



TRENDS IN PRE-PREGNANCY BODY MASS INDEX AND GESTATIONAL WEIGHT GAIN AMONG PREGNANT WOMEN IN CROATIA

Katja Vince¹, Marija Švajda², Tamara Poljičanin² and Ratko Matijević^{1,3}

¹Department of Obstetrics and Gynecology, Merkur University Hospital, Zagreb, Croatia;

²Croatian Institute of Public Health, Zagreb, Croatia;

³Department of Obstetrics and Gynecology, School of Medicine, University of Zagreb, Zagreb, Croatia

SUMMARY – Maternal overweight, obesity and weight gain during pregnancy have become important obstetric concerns as they represent the most common risk factor for adverse perinatal outcomes in developed countries. The aim of this study was to determine trends in pre-pregnancy body mass index (BMI) and gestational weight gain (GWG) in Croatia. Pre-pregnancy BMI and GWG trends from 2003 to 2019 were analyzed using national delivery data. Joinpoint regression analysis was performed. Age adjusted obesity rate among pregnant women significantly increased from 59.4 to 77.7 *per* 1000, with a mean of 1.7% *per* year (95% CI 0.6 to 2.8, $p=0.004$), while age adjusted rate of women achieving GWG above recommendations significantly decreased from 352.1 to 301.1 *per* 1000 women (annual percent change -1.0%, 95% CI -1.4 to -0.6, $p<0.001$). The rate of women with normal BMI and those achieving recommended GWG increased, but these trends were not statistically significant. In conclusion, the rate of obesity in pregnant women in Croatia is high and has an increasing trend that has not been halted or reversed. Public health strategies addressing weight management require reevaluation with emphasis on preconception care. A decreasing trend of pregnant women achieving GWG above recommendations is welcoming and reflects increasing awareness of appropriate weight management during pregnancy.

Keywords: *Body mass index; Gestational weight gain; Joinpoint regression; Public health; Pregnancy*

Introduction

Obesity and being overweight have become important obstetric concerns as they represent the most common risk factor for adverse perinatal outcomes among pregnant women^{1,2}. The increasing prevalence of obesity and overweight among women of reproductive age is being reflected among pregnant women³⁻⁵. Worldwide, the proportion of adult women with body mass index (BMI) of 25 kg/m² or greater has increased from 29.8% in 1980 to 38.0% in 2013⁴. In the US,

pre-pregnancy obesity rates have been increasing by a mean of 0.5 percentage points *per* year (from 17.6% in 2003 to 20.5% in 2009)⁵ and approximately one-half of US women are either overweight or obese prior to becoming pregnant⁶. In Europe, the obesity

Correspondence to: *Katja Vince, MD*, Department of Obstetrics and Gynecology, Merkur University Hospital, Zajčeva 19, HR-10000 Zagreb, Croatia
E-mail: katjavince@gmail.com

Received February 12, 2021, accepted September 12, 2022

prevalence figures are lower but are also increasing, e.g., in England, the prevalence of obesity in the first trimester of pregnancy increased from 7.6% to 15.6% between 1989 and 2007⁷. Data regarding trends of underweight or overweight pregnant women are limited. The prevalence of overweight among pregnant women in Canada is 24.0%⁸, while a study by Eiríksdóttir *et al.* reports that the prevalence of overweight in Iceland increased from 25.9% in 2001 to 27.7% in 2010⁹.

Maternal underweight, overweight and obesity are associated with a variety of adverse perinatal outcomes^{10,11}. Underweight women have a higher risk of delivering preterm and low birth weight babies¹², while overweight and obese mothers have higher risks of hypertensive disorders of pregnancy, gestational diabetes mellitus (GDM)¹³⁻¹⁵, and stillbirth¹⁶. Overweight and obese pregnant women are more likely to have labor induced or require a cesarean section, and their children are at a greater risk of dying in the neonatal period compared to women with normal BMI^{11,17,18}. Also, maternal obesity during pregnancy impacts further development of the newborn and represents a higher risk of childhood and adolescence overweight, obesity, and elevated blood pressure¹⁹.

Recommendations for gestational weight gain (GWG) in singleton pregnancies were revised and endorsed in 2009 by the Institute of Medicine (IOM)²⁰. They support an average mean GWG of around 13-18 kg for underweight women, 11-16 kg for women with normal weight, 6-11 kg for overweight, and 5-9 kg for obese women²⁰. Studies using these guidelines show that excessive GWG was associated with a higher risk of macrosomia, large for gestational age babies and cesarean delivery, while GWG below recommendations was associated with a higher risk of small for gestational age babies and preterm birth^{21,22}. Furthermore, excessive weight gain during pregnancy is proven to be an independent risk factor for cesarean birth, even when newborn birth weight is not excessive²⁵, while both high pre-pregnancy BMI and excessive GWG are associated with increased risks of hypertensive disorders during pregnancy^{14,15}. Despite these well-established associations, according to a systematic review and meta-analysis performed on more than one million pregnant women, almost half of all pregnant women (47%) gained more weight than recommended during pregnancy²¹. On the other hand, 23% of women had

GWG less than IOM recommendations, while only less than one-third of all pregnant women reached recommended weight gain during pregnancy. Considering these important effects of adverse pre-pregnancy BMI and excessive or insufficient GWG on adverse perinatal outcomes, it is important to assess the burden of these conditions among pregnant women. The aim of this study was to determine trends in the prevalence of pre-pregnancy BMI and GWG among women in Croatia.

Material and Methods

This study was performed using data from medical birth certificates (MBC) collected by the Croatian Institute of Public Health (CIPH) as part of perinatal statistics reporting in Croatia. Medical staff attending each delivery are obliged to complete MBC for each birth and send it to CIPH. Data in MBC are copied from personal and hospital records. Specifically, pre-pregnancy weight and height were measured at the first antenatal visit and recorded in patient medical documents, while data on GWG were measured during admission to labor ward. Pregnant women with singleton pregnancies were included in the study. Trends in the rates of pre-pregnancy BMI and GWG among women who gave birth in Croatia from 2003 through 2019 were examined, since data prior to 2003 were of poor quality.

According to pre-pregnancy BMI, women were categorized into four groups (underweight <18.5 kg/m², normal weight 18.5-24.9 kg/m², overweight 25.0-29.9 kg/m², and obese ≥30.0 kg/m²)²³; according to GWG women were categorized as below, within or above IOM recommendations²¹. Joinpoint regression analysis was carried out using Joinpoint Statistical Software for analysis of continuous linear trends with change points, i.e., joinpoints, version 4.6.0.0. Given the number of time periods, considered maximum number of joinpoint was set at 2. Logarithmic transformation was applied, with statistical significance for annual percent change (APC) set at 0.5 level. In calculation of age-adjusted rates, the European Standard Population (2013) was used. Ethical approval for the study was obtained from CIPH Ethics Committee for Public Health Researches grant number 381-10-18-2.

Results

The age-adjusted rates of obesity, normal BMI and underweight BMI among pregnant women increased from 2003 to 2019 (obesity from 59.4 to 77.7 *per* 1000 women, underweight from 43.7 to 45.9 *per* 1000 women, normal BMI from 563.4 to 588.6 *per* 1000 women), while age-adjusted rate of overweight women only slightly decreased (from 180.0 to 178.7 *per* 1000 women). Only increase of obesity rate was statistically significant (APC=1.7%, 95% CI 0.6 to 2.8, p=0.004), while other rate changes were not significant (underweight APC=0.3, p=0.180, normal weight APC=0.3, p=0.305, overweight APC=-0.04, p=0.909). The analyses did not show significant change in trends in any BMI group, with all groups having 0 joinpoints

(Fig. 1). The crude prevalence rates of overweight increased from 16.9 to 21.0% and of obesity from 4.8 to 9.0% between 2003 and 2019.

The age-adjusted rate of pregnant women achieving recommended weight gain during pregnancy increased slightly between 2003 and 2019 (from 361.2 to 365.6 *per* 1000 women), but this change was not significant (APC=0.1, p=0.735). The age-adjusted rate of pregnant women who achieved GWG above IOM recommendations significantly decreased from 352.1 to 301.1 *per* 1000 women (APC=-1.0%, 95% CI-1.4 to -0.6, p<0.001), while the age-adjusted rate of pregnant women who achieved GWG below IOM recommendations significantly increased from 157.7 to 202.0 *per* 1000 women (APC=1.6, 95% CI 0.2 to 3.0, p=0.031). The analyses did not show significant

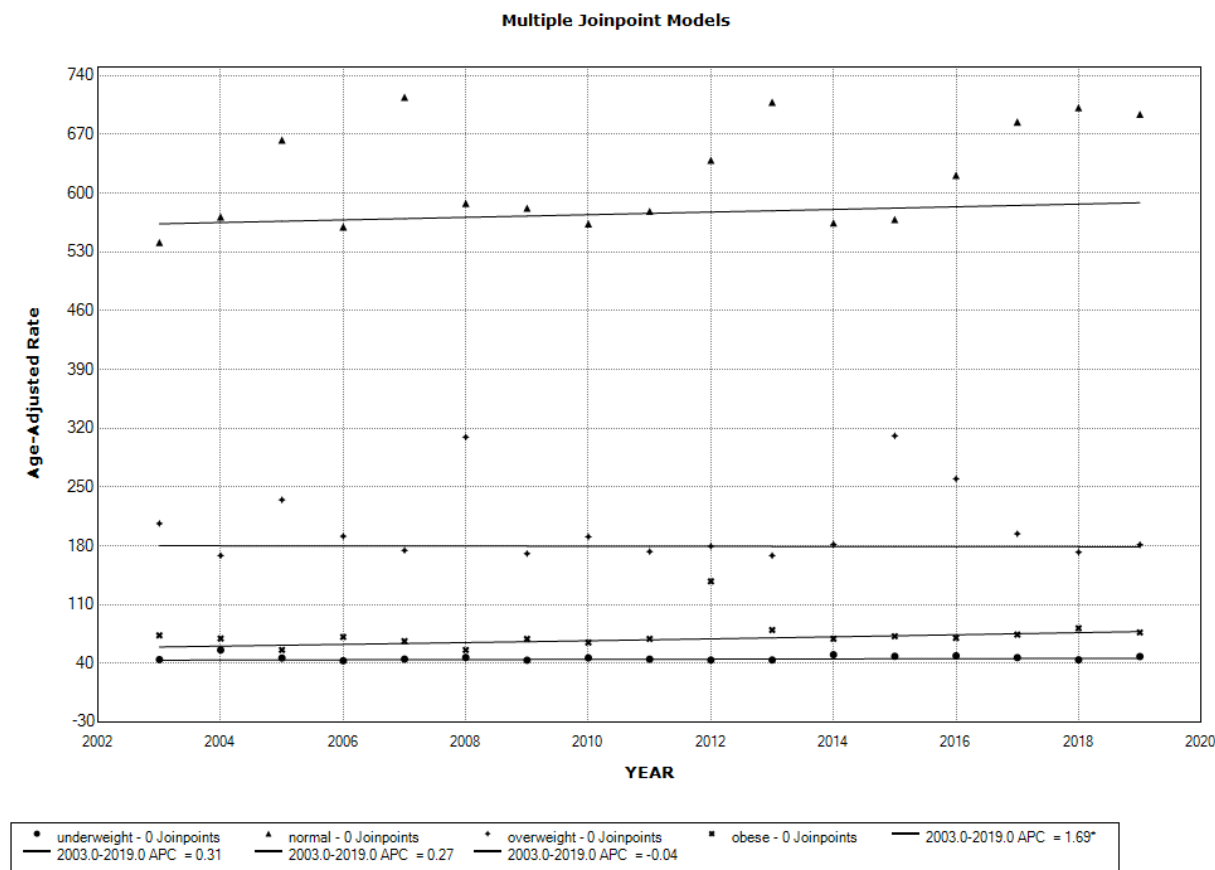


Fig. 1. Age-adjusted rates according to body mass index groups among pregnant women in Croatia during the 2003-2019 period (*per* 1000).

change in trends in any GWG group, with all groups having 0 joinpoints (Fig. 2). The crude prevalence rate of women achieving recommended weight gain during pregnancy continuously involved around 42% of pregnant women between 2003 and 2019.

Discussion

The age-adjusted rate of pre-pregnancy obesity among pregnant women increased by a mean of 1.7% *per year* from 2003 to 2019, while the mean absolute crude prevalence rate of obesity increased by 0.26% *per year*. This mean increase in crude prevalence is lower than the one reported by Fisher *et al.*, where pre-pregnancy obesity in US from 2003 to 2009 increased by a

mean of 0.5% *per year*, from 17.6% in 2003 to 20.5% in 2009⁵. Still, these data need to be compared with caution since obesity rates vary among populations and are much higher in the US than in Croatia. A study by Chen *et al.* also reports an increase in overweight and obese pregnant women but mainly in middle- and low-income countries²⁴.

The increasing prevalence of obesity among pregnant women reflects the increasing prevalence of obesity in the general female population in Croatia, which has escalated from 20.6% in 2003 to 34.1% in 2008 according to the Croatian National Survey²⁵. Moreover, in this survey, the rise in the prevalence of obesity was mostly noticeable among women in the age group under 45 years²⁶. According to the Eurostat database, 8.3% of women aged between 18 and 44 years are obese,

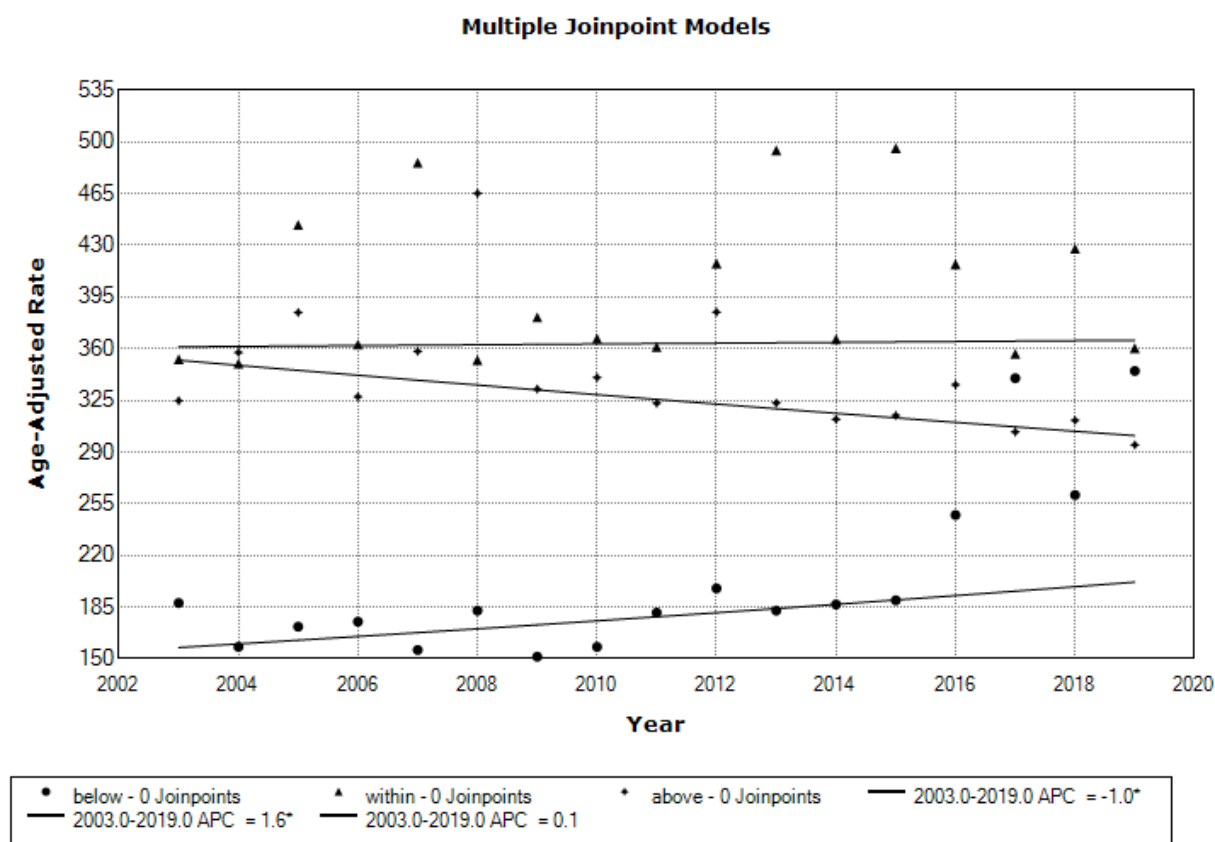


Fig. 2. Age-adjusted rates according to gestational weight gain groups in pregnant women in Croatia during the 2003–2019 period (*per 1000*).

which includes women of reproductive age and is in concordance with results of this study²⁷. Following this and other reports, certain national programs and public health initiatives have been launched in Croatia, such as the Healthy Living program launched by the CIPH and funded by the European Union funds. This program aims at promoting healthy nutrition and physical activity, preventing obesity and improving mental and reproductive health²⁸. Similar strategies and programs exist in other countries worldwide, but reports suggest that pregnant women have poor knowledge regarding perinatal complications associated with excessive maternal weight and commonly misperceive what is appropriate weight gain in pregnancy²⁹. These issues, as well as the increasing trend of obesity among pregnant women reported in this study are alarming and require reevaluation and enhancement of existing strategies aimed at reducing obesity rates.

The crude prevalence rates of overweight in Croatia are lower than in other developed countries such as Canada or Iceland^{8,9}, but increased between 2003 and 2019. If this increasing trend does not cease, figures of overweight prevalence might become comparable to those in other developed countries.

The proportion of pregnant women who gained recommended weight gain during pregnancy did not significantly increase during the study period. Luckily, it did not decrease, unlike a study performed in North Carolina where the percentage of pregnant women achieving recommended weight gain decreased by 6.3% during a 15-year time span³⁰. Compared to other studies, the result of this study of around 42% of women gaining recommended weight during pregnancy is better than 30% reported in a meta-analysis by Goldstein *et al.*²¹ or 24% reported among Hispanic women by Sangi-Haghpeykar *et al.*³¹. In addition, a significant decreasing trend of women gaining weight during pregnancy above the recommended one is encouraging. We believe that it reflects good antenatal care and increasing awareness and motivation among pregnant women of appropriate weight management during pregnancy. This is supported by the research showing pregnancy to be a powerful stimulus for positive changes in food choices among overweight and obese pregnant women³². Also, it is interesting to note that no change in GWG trend was observed after 2010, which was the first year following publication of new

IOM guidelines on GWG²⁰. It can be hypothesized that these guidelines have not been promoted enough to health care professionals caring for pregnant women or to pregnant women themselves.

Results of this study may have certain implications on obesity-related pregnancy and labor complications, with a possible increase in their prevalence due to an increasing obesity trend. A systematic review and meta-analysis from 2019 reports a 264% increase in the odds of child obesity when mothers are obese before conception³³. The World Health Organization European Childhood Obesity Surveillance Initiative reports that overweight and obesity among primary school children is increasing in certain countries³⁴. Data from Croatia report a 35.9% prevalence of overweight and obesity in 7-9-year-old children³⁵. It should be kept in mind that these children are soon entering reproductive age and if preconceptional care does not address these issues, it is likely that both pre-pregnancy overweight and obesity rates will increase in the nearest future.

Results of this study include most recent data on BMI trends among pregnant women. They are based on a large national sample of pregnant women and are therefore representable and reproducible. A possible limitation of this study is the lack of validation of data acquired at CIPH. Still, since MBC are completed by medical staff (most often medical doctors present at labor) and occasionally verified for their accuracy by members from the CIPH, data are considered accurate and reliable.

Despite numerous public health initiatives and strategies developed in recent years, pre-pregnancy age-adjusted obesity rates in Croatia are high and have been increasing by a mean of 1.7% *per year*. This partially reflects pregnant women's poor knowledge about optimal weight management before pregnancy. Raising public awareness and knowledge regarding weight management among reproductive age women might be the first step in reducing the prevalence of adverse pre-pregnancy BMI among pregnant women. Educating women about the risks of overweight and obesity to both their own and their offspring's health might motivate them to reach normal BMI before conception and maintain appropriate GWG during pregnancy. Prevention of pre-pregnancy obesity should become a priority for public health due to its impact

on pregnancy and early childhood development. Interventions designed at supporting appropriate weight before and during pregnancy should be reexamined and additional measures must be aimed at raising awareness of this condition among general population. A decreasing trend of women gaining weight during pregnancy above recommendations is encouraging and reflects good antenatal care and increasing awareness and motivation among pregnant women of appropriate weight management during pregnancy.

Acknowledgment

The authors thank Professor Urelija Rodin and employees of the Croatian Institute of Public Health for supporting and collecting medical birth certificates. We thank Domina Vusio for advice regarding data analysis. We also thank all fellow colleagues working at delivery wards for completing medical birth certificates and sending them to the Croatian Institute of Public Health.

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Sažetak

TRENDOVI INDEKSA TJELESNE MASE PRIJE TRUDNOĆE I PRIRASTA TJELESNE TEŽINE KOD TRUDNICA U HRVATSKOJ

K. Vince, M. Švajda, T. Poljičanin i R. Matijević

Prekomjerna tjelesna težina, pretilost i prirast tjelesne težine u trudnoći najčešći su rizični čimbenici za nepoželjne perinatalne ishode u razvijenim zemljama. Cilj ovog istraživanja bio je utvrditi trendove indeksa tjelesne mase (ITM) prije trudnoće i prirasta tjelesne težine (PTT) kod trudnica u Hrvatskoj. Pomoću nacionalnih podataka prijave porođaja analizirani su trendovi ITM prije trudnoće i PTT kod trudnica. Provedena je regresijska analiza točaka pregiba. Dobno-standardizirana stopa pretilosti među trudnicama značajno je porasla s 59,4 na 77,7 na 1000 trudnica, prosječno 1,7% na godinu (95% CI 0,6 do 2,8, $p=0,004$), dok se dobno-standardizirana stopa trudnica koje su imale PTT iznad preporuka značajno smanjila s 352,1 na 301,1 na 1000 trudnica (godišnja postotna promjena -1,0%, 95% CI -1,4 do -0,6, $p<0,001$). Stopa trudnica s normalnim ITM i onih koje su postigle preporučeni PTT je porasla, no ovi trendovi nisu bili statistički značajni. Zaključno, stopa pretilosti među trudnicama u Hrvatskoj je visoka i ima rastući trend koji nije zaustavljen niti obrnut. Javnozdravstvene strategije o kontroli tjelesne težine zahtijevaju reevaluaciju s naglaskom na razdoblje prije začeca. Smanjujući trend trudnica s PTT iznad preporuka je ohrabrujuć i odražava povećanje svjesnosti o kontroli tjelesne težine u trudnoći.

Ključne riječi: *Indeks tjelesne mase; Prirast tjelesne težine u trudnoći; Regresijska analiza; Javno zdravlje; Trudnoća*