

# Secular Changes in Growth and Obesity in Perinatal Population

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## ABSTRACT

The survey was conducted during the last 25 years and included 2414 healthy women who delivered in »Sestre milosrdnice« University Hospital Center in Zagreb, Croatia and their newborns. The aim was to establish the secular trend of some anthropological factors through two generations. Anthropological features such as pre-pregnancy weight, body mass index before pregnancy, height, age, place of residence, educational level, parity and the newborn weight were registered. The study was randomized. The mothers from the city of Zagreb and the surrounding villages, rural areas are examined. The women age was different and also different levels of education and socioeconomic status. The study included women who had not given birth yet, who had delivered once, twice, and three or more times. Maternal height in 25 years increased by 3.1cm. and increases with education. The pre-pregnancy weight increased 2.8 kg and increases with age, parity and rural life. The body mass index (BMI) which the women had before pregnancy was calculated, and according to its value the participants were divided in three groups: with normal weight, overweight and fat. Among the studied periods BMI does not differ significantly, but does differ significantly with respect to the ordinal number of births, parity, age and living environment. Higher BMI was associated with deliveries to heavier children.

**Key words:** height, weight, BMI, secular changes

## Introduction

In the last few decades very interesting changes of human constitutional features are observed probably due to more rapid industrial development and quality of life, new habits (food, sports, leisure patterns, automation, television), occupation and lifestyle. The factors that most affect these changes are examined in our study.

Unfortunately, one of the most important and more common change is obesity. There are many methods used for measuring obesity, but most commonly used is body mass index (BMI). BMI is calculated as the ratio of the mass and the square of the man height ( $\text{weight} / \text{height}^2$ ) and is expressed as a ratio of weight and the square meter ( $\text{kg}/\text{m}^2$ ). Normal weight is defined with BMI between 18.5 to 24.9  $\text{kg}/\text{m}^2$ , overweight; BMI of 25 to 29.9  $\text{kg}/\text{m}^2$ , and obesity; BMI above 30  $\text{kg}/\text{m}^2$ . Obesity is further divided into three classes: I-BMI 30 to 34.9  $\text{kg}/\text{m}^2$ , II – BMI 35–39.9  $\text{kg}/\text{m}^2$ , and III – 40 or more  $\text{kg}/\text{m}^2$ .

The percentage of overweight people is growing. In the research recently conducted on Mediterranean population, 3421 people were included. An increase in the percentage of overweight people was found (18.9%)<sup>3</sup>. Similar reports are observed in other countries: Denmark, Australia, Greece, Southern Europe, UK and USA<sup>4,5</sup>. Secular trend in increase body size is present in the Croatian population of children and adults<sup>5</sup>. As the result of an increasing share of obese people disease embroidered with the thickness is also frequent. Besides increased weight during 20th century, increased height from generation to generation is also found. In adulthood, an increase of height in different population is reported, varying from 1–2 cm/decade, with slightly higher values in developed countries<sup>6</sup>. In Croatian population a trend of increasing height is noticed during 40 years period (from 1951 to 1991). The secular growth of height in 19-year-old boys

was seven inches and five inches in girls, which equals about 1.75 centimeters *per* decade for boys and 1.25cm *per* decade for girls<sup>5</sup>. The tendency to height change in humans is associated with change in living quality, particularly in more developed areas: improved nutrition and housing, reduced number of children, education, reduction of children employment, availability and development of medicine (vaccination improved healthcare and greater medical capabilities). As unfortunately some of these benefits are still absent in the whole world, the higher increment in height is marked in developed countries where the difference regarding socioeconomic conditions exist. Growth depends on the capacity and the support for growth. Thus, the final height of humans largely depend on the genetic potential inherited from their parents, the growth rate of a child may depend on environmental factors, ie, support for growth. Since the living standard in Croatia especially after the war period is growing, some changes in anthropological characteristics similar to developed world are observed. In the research conducted in the maternity ward »Sestre milosrdnice« University Hospital Center anthropological characteristics of women over a period of 25 years were tested. The aim was to compare these characteristics through practically two generations. In conclusion, there are no statistically significant differences among certain anthropological individual factors. Interactions among some factors are also investigated to establish the reasons for higher incidence of some factors in individual groups.

## Materials and Methods

The survey was conducted during the last 25 years and included 2414 healthy women who delivered in »Sestre milosrdnice« University Hospital Center and their newborns. The first study period was from 1985 to 1986, second from 1992 to 1994, the third since 2000 – 2002 and the last from the 2007 to 2009 year. Anthropological features such as pre-pregnancy weight (mothers weight diminished for the weight gained during pregnancy), body mass index before pregnancy, height, age, place of residence, educational level, parity and the newborn weight were registered. The study was randomized. In the first period there were 550 women, in the second 564, 570 in the third and 730 in the last fourth. The women were either from the City of Zagreb or the surrounding villages. Regarding the education of mothers and their partners they were divided into three groups, namely those with university or higher education, high school diploma and without high school diploma. Parity was also determined. According to the obtained body mass index (BMI) before pregnancy (mothers mass-gained mass in pregnancy) / height<sup>2</sup>) women were divided into those with normal weight (BMI up to 24.9kg/ m<sup>2</sup>), overweight (BMI 25–29.9 kg / m<sup>2</sup>) and obese women (BMI > 30kg / m<sup>2</sup>). The group differences are examined and described through the time periods to detect secular trends in general, and in all these subpopulations. For testing the difference among the results of several groups nonparametric

chi-square test was used and the results were expressed in frequencies. For testing significant difference in arithmetic mean among groups, parametric test one- or two-way analysis of variance was used. Additionally, after analysis of variance, post hoc tests (Tukey HSD and Sheffe) were performed to accurately determine among which groups significant difference is found.

## Results

2414 mothers participated the study, during four tested periods. 550 pregnant women gave birth in the period 1985 – 1986, 564 between 1992 – 1994, 570 between 2000 – 2002, and in the last period from 2007 to 2009 730 women. Maternal height over time, through different periods significantly increases, so the biggest difference in height was observed between the first and the last group. The average height difference between these two group is 3.1cm (Figure 1).

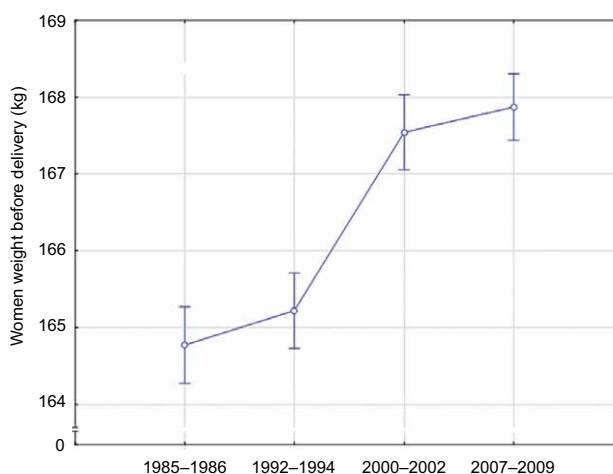


Fig. 1. Women height regarding time period.

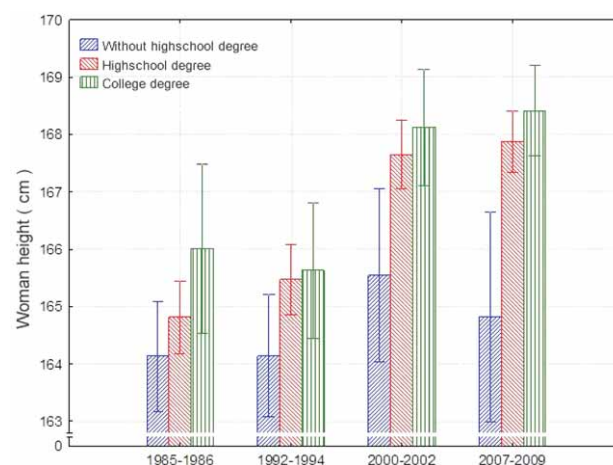


Fig. 2. Women height regarding education and time period.

Women with a college degree are significantly higher than those with lower education level (Figure 2).

Maternal height regarding to the place of residence does not differ significantly.

The women weight before pregnancy is significantly different regarding the investigated period (Figure 3). The women weight before pregnancy, during the last period (2007 – 2009) was 2.8 kg higher on average compared to the initial period.

The difference in weight regarding education is not observed.

Women who live in the city weight less than those who live in the village for about 1–2 kg on the average (Figure 4).

The weight before pregnancy was lower in younger women (Figure 5).

Women who gave birth more than once had a significantly greater weight before pregnancy (Figure 6).

The weight before pregnancy is significantly different regarding to the examined period, and the number of birth. Women who gave birth three or more times had about 5 kg more than those who had not given birth during the first period (1985 – 1986), and this difference increases even more in the last period (2007 – 2009), when the weight difference is 10 kg. We conclude that regardless to the number of births the women weight is bigger in the last period. The weight difference among women who delivered three or more times and women who had not delivered is also increasing (Figure 6).

Among the studied periods BMI does not differ significantly, but does differ significantly with respect to the ordinal number of births, i.e., multiparous women have a higher BMI (Figure 7).

The proportion of women with normal body mass index (up to 24.9 kg/m<sup>2</sup>), overweight women (BMI 25–29.9 kg/m<sup>2</sup>) and obese women with BMI higher than 30 kg/m<sup>2</sup> before pregnancy in the first and the last tested period is

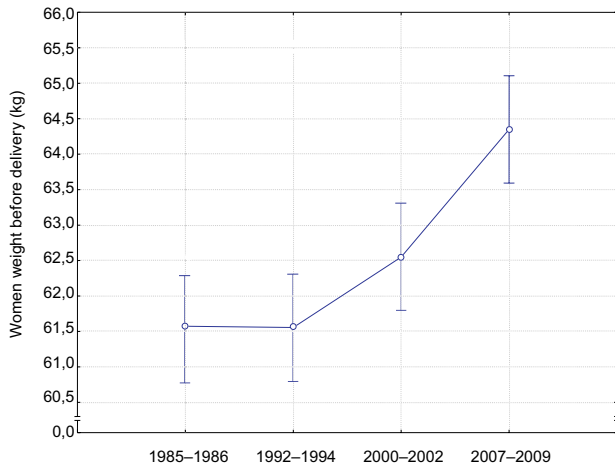


Fig. 3. The woman weight before pregnancy (kg) regarding different time period.

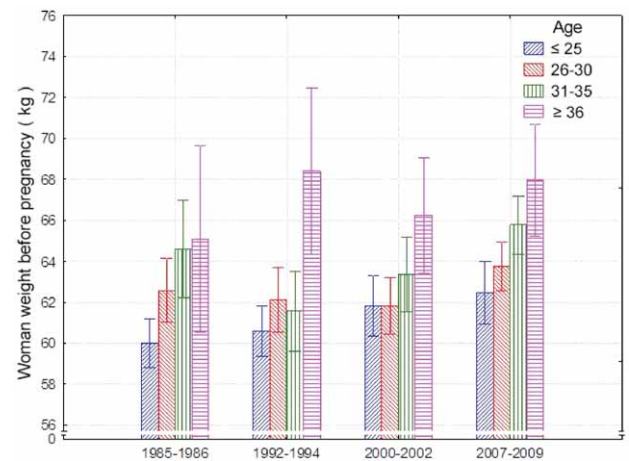


Fig. 5. Women mass before pregnancy regarding age and time period.

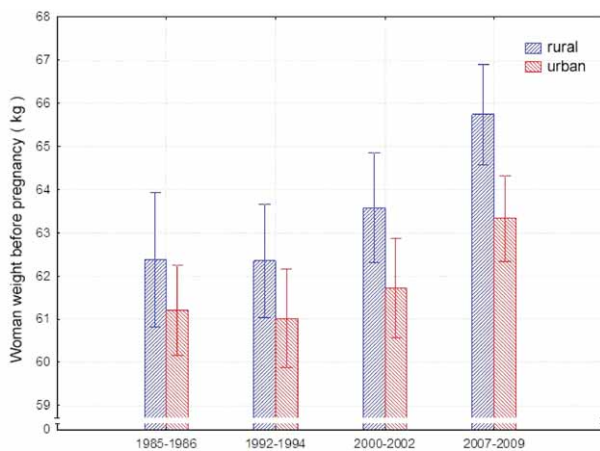


Fig. 4. Woman weight before pregnancy regarding place of living and time period.

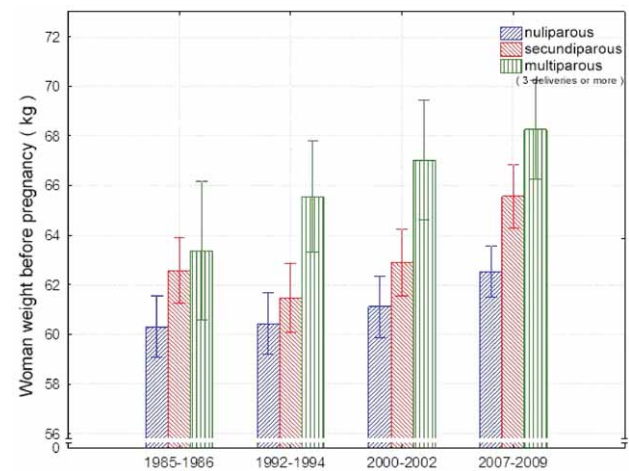


Fig. 6. Woman weight before pregnancy regarding number of deliveries and time period.

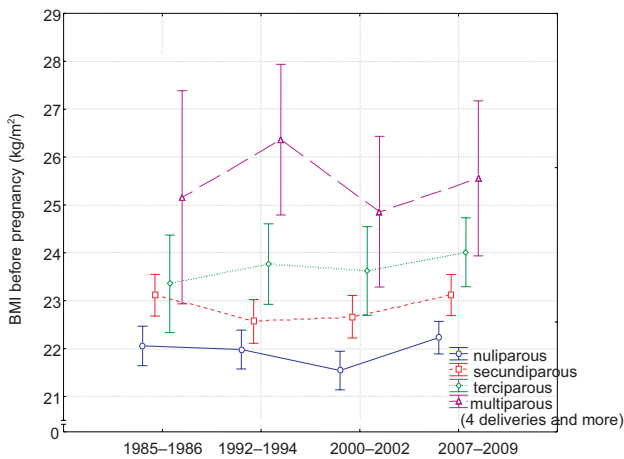


Fig. 7. Women BMI before pregnancy ( $\text{kg}/\text{m}^2$ ) regarding different time periods and number of deliveries.

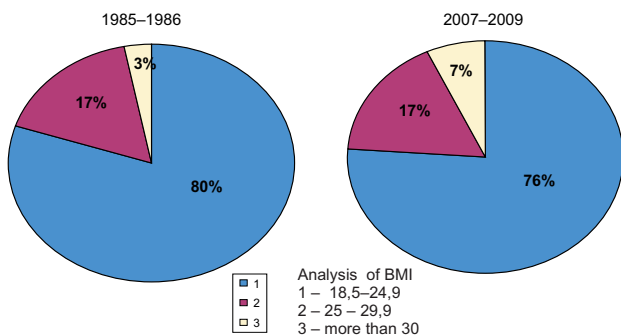


Fig. 8. The proportion of woman with specified BMI in two periods; 1985–1986 and 2007–2009.

shown in Figure 8. Although we have noticed an increase in the proportion of obese women in the final period, no statistically significant differences in the proportions of women with different BMI were found.

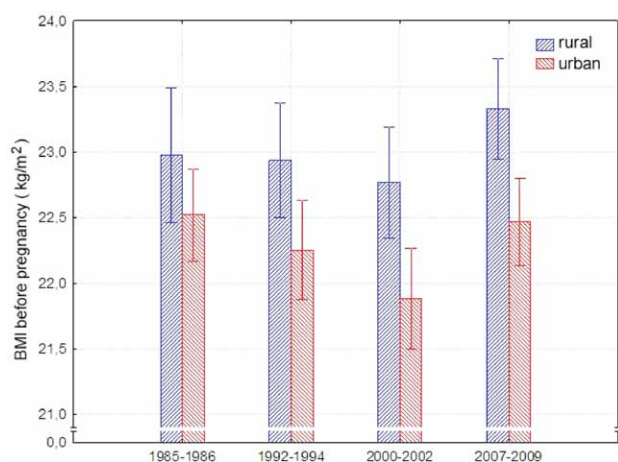


Fig. 9. BMI before pregnancy regarding place of residence and time period.

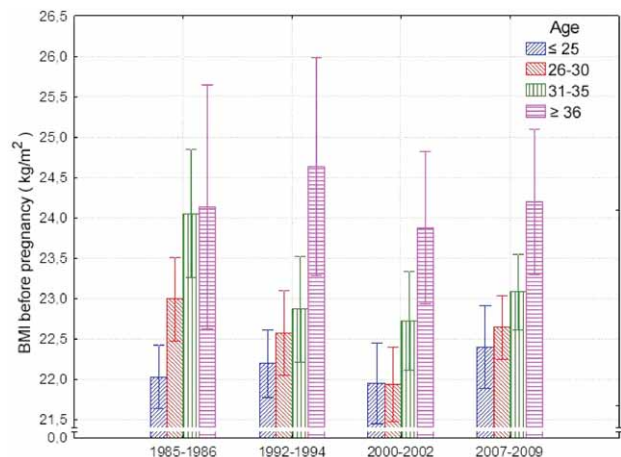


Fig. 10. BMI before pregnancy regarding age and time period.

Body mass index before pregnancy does not differ significantly with respect to the education in either tested period.

BMI before pregnancy varies according to the place of residence. Women who live in the city have lower body mass index. From 1985–1986 to 2000–2002 a gradual decline is observed, and then its increase in 2007–2009 (Figure 9).

Before pregnancy varies according to the age, so older mothers have higher BMI before pregnancy. With respect to the time period significant change is not present (Figure 10).

For women who gave birth to babies with different masses BMI before pregnancy is different. Women with higher body mass index before pregnancy delivered heavier babies.

## Discussion and Conclusion

Diverse anthropometric measurements or observations are registered through art during time, from the earliest findings related to the man until today. Civilization development resulted with changed understanding of beauty and expression.

The artists of the Renaissance in their observations and measurements showed an evidence of a thick, dissolute men, unlike the perfect human muscle placed in the art of the ancient Greeks, showing a completely different human body structure. At that time, even angels were pretty if they were plump, and that is how Rafael had painted them in the 16th century.

Except for anthropometric observations and studies of various artists throughout history, consciously or unconsciously anthropometry was used for practical purposes from the very beginning of our existence. For protection from the cold a man made himself a best suited coat for which he also used his body measurements in. Even today anthropometric human measures are con-

stantly upgrading and adapting for better clothing and shoes accommodation<sup>7</sup>.

From the Neolithic all the way around to the Bronze Age the man's height is changing. Until 12th century significant changes in man's height were not found after which a slight decrease of height is noticed up to the nineteenth century<sup>8</sup>.

The fact that the man's height is rising due to the higher living standards in recent decade is witnessed by many authors<sup>9–11</sup>.

In this research on women after delivery since 1985 year until 2009 the height of women is significantly increased. The overall average difference in women height in 1985–1986 and 2007–2009 is 3.1 cm.

Statistically significantly higher are women with college or university degree. Such differences also exist with respect to the place of residence (urban-rural). According to the literature there is a significant difference in growth due to financial status and level of education<sup>9</sup>.

Perhaps, a statistically significant difference in height among highly educated mothers and others may be explained by the fact that highly educated women often have higher economic standard, which enables a better dietary habits which result with higher growth.

Although the literature suggests some significant difference in height of people living in the cities compared to those from rural areas<sup>9</sup> with the explanation of different economic standard, in our study such a difference is not really considered.

During the 25 years the women weight before pregnancy has significantly grown. In the period from 1985–1986 women weighted 2.8 kg less on the average before pregnancy than from 2007–2009 year.

Portuguese authors<sup>12</sup> recorded an increasing of over-weight people, almost 3% in ten years. The weight difference was 1.5kg/decade for younger girls and boys, and 3kg/decade for older girls and boys.

Regarding the level of education and the prevalence of obesity very different results of the tests in the literature can be found. According to the Spanish Authors<sup>2</sup> the lower education is directly linked with an increased risk for weight gain. Reports from Portugal<sup>13</sup> show quite the opposite, namely the likelihood of obesity in Portuguese women increase with their level of education. We studied Croatian women and according to our results the level of education is a risk factor for weight gain.

Women living in the city are easier 1–2 kg on the average comparing to those from countryside. Women included in this survey who live in the villages were from the village area of Zagreb. In these as in other parts of the Croatian mainland and in is common cooking with lard. This could be a risk factor for the incidence of obesity as it is already reported in the literature<sup>14</sup>.

Regarding education and the place of residence, there are very conflicting reports in the literature. In some studies women from cities have higher body weight than those from the countryside<sup>3</sup>. Given the fact that these re-

ports come from the U.S. and the UK probable cause of higher weight of women living in the cities is higher availability of fast, unhealthy and cheap food due to the hectic life and lack of time for preparing healthy food as well as lack of movement and sport activities. Other american authors state the highest percentage of over-weight women from the village<sup>15</sup>.

In our study, the body weight before pregnancy is higher in older women in all tested periods. In other research conducted in Croatia the body weight increases significantly with age<sup>14</sup>.

Women who did not give birth have significantly the lowest body weight and the highest body weight have women who delivered three or more times. The weight of ones with two deliveries is between these two groups. Women who had three or more deliveries in the first period (1985 – 1986) had 5 kg higher weight on the average comparing to women who had not given birth. The difference in weight increases during time, so women who delivered at least three times before the next pregnancy, during the last period (2007–2009) were heavier 10 kg on the average compared to women who had not given birth. Other studies also find statistically significant higher weight in women who gave birth compared to ones who had not delivered<sup>16</sup>.

For calculation of BMI beside body mass the height is important. Considering secular changes of weight and height BMI does not change for the past 25 years.

In our research statistically significant difference in weight is determined regarding the number of births and we confirmed close relation of number of births with the woman weight. Similar objections have been already observed recorded in the recent literature<sup>16</sup>.

We divided the participants according to the weight, the group with normal weight, overweight and fat. No statistically significant difference in the proportion of woman with specific BMI was found during time but the largest proportion of fat women was found in the last period (2007–2009).

The data about body mass index change in relation to education are various. Some authors noted that the increase in body mass index is clearly associated with the level of education<sup>13</sup>, while others state the opposite<sup>17</sup>. In our study the body mass index before pregnancy do not differ significantly regarding to the level of education.

Women who live in the city, had a statistically significant lower body mass index before pregnancy, compared to rural women. This result stems from the fact that the mass of rural women is significantly higher.

In the period from 1985 to 2000 year body mass index before pregnancy leads to a shows a slight decrease, while in the last period (2007–2009) BMI increases. During the period in which we noticed a slight decrease in body mass index the war lasted in Croatia. Decrease in body mass index could be a common consequence of stress and poor nutrition during this period. The in-

crease in body mass index in the last period corresponds with the world trends in developed countries<sup>18</sup>.

Older women have a higher body mass index before pregnancy than younger, and this difference was statistically significant. This difference results from a larger mass of elderly women, which we have already noticed in the study, correlates with the literature data<sup>14–19</sup>.

Our study of women with higher body mass index before pregnancy show a significantly heavier children during delivery, and women with lower body mass index will deliver easier children. It is conceivable that obese women, ie, women with higher BMI have a genetic potential for bigger kids but also »offer« to the fetus a greater amount of glucose, vitamins, minerals and other nutrients.

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## SEKULARNE PROMJENE VISINE I DEBLJINE U PERINATALNOJ POPULACIJI

### SAŽETAK

U Kliničkom bolničkom centru »Sestre milosrdnice« u Zagrebu provedeno je istraživanje na 2414 majki i njihove novorođenčadi u periodu od 1985.–2009. godine. Željeli smo utvrditi trend sekularnih antropoloških faktora u dvije generacije. Ispitani su: težina prije trudnoće, BMI prije trudnoće, visina, dob, mjesto stanovanja, stupanj edukacije, paritet i težina novorođenčeta. Ispitane su majke sa područja Zagreba i okolnih sela, tj. ruralne sredine. Dob žena kao i stupanj edukacije o socioekonomski statusu su različiti. Uključene su žene koje nisu rodile, one koje su rodile jedanput, dvaput, tri ili više puta. Visina majki u 25 godišnjem periodu povišala se za 3.1cm i porast korelira sa stupnjem edukacije. Težina prije trudnoće viša je za 2.8 kg i povišuje se s dobi, paritetom i životom u ruralnoj sredini. Indeks tjelesne mase (BMI) izračunat je kod ispitanica prije trudnoće ovisno o iznosu podijelili smo ispitanice u tri grupe: sa normalnom težinom, umjereno pretile i pretile. Tijekom 25 godina nije bilo značajnih promjena u indeksu tjelesne mase ali je nađeno povećanje obzirom na paritet godine i mjesto življenja. Viši BMI povezan je sa rađanjem teže novorođenčadi.