian female population contradict to various literature data reporting an increasing prevalence of overweight and obesity in pre-pregnancy and, therefore, are promising. We aimed at conducting a study to further analyze changes in body mass index among women of reproductive age and possible trends of BMI in pre-pregnancy in the Lithuanian urban area.

OBJECTIVE

To determine the prevalence of overweight and obesity in the Lithuanian pre-pregnant female population in the urban area during three decades.

MATERIALS AND METHODS

The study was approved by Kaunas Regional Biomedical Research Ethics Committee, Lithuania (No. BE-2-49).

This study was part of the GESTAD study, which surveys the influence of gestational diabetes and obesity during pregnancy on health of women and their offspring. We reviewed antenatal records of 2896 pregnant women who gave birth in 1987-1989, 1996-1997 and 2007-2010, and received maternity care services in 2 outpatient departments of Kaunas city (Lithuania) with a population of 348 000. Records of women who were younger than 18 years or older than 44 years and those with missing or biologically implausible height and weight were excluded from the analysis. The final study population comprised 2827 women: 861 (30.5%) in 1987-1989, 995 (35.2%) 1996-1997 and 971 (34.3%) in 2007-2010.

Information on age recorded at the first antenatal visit and pre-pregnancy self-reported weight and height was gathered from antenatal records. BMI was calculated from self-reported pre-pregnancy weight and height as the weight in kilograms divided by the square of the height in meters (kg/m^2). All the women were divided by BMI into the following groups according the World Health Organization (WHO) classification: underweight women (BMI <18.5 kg/m^2), women with normal weight (BMI 18.5–24.9 kg/m^2), overweight (BMI 25–29.9 kg/m^2) and obese women (BMI ≥30 kg/m^2). Obesity was categorized as class 1 obesity (BMI 30.0–34.9 kg/m^2), class 2 obesity (BMI 35.0–39.9 kg/m^2) and class 3 or morbid obesity (BMI 40 kg/m^2 and more). According to the age, women were divided into the following groups: aged from 18 to 24 years, aged from 25 to 34 years, and aged from 35 to 44 years.

A database was created using Microsoft Office Excel. For statistical analysis, data were exported to the statistical package IBM SPSS Statistics, version 21. Quantitative parametric variables are presented as a mean and standard deviation; qualitative variables, as absolute numbers (n) and percentage (%). Analysis of variance (ANOVA) was employed to compare three or more groups of parametric data. For comparison of two groups, the χ^2 test was used. Correlation analysis of parametrical data was performed by Pearson's correlation. To assess the potential effect of age on BMI, odds ratios were calculated. Differences were considered statistically significant at $P<0.05$.

RESULTS

A total of 2827 pregnant women were included in the study population. The final sample size in the analyses included 861 for group 1987-1989 (30.5%), 995 for group 1996-1997 (35.2%) and 971 for group 2007-2010 (34.3%). The characteristics of women of reproductive age by different periods are shown in **Table 1**.

Table 1. The characteristics of women's age at the first antenatal visit and body mass index data in pre-pregnancy by different periods (1987-1989, 1996-1997, 2007-2010) in the Lithuanian urban area.

Characteristic	1987–1989 (N=861, 30.5%)	1996–1997 (N=995, 35.2%)	2007–2010 (N=971, 34.3%)	*P* value
Age at the first antenatal visit, mean ± SD, years	25.6 ± 5.16	25.26 ± 4.88	28.37 ± 5.51	<0.001
Age at the first antenatal visit, n (%)				
18–24 years	429 (49.8)	504 (50.7)	255 (26.3)	<0.05
25–34 years	375 (43.6)	435 (43.7)	580 (59.7)	<0.05
35–44 years	57 (6.6)	56 (5.6)	136 (14.0)	<0.05
Height, mean ± SD, cm	1.65 ± 0.05	1.66 ± 0.05	1.67 ± 0.06	<0.001
Weight, mean ± SD (range), kg	65.28 ± 10.79 (44–123.9)	61.68 ± 9.88 (40–117)	64.87 ± 12.90 (42–127)	<0.001
BMI, mean ± SD, kg/m^2	23.9 ± 3.68	22.14 ± 3.36	23.05 ± 4.32	<0.001
BMI, n (%)				
<18.5 kg/m^2	21 (2.4)	82 (8.2)	81 (8.3)	<0.05
18.5–24.9 kg/m^2	580 (67.4)	746 (75)	659 (67.9)	<0.05
25–29.9 kg/m^2	200 (23.2)	136 (13.7)	156 (16.1)	<0.05
30–34.9 kg/m^2	52 (6.0)	26 (2.6)	53 (5.5)	<0.05
35–39.9 kg/m^2	6 (0.7)	3 (0.3)	19 (2.0)	<0.05
≥40 kg/m^2	2 (0.2)	2 (0.2)	3 (0.3)	>0.05

Overall, the BMI increased with an increasing age of women (r=0.254, P<0.05) (Figure 1A). There was a significant positive correlation between BMI and age at the first antenatal visit during all study periods investigated: r=0.325 (P<0.001) in 1987–1989 (Figure 1B), r=0.266 (P<0.001) in 1996–1997 (Figure 1C) and r=0.210 (P<0.001) in 2007–2010 (Figure 1D).

Figure 1. Correlation between body mass index and age at the first antenatal visit during all three periods (A), 1987–1989 (B), 1996–1997 (C) and 2007–2010 (D).

FIGURE 1A
FIGURE 1B
FIGURE 1C
FIGURE 1D

The women aged 25–34 years and 35–44 years were 2.34 (95% CI, 1.93–2.83) and 3.39 (95% CI, 2.59–4.42) times, respectively, as likely to be overweight than their youngest counterparts.

Table 2 shows the mean BMI of pre-pregnant women by different periods and age groups indicating that the women in the oldest age group (35–44 years) had a significantly higher BMI compared to the younger women (P<0.001). A declining trend in BMI is best seen in the largest age group, which included women aged 25–34 years, where we observed a statistically significant difference comparing 1987–1989 vs. 1996–1997 and 1987–1989 vs. 2007–2010. However, there was no statistically significant difference in the mean BMI between 1996–1997 and 2007–2010. This indicates a declining and stabilizing trend in the prevalence of pre-pregnancy obesity in the Lithuanian urban area.

Table 2. Body mass index of pre-pregnant women by different periods (1987-1989, 1996-1997, 2007-2010) and age groups in the Lithuanian urban area.

Age groups	Period			*P* value
	1987–1989	1996–1997	2007–2010	
18–24 years	22.89 ± 3.084 (22.60–23.19)	21.34 ± 2.78 (21.10–21.59)	22.03 ± 3.65 (21.57–22.48)	<0.001, 1987–1989 vs. 1996–1997 <0.001, 1987–1989 vs. 2007–2010 0.004, 1996–1997 vs. 2007–2010
25–34 years	24.63 ± 3.91 (24.23–25.03)	22.83 ± 3.75 (22.48–23.19)	23.02 ± 4.26 (22.67–23.37)	<0.001, 1987–1989 vs. 1996–1997 <0.001, 1987–1989 vs. 2007–2010 0.450, 1996–1997 vs. 2007–2010
35–44 years	26.60 ± 3.83 (25.59–27.62)	23.86 ± 3.24 (22.99–24.73)	25.10 ± 4.97 (24.26–25.95)	0.002, 1987–1989 vs. 1996–1997 0.068, 1987–1989 vs. 2007–2010 0.055, 1996–1997 vs. 2007–2010

Values are mean ± standard deviation (95% confidence interval).

Table 3 indicates the distribution of the study subjects by different BMI, periods and age groups. In subgroup analyses, the prevalence of overweight and obesity among women aged 18 to 24 years decreased from 20.9% in 1987–1989 to 9.5% in 1996–1997 and to 15.7% in 2007–2010 (P<0.05). The proportion of 25–34-year-old women with a BMI of more than 25 kg/m^2 decreased from 35.5% in 1987–1989 to 23% in 1996–1997 (P<0.05) and to 22.4% in 2007–2010 (P<0.05). Among women aged 35 to 44 years, the prevalence of overweight and obesity decreased from 64.9% in 1987–1989 to 34% in 1996–1997 (P<0.05) and to 45.3% in 2007–2010 (P<0.05). A slight increase in the prevalence of overweight and obesity seen in 2007–2010 compared with 1996–1997 was not statistically significant and most likely occurred due to older maternal age.

Overall, the prevalence of overweight and obesity across to the periods decreased from 30.1% in 1987–1989 to 16.8% in 1996–1997 and 23.8% in 2007–2010.

Table 3. The distribution of body mass index in women in pre-pregnancy according to different periods (1987-1989, 1996-1997, 2007-2010) and age groups in the Lithuanian urban area.

BMI, kg/m^2	Periods											
	1987-1989			Total	1996-1997			Total	2007-2010			Total
	Age groups				Age groups				Age groups			
	18–24	25–34	35–44	18–44	18–24	25–34	35–44	18–44	18–24	25–34	35–44	18–44
<18.5	18 (4.2)	3 (0.8)	0 (0)	21 (2.4)*/**	55 (10.9)	26 (6.0)	1 (1.8)	82 (8.2)*	36 (14.1)	39 (6.7)	5 (3.6)	80 (8.2)**
18.5–24.9	321 (74.8)	239 (63.7)	20 (35.1)	580 (67.4)*	401 (79.6)	309 (71.0)	36 (64.3)	746 (75.0)*/**	179 (70.2)	410 (70.8)	70 (51.1)	659 (67.9)**
25–29.9	80 (18.6)	94 (25.1)	26 (45.6)	200 (23.2)*/**	39 (7.7)	80 (18.4)	17 (30.4)	136 (13.7)*	29 (11.4)	84 (14.5)	43 (31.4)	156 (16.1)**
≥30	10 (2.3)	39 (10.4)	11 (19.3)	60 (6.9)*	9 (1.8)	20 (4.6)	2 (3.6)	31 (3.1)* /**	11 (4.3)	46 (7.9)	19 (13.9)	76 (7.7) **
Total (within group)	429 (100)	375 (100)	57 (100)		504 (100)	435 (100)	56 (100)		255 (100)	579 (100)	137 (100)	
Total	861 (100)				995 (100)				971 (100)			

Values are number (percentage).

*/**$P<0.05$, a statistical significant difference comparing the relevant values in rows.

DISCUSSION

The rapid growth in obesity represents a major public concern. A significant increase in obesity during the last 40 years has been documented in developed and developing countries [24]. The prevalence of overweight and obesity is increasing among women of reproductive age as well [24]. Data from some countries have shown a decline or stabilization in obesity levels, especially among children [7]. Recently, a declining trend in the prevalence of obesity has been reported in some populations of youth in Europe and the United States, and the rate of increase in adult BMI has

slowed down in England [6]. Unfortunately, the prevalence of pre-pregnancy obesity continues to increase and varies by race–ethnicity and maternal age [12] [13].

In our study, we chose to analyse the BMI of reproductive-age women as it is very important not only for their own health, but also for their offspring – the future generation. The mechanisms that link maternal obesity to obesity in offspring are not completely elucidated yet, but gestational programming could play an important role [25] [26] [27]. Among women of childbearing age, it is of paramount importance due to its association with multiple adverse health outcomes for the mother and the foetus once a woman becomes pregnant [16].

Obesity is an issue of particular concern in the Baltic countries, where data from multinational surveys have shown rates that are among the highest in the world. Data from the WHO MONICA project, collected between 1983 and 1988, placed the 5 centres in the former Soviet Union among the top six positions of 48 centres world-wide in terms of female obesity, with Kaunas in Lithuania occupying the highest position [28]. A study by Pomerleau et al., which was conducted in Lithuania, Latvia and Estonia in 1997, identified obesity to be a major health problem in the Baltic countries, particularly among Lithuanian and Latvian women. More than half (51%) of female respondents from Lithuania had an excess weight, i.e., were overweight or obese. The proportion of women who were obese in Latvia and Lithuania was approximately three times greater than the proportion of such women in Estonia. The difference was especially considerable among women aged less 35 years, with more than 4 times as many women in Lithuania being obese compared with those in Estonia [29]. However, it is worth noting that in this survey, the proportion of Lithuanian women who were obese was smaller than in the earlier MONICA study [28] [29].

The study by Pomerleau et al. also evaluated BMI by different age groups, and for comparison with our results, only the data about Lithuanian women of reproductive age were extracted. In the study by Pomerleau et al., the BMI of 19–34-year-old and 35–49-year-old women was 23.2±4.6 kg/m^2 and 25.7±4.6 kg/m^2, respectively, and 28.1% and 11.2% of Lithuanian women aged 19–49 years (N=751) were overweight and obese, respectively [29]. The analysis of epidemiological data gathered during the Lithuanian health behaviour monitoring project from 1994 to 2012 revealed a varying prevalence of overweight and obesity among women of reproductive age, but during recent years (2010–2012) a declining trend was observed [21] [22] [23]. Our results showed a decreasing trend in BMI among pre-pregnant women (≤34 years and ≥35 years): from 23.76±3.49 and 26.60±3.83 in 1987–1989 to 22.52±3.95 and 25.10±4.97 in 2007–2010, respectively. The prevalence of obesity among women aged 18 to 44 years decreased from 6.9% in 1987–1989 to 3.1% in 1996–1997 and increased to 7.7% in 2007–2010. Moreover, the merged prevalence of overweight and obesity decreased from 30.1% in 1987–1989 to 16.8% in 1996–1997 and to 23.8% in 2007–2010.

Several limitations should be considered while interpreting the results of our study. Firstly, the interpretation of our data is limited as pre-pregnancy BMI was calculated from self-reported weight and height, and no detailed measurements of pre-pregnancy weight and height were taken. On the other hand, some investigators have observed that self-reported pre-pregnancy weight and weight measured at the first prenatal visit result in identical classification of pre-pregnancy BMI status [30-32]. It is common to evaluate self-reported pre-pregnancy data in order to avoid possible changes in weight occurring during the first trimester of pregnancy. Most women come for their first antenatal visit early in their pregnancy, i.e., before the 12th week. During the normal course of pregnancy, a woman may already gain some weight, but in cases of hyperemesis, the weight can be lower. This means that some women will exceed a BMI of >30 kg/m^2 due to weight gain of a few kilos, and

some other women who lost weight will not be considered as obese. To avoid potential bias, pre-pregnancy BMI calculated from self-reported weight and height was analysed in our study. It is practically impossible to measure pre-pregnancy weight and height among young healthy women as they rarely visit a clinic, as well as the possible unplanned pregnancies, and this leaves the only option to evaluate pre-pregnancy BMI from self-reported data.

The diverse distribution of our study subjects by age across different periods limited the opportunities for more accurate assessment of obesity prevalence, because older women have been shown to have a higher BMI [33] [34]. The evaluation of BMI among women older than 35 years is complicated as the number of pregnant women in 1987–1989 and 1996–1997 was twice smaller than that in 2007–2010. A slightly (not significantly) greater pre-pregnancy BMI in 2007–2010 compared with 1996–1997 is likely to be determined by older age associated with decreased physical activity, sedentary lifestyle and changes in hormone levels, but not by the particular period. We could not influence the data as our study was not a randomised study, but a retrospective study of antenatal data of all pregnant women who were observed in the largest outpatient clinics in Kaunas, a Lithuanian urban area. Analysis of our data has revealed that recently women are giving birth being rather older than previously. Literature data confirm that during 2001–2010 in Kaunas (Lithuania), the percentage of pregnant women younger than 25 years decreased from 35% to 16%, while the proportion of pregnant women aged 25–39 years increased from 56% to 72% [35]. To assess the potential modifying effects of age on BMI, women were assigned to various age groups.

Comparison of the results of the study by Pomerleau et al., epidemiological Lithuanian health behaviour monitoring project and our study revealed a downward trend in the prevalence of overweight and obesity among women of reproductive age. These data contradict to various literature sources indicating an increasing prevalence of overweight and obesity in pre-pregnancy and, therefore, are encouraging. To our knowledge, this is the first publication that presents the downward and stabilizing trend in pre-pregnancy BMI. These promising data could be determined by public health promotion, improvement in social health, organization of physical activity campaigns, improved access to physical activity and provision of more information about harmful effects of obesity on the body and could mean effective prevention of obesity. However, it also may be only a temporary phenomenon mainly caused by the media that recently promotes very lean body. Therefore, the monitoring of future trends in female BMI is of crucial importance.

In summary, global activity is needed for more effective prevention of obesity. The results of our study are encouraging to further implement preventive strategies, disseminate information about the principles of healthy nutrition and promote physical activity. Talking about future generations, the early life environment may represent a critical period for which intervention strategies could be developed to enchain a current obesity epidemic; therefore, it is very important for obese women of reproductive age to plan pregnancy. Overweight and obese women should receive assessment and counselling before pregnancy with an attitude towards specific information regarding the maternal and fetal risks of obesity in pregnancy. Moreover, they might benefit from regular visits to a dietician for dietary and physical activity recommendations. Our goal should be a vicious circle of obesity closing.

CONCLUSION

The prevalence of overweight and obesity among pre-pregnant women tended to decrease in the Lithuanian urban area during three decades. A slight increase in overweight and obesity documented in 2007–2010 compared with 1996–1997 most likely was caused by older maternal age.

Competing interests: the authors declare that they have no competing interests.

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Authors' contributions: M.F.D. acquired, analysed and interpreted data as well as drafted the manuscript. P.V. and D.B. acquired, analysed and interpreted data as well as contributed to the discussion. D.V. designed the study, contributed to the discussion, made a critical revision of the manuscript.

Data Sharing Statement: No additional data available.

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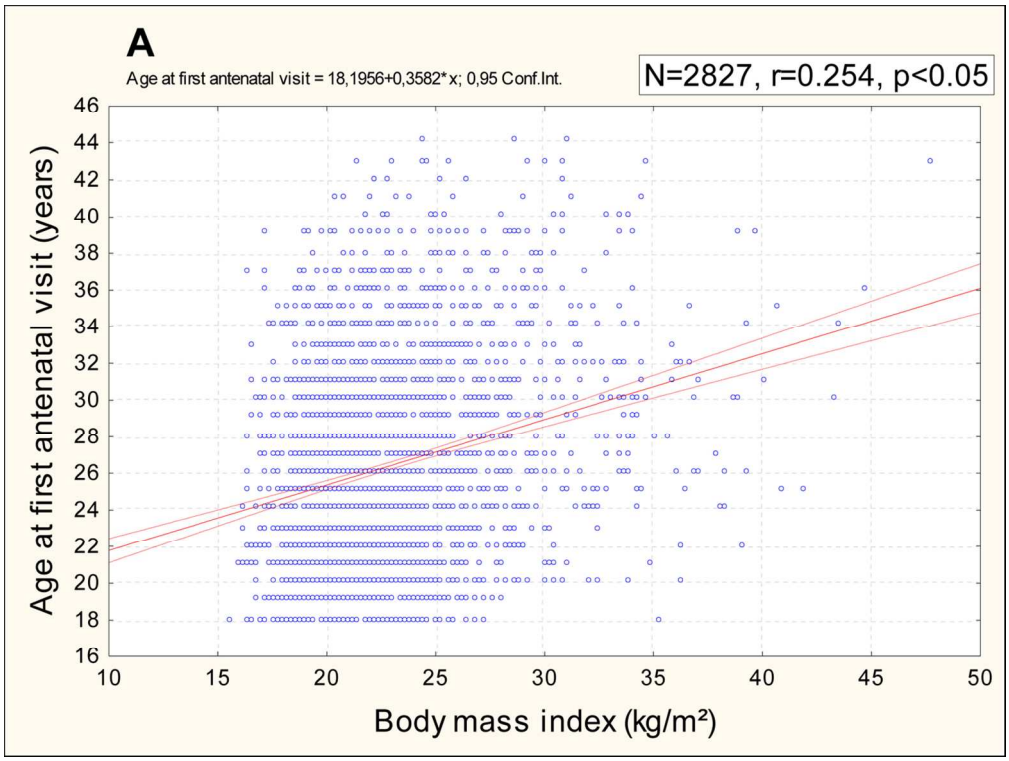

FIGURE 1A

130x97mm (300 x 300 DPI)

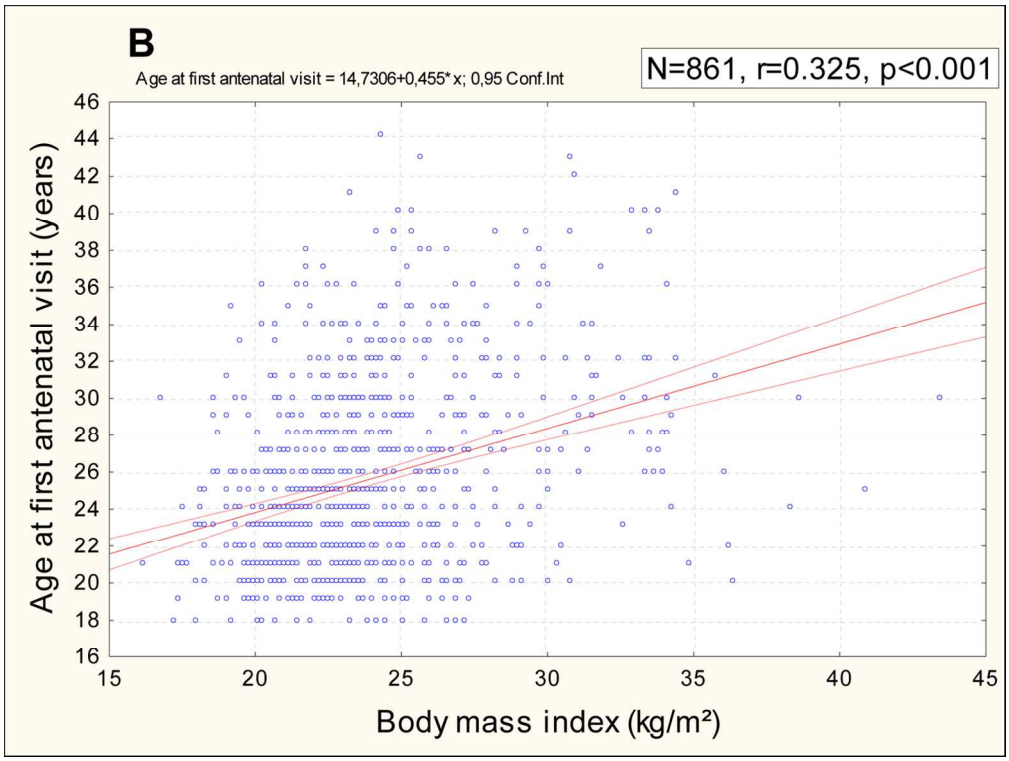

FIGURE 1B

129x97mm (300 x 300 DPI)

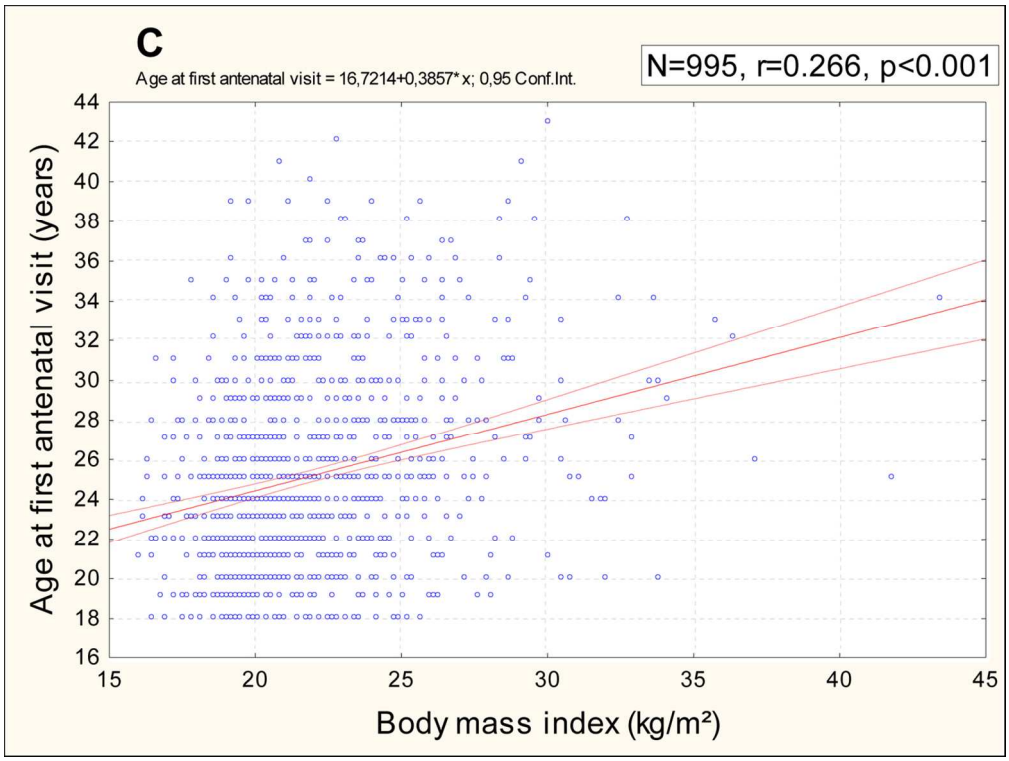

FIGURE 1C

129x97mm (300 x 300 DPI)

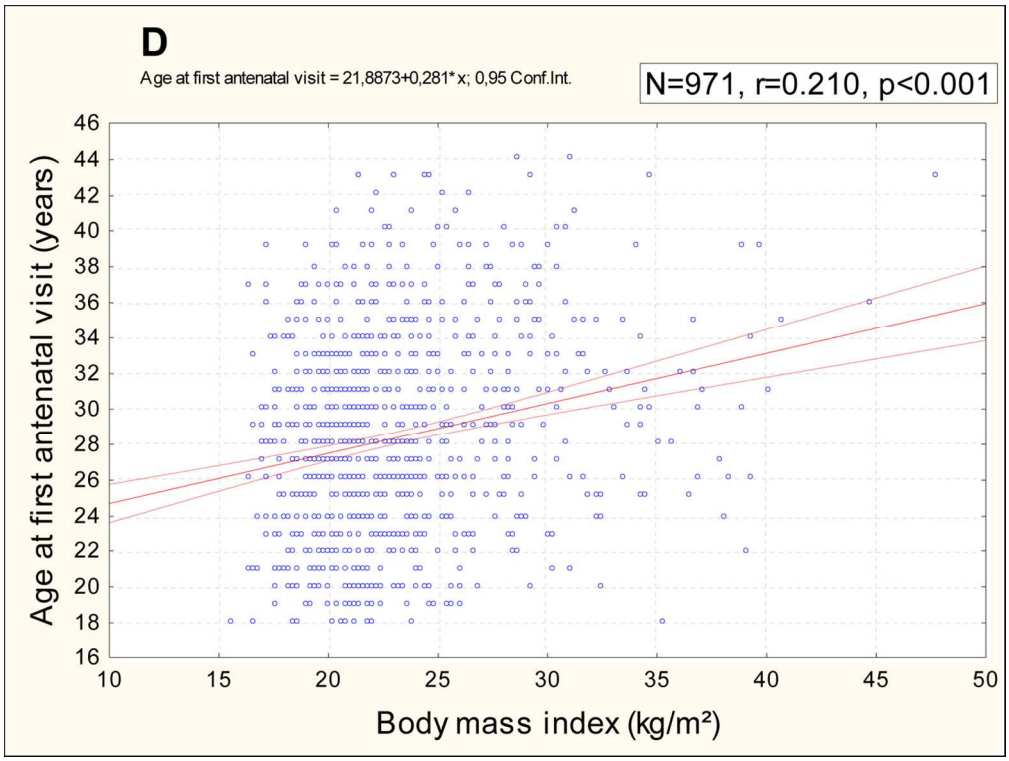

FIGURE 1D

129x97mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract: **Page 1.**
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found: **Page 2.**
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported: **Page 3-4.**
Objectives	3	State specific objectives, including any prespecified hypotheses: **Page 4.**
Methods		
Study design	4	Present key elements of study design early in the paper: **Page 5.**
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection : **Page 5.**
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up: **Page 5.**
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable. **Page 5.**
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group: **Page 5.**
Bias	9	Describe any efforts to address potential sources of bias **Page 3.**
Study size	10	Explain how the study size was arrived at: **Page 5.**
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding: **Page 5.**
		(*b*) Describe any methods used to examine subgroups and interactions **Page 5.**
		(*c*) Explain how missing data were addressed: **Page 5.**
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed **Page 5.**
		(*e*) Describe any sensitivity analyses **Page 5.**
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed: **Page 5-6.**
		(b) Give reasons for non-participation at each stage: **Page 5.**
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders: **Page 5.**
		(b) Indicate number of participants with missing data for each variable of interest: **Page 5.**

		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount): **Page 5.**
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time: **Page 7.**
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included **Page 6-7.**
		(*b*) Report category boundaries when continuous variables were categorized: **Page 5.**
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses **Page 5.**
Discussion		
Key results	18	Summarise key results with reference to study objectives: **Page 9.**
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias: **Page 8.**
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence: **Page 8-9.**
Generalisability	21	Discuss the generalisability (external validity) of the study results **Page 8-9.**
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based: **Page 9.**

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.