BMJ Open Retrospective analysis of age-adjusted body mass index among pre-pregnant women in the Lithuanian urban area during three decades

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ABSTRACT

Background: The prevalence of maternal obesity at the beginning of pregnancy is increasing. However, there are some studies reporting the stabilisation 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 women during 3 decades.

Methods: This observational retrospective study included a sample of 2827, women aged 18–44 years 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 SD; qualitative variables, as absolute numbers (n) and percentage (%). For parametric data, analysis of variance (ANOVA) was used. Differences were considered statistically significant at $p<0.05$.

Results: The prevalence of overweight and obesity among women aged 18–24 years decreased from 20.9% in 1987–1989 to 9.5% in 1996–1997 but increased to 15.7% in 2007–2010; among women aged 25–34 years, decreased from 35.5% in 1987–1989 to 23% in 1996–1997 and to 22.4% in 2007–2010; and among women aged 35–44 years decreased from 64.9% in 1987–1989 to 34% in 1996–1997 but increased 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).

Conclusions: The prevalence of overweight and obesity among pre-pregnant women tended to decrease in the Lithuanian urban area during 3 decades. A slight increase in overweight and obesity documented in 2007–2010 compared with 1996–1997 most likely was caused by older maternal age.

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 the best of our knowledge, this is the first publication that presents the downward and stabilising 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 participants 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 past five 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 are increasing both in high-income, and also in low-income countries.[4] Recently, there is a

growing body of evidence about the stabilisation of obesity epidemic or slowing down of body mass index (BMI) trend increases; however, in any case, the prevalence of obesity remains high.[5]–[8] A declining trend in obesity prevalence is documented more commonly among children,[7–10] but stabilisation 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] Worldwide 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 mothers and their offspring. It has been reported to be associated with an increased risk of gestational diabetes, hypertension, pre-eclampsia, stillbirth, fetal macrosomia and caesarean section.[16]–[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 $25–29.9 \text{ kg/m}^2$) and obesity (BMI$>30 \text{ kg/m}^2$) in the adult female population aged 20–64 years ranged from 44% to 50% and from 16% to 20%, respectively. However, no changes were observed in the prevalence of overweight and obesity among the women aged 20–64 years during the period of 1994–2012.[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 final years of the project (2010–2012), a declining trend was observed. These data of the Lithuanian women contradict various literature data reporting an increasing prevalence of overweight and obesity during pre-pregnancy and, therefore, are promising. We aimed at conducting a study to further analyse changes in BMI among women of reproductive age and possible trends of BMI during pre-pregnancy in the Lithuanian urban area.

OBJECTIVE

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

MATERIALS AND METHODS

This study was part of the GESTAtional Diabetes long term consequences (GESTAD) study, which surveys the influence of gestational diabetes and obesity during pregnancy on the 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 two 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 metres (kg/m^2). All the women were divided based on their BMI into the following groups according the WHO classification: underweight women (BMI$<18.5 \text{ kg/m}^2$), women with normal weight (BMI $18.5–24.9 \text{ kg/m}^2$), overweight (BMI $25–29.9 \text{ kg/m}^2$) and obese women (BMI$\geq30 \text{ kg/m}^2$). Obesity was categorised as class 1 obesity (BMI $30.0–34.9 \text{ kg/m}^2$), class 2 obesity (BMI $35.0–39.9 \text{ kg/m}^2$) and class 3 or morbid obesity (BMI 40 kg/m^2 and more). According to the age, women were divided into the following groups: age from 18 to 24 years, age from 25 to 34 years and age 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, V.21. Quantitative parametric variables are presented as a mean and SD; 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, ORs 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.

Overall, the BMI increased with 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).

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

Table 1 The characteristics of women's age at the first antenatal visit and body mass index (BMI) 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 (kg/m^2), n (%)				
<18.5	21 (2.4)	82 (8.2)	81 (8.3)	<0.05
18.5–24.9	580 (67.4)	746 (75)	659 (67.9)	<0.05
25–29.9	200 (23.2)	136 (13.7)	156 (16.1)	<0.05
30–34.9	52 (6.0)	26 (2.6)	53 (5.5)	<0.05
35–39.9	6 (0.7)	3 (0.3)	19 (2.0)	<0.05
≥40	2 (0.2)	2 (0.2)	3 (0.3)	>0.05

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 with 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 stabilising trend in the prevalence of pre-pregnancy obesity in the Lithuanian urban area.

Table 3 indicates the distribution of the study participants by different BMI, periods and age groups. In subgroup analyses, the prevalence of overweight and obesity among women aged 18–24 years decreased from 20.9% in 1987–1989 to 9.5% in 1996–1997 but increased to 15.7% in 2007–2010 (p<0.05). The proportion of women aged 25–34 years 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 35–44 years, the prevalence of overweight and obesity decreased from 64.9% in 1987–1989 to 34% in 1996–1997 (p<0.05) but increased 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.

DISCUSSION
The rapid growth in obesity represents a major public concern. A significant increase in obesity during the past 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 stabilisation 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 USA, 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 both for their own health, and 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]–[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 fetus once a woman becomes pregnant.[16]

Obesity is an issue of particular concern in the Baltic countries, where data from multinational surveys have shown that the rates of obesity are among the highest in the world. Data from the WHO Multinational MONItoring of trends and determinants in CArdiovascular disease (MONICA) project, collected between 1983 and 1988, placed five centres in the former Soviet Union among the top six positions of 48 centres worldwide in terms of obesity among women, 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 excess weight, that is, were
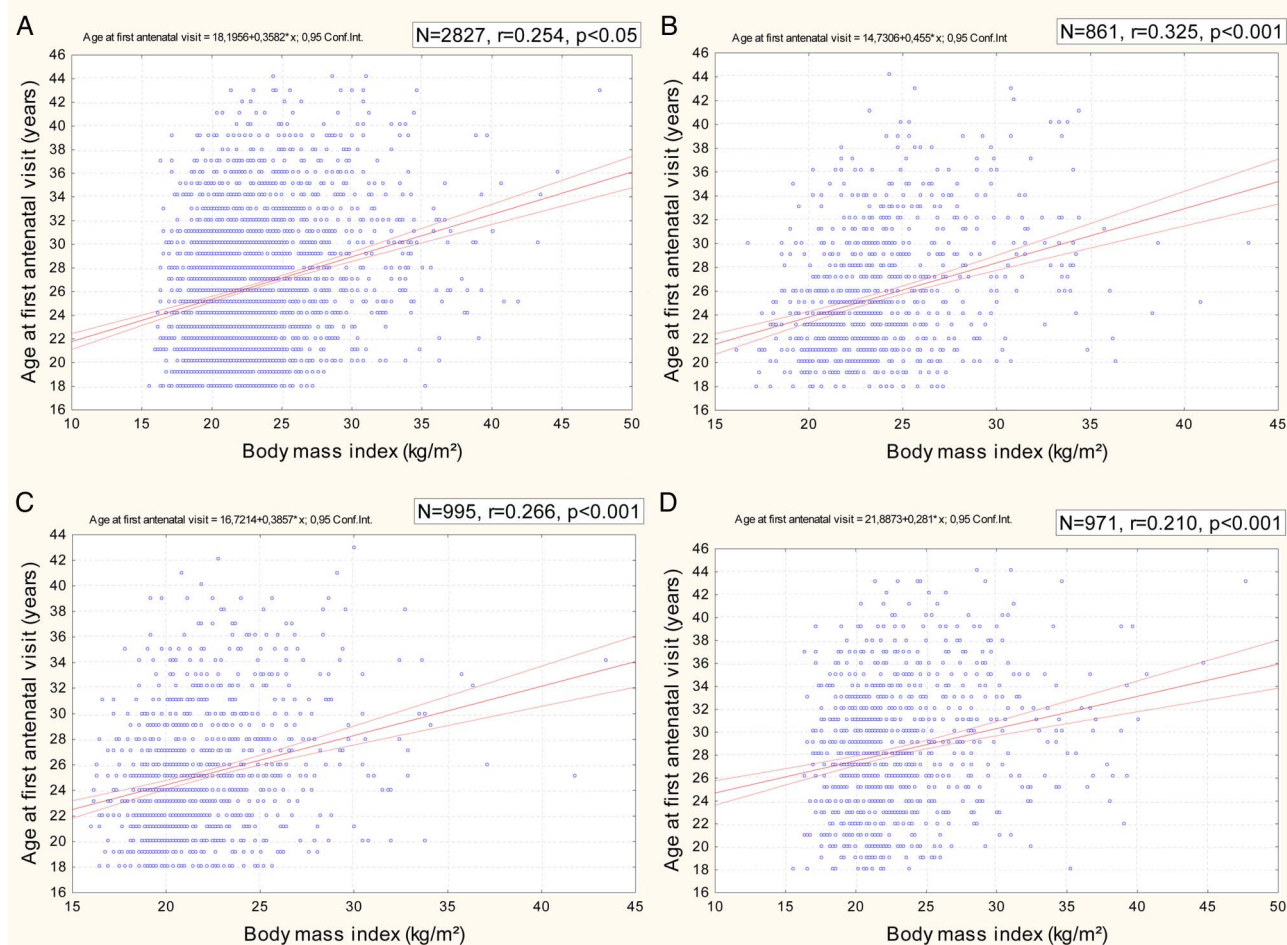
Figure 1 Correlation between body mass index and age at the first antenatal visit during all three periods (A), 1987–1989 (B), 1996–1997 (C) and 2007–2010 (D).

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

	Period			
Age groups (years)	**1987–1989**	**1996–1997**	**2007–2010**	**p Value**
18–24	22.89±3.084 (22.60 to 23.19)	21.34±2.78 (21.10 to 21.59)	22.03±3.65 (21.57 to 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	24.63±3.91 (24.23 to 25.03)	22.83±3.75 (22.48 to 23.19)	23.02±4.26 (22.67 to 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	26.60±3.83 (25.59 to 27.62)	23.86±3.24 (22.99 to 24.73)	25.10±4.97 (24.26 to 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±SD (95% CI).

overweight or obese. The proportion of women who were obese in Latvia and Lithuania was approximately three times higher than the proportion of such women in Estonia. The difference was especially considerable among women aged <35 years, with more than four 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 on Lithuanian women of reproductive age were extracted. In the study by Pomerleau

Table 3 The distribution of body mass index (BMI) 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/m²	Periods											
	1987–1989				1996–1997				2007–2010			
	Age groups			Total	Age groups			Total	Age groups			Total
	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 * and **.

et al,[29] the BMI of women aged 19–34 years and 35–49 years was 23.2±4.6 kg/m² and 25.7±4.6 kg/m², respectively, and 28.1% and 11.2% of Lithuanian women aged 19–49 years (N=751) were overweight and obese, respectively. 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.[21–23] 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 but increased to 23.8% in 2007–2010.

Several limitations should be considered while interpreting the results of our study. First, 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, that is, 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/m² 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 participants 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 two times smaller than that in 2007–2010. A slightly (not significantly) higher 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*, an 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 various literature sources indicating an increasing prevalence of overweight and obesity during prepregnancy and, therefore, are encouraging. To the best of our knowledge, this is the first publication that presents the downward and stabilising trend in prepregnancy BMI. These promising data could be determined by public health promotion, improvement in social health, organisation 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 has recently been promoting very lean body. Therefore, the monitoring of future trends in BMI of women 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 purpose 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.

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