

Underweight as a Risk Factor for Miscarriage (Population Study)

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Abstract

A retrospective cohort study was carried out to investigate the influence of body mass index (BMI, kg/m²) on miscarriage in a population of 860 pregnant women aged 17 - 36 years, residents of a small city in the middle of Russia. BMI varied from 16 to 32, average value - 22.8 kg/m². The number of miscarriages is 49 (5.7% of all pregnancies). With the distribution of women by the BMI, the spontaneous abortions rate revealed U-shaped trajectory. The smallest proportion, 1.6%, had 189 women with 22-23.9 kg/m² - optimal interval. The highest proportion, 7.8%, had 416 women with underweight. Among 248 women with overweight there were 5.3% miscarriages. A similar nonlinear dependence with BMI had early toxicosis, pre-labor rupture of the membranes, obstetrical bleeding, weak uterus labor, defects of placenta, cesarean section, fetal hypoxia. The sum of previous pregnancies (childbirths, artificial abortions, spontaneous miscarriages) turned out to be the smallest at a low BMI and the highest at a high BMI. The idea of underweight as a global risk factor of reproductive disturbance is being formed. The nature of this relationship remains poorly understood. The population-based character of the study allows to transfer its results to the national level. The numbers of excess miscarriages in the opposite groups were calculated. The excess losses at low BMI amounted 25.2 cases, or 51.4% of 49 miscarriages. At the high BMI, excess losses amounted 9.9 cases, or 20.2% of all miscarriages. The total excess loss amounted 35.1 cases or 76.6%. This means, that three quarters of spontaneous abortions were caused by inadequate BMI for pregnant women. It is logical to assume, if all pregnant women will have BMI in the range of 22-23.9 kg/m², the number of spontaneous abortions will reduce approximately by three quarters of the existing level. Plus, stimulation of fertility will provide the fetus conceptions growth, resulting in the birth rate elevation.

Keywords: Body Mass Index; Miscarriage; Population; Pregnancy; Spontaneous Abortions; Underweight; Overweigh; Nonlinear Dependence; Early Toxicosis; Pre-Labor Rupture of the Membranes; Obstetrical Bleeding; Weak Uterus Labor; Defects of Placenta; Cesarean Section; Fetal Hypoxia; Childbirths

Abbreviation

BMI: Body Mass Index

Introduction

The demographic reproduction of the developed countries is in a critical condition. According to the World Bank, in 2017 out of 42 countries in Europe and North America two thirds were in depopulation regime - total fertility rate (TFR) is below 2.15. The situation is complicated by a high level of miscarriages, reaching 15 - 20% of the pregnant women [1-3]. Miscarriage is a spontaneous termination of pregnancy up to 20 weeks, declared at the visit to a doctor [4]. In the USA annual losses of fetuses reach about 0.75 - 1 million [5]. Finding a way out of the reproductive crisis is a challenge to medical and demographic science [6]. The first step in this direction can be the prevention of spontaneous miscarriages, which does not require large economic investments and needn't efforts to motivate families to have children.

The nature of miscarriage is complex [7]. The internal roots are mainly caused by defects of the fetus: genetic or acquired. External roots include diseases of the pregnant woman, adverse environmental conditions, stress, vitamin deficiency, hard work, smoking. In recent years, the dependence of miscarriages upon the women’s fatness had been studied. For its assessment, the body mass index (BMI) is used - the ratio of body weight to square of growth (kg/m²). According to WHO recommendations, the range 18.5 - 24.9 kg/m² is considered normal. Many studies have shown the adverse effects of overweight on gestation [8,9]. The role of underweight is considered less significant and is often disputed [10].

Numerous cohort observations and prevention programs for major noncommunicable diseases have revealed a similar U-shaped relationship between mortality and BMI. In a majority of studies the lower limit of the optimal BMI was not 18.5 kg/m², but 22 - 23 kg/m² [11,12]. At lower values mortality increased sharply. Given the disagreement in the criteria for the norm, a need arose to study the miscarriages over the entire range of the BMI distribution.

Materials and Methods

A retrospective cohort study was carried out, using the general population of 860 pregnant women 17-36 years old, permanently living in 1998 - 2002 in a small city in the middle zone of Russia, applying up to 7 weeks of pregnancy for gynecological registration in the district clinic. Archival documents for the specified five-year period were studied. Seven people left the study due to moving to another place of residence. The remaining 853 patients were monitored until the end of pregnancy.

To assess the physiological condition of pregnant women there were measured length and body weight; dimensions of the pelvis; systolic and diastolic blood pressure; heart rate per minute. A smoking habit was revealed. Pregnancy complications (early toxicosis, the threat of miscarriages, occurring miscarriages), peculiarities of the childbirth course (early pre-labor rupture of the membranes, obstetrical bleeding, weak uterus labor, defects of placenta, cesarean section), the condition of newborn (hypoxia, anthropometric sizes) were recorded. Pregnancy groups with different levels of BMI were compared. The significance of differences was assessed by the Student criterion and by χ^2 at $p < 0.05$. To assess the contributions of multiple parameters to dynamics of miscarriage stepwise linear regression was used.

Results and Discussion

The age of the pregnant women averaged ($M \pm m$) 26.1 ± 0.2 years. The body mass index varied from 16 to 32 kg/m², the average value was 22.8 ± 0.14 kg/m². The number of miscarriages is 49 (5.7% of all pregnancies). With the pregnant women distribution by the BMI, the spontaneous abortions rate was the smallest in the interval 22 - 23.9 kg/m² - 1.6% (the optimal range). On both sides, the abortion rate increased: from 1.6 to 12.5% (p for $\chi^2 < 0.00$) and from 1.6 to 8.5% (p for $\chi^2 < 0.00$). Graphically, this was expressed by a U-shaped trajectory, where the maximum value of the left segment exceeded the optimum by 7.8 times and the right segment - by 5.3 times (Figure 1).

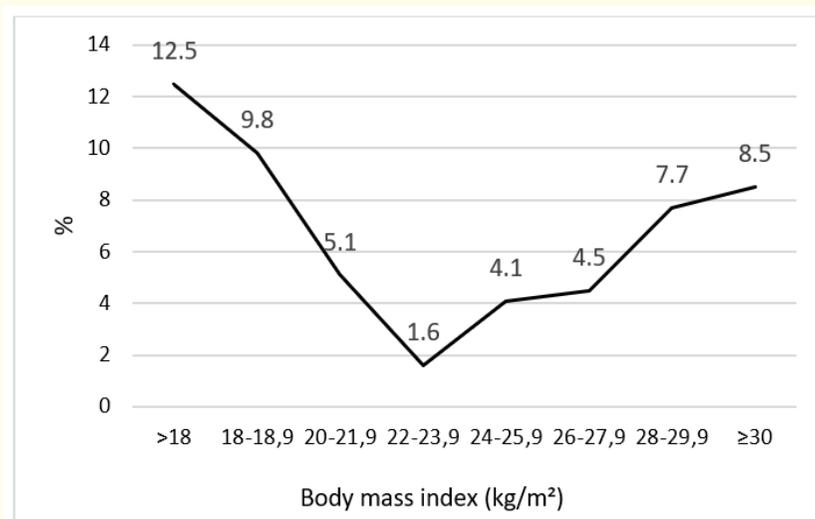


Figure 1: U-shaped distribution of abortion rate at different intervals of body mass index.

On this basis, three groups were identified: I - 416 women with insufficient body weight (BMI < 22 kg/m²); II - 189 women with normal body weight (BMI = 22 - 23.9 kg/m²); III - 248 overweight women (BMI ≥ 24 kg/m²). Pregnant women with a low BMI had lower systolic and diastolic blood pressure, the obstetric sizes of the pelvis. The proportion of smokers was minimal in the middle group, increasing to the left and to the right (Table 1).

Indicators	Body mass index (kg/m ²)		
	I. < 22 (n = 416)	II. 22 - 24 (n = 189)	III. > 24 (n = 248)
Age, anthropometry, smoking			
Age (years)	24,5 ± 0,2	25,7 ± 0,4	27,3 ± 0,3
Height (cm)	165,4 ± 0,3	165,1 ± 0,4	164,8 ± 0,4
Weight (kg)	54,3 ± 0,3*	62,6 ± 0,3	75,1 ± 0,7**
Smokers (%)	7,5*	3,0	4,5**
Physiological characteristics			
Systolic blood pressure (mmHg)	108,0 ± 0,5*	111,4 ± 0,7	115,0 ± 0,7*
Diastolic blood pressure (mmHg)	65,9 ± 0,3*	68,2 ± 0,6	71,2 ± 0,5*
Heart rate (per min.)	80,1 ± 0,3	79,6 ± 0,5	80,5 ± 0,5
Pelvic dimensions			
Distancia spinarum (cm)	23,8 ± 0,1	24,3 ± 0,1	24,8 ± 0,1**
Distancia cristarum (cm)	27,0 ± 0,1*	28,0 ± 0,1	29,0 ± 0,1**
Distancia trochanterica (cm)	30,8 ± 0,1*	32,2 ± 0,1	33,8 ± 0,1**
Conjugata externa (cm)	18,9 ± 0,1*	19,8 ± 0,1	20,8 ± 0,1**

Table 1: Anthropometric and physiological parameters of pregnant women at different levels of body mass index (M ± m)***.

*: p I-II < 0,05; **: p II-III < 0,05.

On the opposite sides from the middle group there was an increase in early toxicosis, pre-labor rupture of the membranes, obstetrical bleeding, weak uterus labor, defects of placenta, cesarean section, fetal hypoxia. The status of live birth and fetal anthropometric sizes did not differ between the groups (Table 2).

Indicators	Body mass index (kg/m ²)		
	I. < 22 (n = 416)	II. 22-24 (n = 189)	III. > 24 (n = 248)
Course of gestation (%)			
Threat of miscarriage	39,9*	24,0	31,2**
Miscarriage	7,4*	2	5,6**
Early toxicosis	13,3*	7,9	8,9
Childbirth' course (%)			
Pre-labor rupture of the membranes	23*	17,1	18,2
Obstetrical bleeding	3,0*	0	1
Weak uterus labor	15,8*	11,4	14,5**
Defects of placenta	7,0*	4,1	6,2**
Caesarean section	13,0*	9,7	17,0**
The condition of the fetus and newborn (%)			
Fetal hypoxia	11,9*	6,0	14,7**
Body length (cm)	51,1 ± 0,1	51,7 ± 0,2	51,9 ± 0,2
Weight (kg)	3,3 ± 0,02	3,4 ± 0,03	3,4 ± 0,03
Alive/Inanimate	99,5	100	98,3

Table 2: The violations of gestation course, childbirth and fetus' condition at different levels of body mass index (%)***.

* p I-II < 0,05 ** p II -III < 0,05

To study the independent effect of body weight on the frequency of miscarriages, stepwise linear regression was used. The independent variables were length and body weight, systolic and diastolic blood pressure, pulse, smoking, four obstetric pelvic sizes, and the age of the pregnant woman. In the final model, the first three places were occupied by body length ($\beta = 0.216$ at $p < 0.000$), body weight ($\beta = - 0.189$ at $p < 0.000$) and smoking ($\beta = 0.077$ at $p < 0.07$). In similar studies, the effect of smoking was also not confirmed [13].

We studied some indicators of reproductive health in BMI groups. Underweight women were predisposed to soreness menarche, less excessive bleeding and regularity. The sum of previous pregnancies (childbirths, artificial abortions, spontaneous miscarriages) turned out to be the smallest at a low BMI and the highest at a high BMI (Table 3).

Indicators	Body mass index (kg/m ²)		
	I. < 22 (n = 416)	II. = 22 - 24 (n = 189)	III. > 24 (n =248)
Menstruation			
The age of the first menstruation	13,1 ± 0,1	13,0 ± 0,1	13,0 ± 0,1
Duration of menstruation (days)	5,3 ± 0,1	5,1 ± 0,1	5,0 ± 0,1
Excessive bleeding (%)	11,2*	14,8	14,4
Soreness (%)	32,3*	22,2	26,0
Regularity (%)	85,2*	90,3	88,1
Marital status and reproductive activity (%)			
Married	88,2	86,0	87,5
Conception frequency:	98*	128	151**
Previous births	35*	46	59**
History of induced abortions	54*	66	77**
Spontaneous miscarriages in the history	9*	16	15

Table 3: Indicators of reproductive health at different levels of body mass index***.

The population-based nature of the study allows to transfer its results to the population level. For this, in the first and in the third groups the numbers of excess miscarriages were calculated (Table 4).

BMI interval	Number of pregnant women	% miscarriages	% excess miscarriages	Number of excess miscarriages
< 18	48	12,5	10,9	5,2
18 - 19,9	153	9,8	8,2	12,5
20 - 21,9	215	5,1	3,5	7,5
22 - 23,9	189	1,6	0	0
24 - 25,9	96	4,1	2,5	2,4
26 - 27,9	66	4,5	2,9	1,9
28 - 29,9	39	7,7	6,1	2,4
≥ 30	47	8,5	6,9	3,2

Table 4: The number of excess miscarriages in the population due to the deviations from the optimum BMI 22 - 23,9 kg/m².

With a low BMI, the excess loss amounted 25.2 cases, or 51.4% of 49 miscarriages. With a high BMI, excess losses amounted 9.9 cases, or 20.2% of all losses. The total loss amounted 35.1 cases or 76.6%. Thus, three quarters of spontaneous abortions were caused by inadequate BMI for pregnant women.

Conclusion

The results indicate the U-link between spontaneous miscarriages and body mass index. The optimal BMI range is 22 - 23.9 kg/m², which is higher than the WHO normal limit.

A similar nonlinear dependence with BMI have early toxicosis, pre-labor rupture of the membranes, obstetrical bleeding, weak uterus labor, defects of placenta, cesarean section, fetal hypoxia.

With a low BMI there was a significant reduction in the frequency of reproductive activity. The maximum frequency have women with excess BMI.

The idea of underweight as a factor of global reproductive risk is being formed. The nature of this relationship remains poorly understood.

It is logical to assume, if all pregnant women will have BMI in the range of 22 - 23.9 kg/m², the number of spontaneous abortions will reduce by three quarters of the existing level. In the example from the USA, this means an increase in the annual birth rate by 550 - 750 thousand babies. Plus, stimulation of fertility will provide the fetus conceptions growth, resulting in the birth rate elevation.

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