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Insufficient physical activity increases cardiovascular risk in women with low birth mass

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Summary

Study aim: The aim of the study was to evaluate the relationship between low birth mass and concentration of high-sensitivity C-reactive protein (hsCRP) as a cardiovascular risk factor in young women with various levels of physical activity.
Materials and methods: 102 female students aged 19.7 ± 0.8 (18.6–23.0) were included. The study group was divided according to the declared physical activity: high physical activity (HPA, n = 69) and low physical activity (LPA, n = 33). Anthropometric indices were measured: body mass, height, hip and waist circumference. hsCRP levels were obtained from venous blood samples. Birth body mass (BBM) and birth height were collected from medical documentation.
Results: Women with low BBM and LPA had a significantly higher concentration of hsCRP than women with low BBM and HPA, as well as women with normal BBM.
Conclusions: Low birth mass together with low physical activity is a strong predictor of raised concentration of hsCRP, which correlates with an increased risk of cardiovascular and metabolic diseases. Regular physical activity in women with low birth mass may prevent an increased hsCRP concentration, and as a result decrease the risk of cardiovascular and metabolic diseases.

Key words: Physical inactivity – Birth weight – Chronic inflammation – Women

Introduction

A crucial problem in the prevention of cardiovascular diseases (CVD) is the evaluation of risk factors and their early reduction or elimination. The main cause of CVD is atherosclerosis, which is a result of a chronic local inflammatory process in the arterial walls. C-reactive protein (CRP) is a sensitive, nonspecific marker of inflammation, which is elevated, among other things, as an effect of the activity of several cytokines. High-sensitivity C-reactive protein (hsCRP) measurement is used for cardiovascular risk estimation, mainly a risk of acute coronary events [19, 20, 25]. CRP concentration depends on many factors, such as gender, age, body mass, smoking, and physical activity [3, 17]. Increased CRP concentrations positively correlated with visceral obesity, insulin resistance and risk factors of metabolic syndrome [1, 13].

Physical activity results in the decrease of cardiovascular risk [30], directly by beneficial changes of hemodynamics (heart rate, blood pressure, stroke volume), functional capacity of the cardio-pulmonary system, and cardiac metabolism, and indirectly by reduction of cardiovascular risk factors. Regular physical activity lowers the visceral fat content, profitably modifies the lipid profile, improves insulin sensibility, reduces inflammatory processes and decreases the concentration of hsCRP [9].

Several studies have shown a significant negative correlation between birth body mass (BBM) and concentrations of hsCRP [2, 5, 23]. In patients with low BBM occurrence of metabolic abnormalities (dyslipidemia, insulin resistance, metabolic syndrome) and increased risk of atherosclerosis are more frequent than in people with normal BBM [2, 7, 23]. These correlations were more often observed in women than in men [17].

Most published studies dealing with the relations between hsCRP and BBM as risk factors of CVD were performed in obese children or overweight and obese adults with a confirmed diagnosis of CVD [6, 14]. Only a few publications of this topic included young women without a history of metabolic diseases.

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The aim of the current study was to evaluate the relationship between low BBM and hsCRP concentrations in young, healthy women with different physical activity in the context of CVD risk evaluation.

Material and methods

Subjects

102 women aged 19.7 ± 0.8 years (18.6–23.0) were recruited to the study at Józef Piłsudski University of Physical Education in Warsaw (UPE) and at Maria Curie-Skłodowska University in Lublin (MCS) as volunteers during physical education classes. The studies included women students identified by children's health books, born in time, without illness and not using medicine. The exclusion criterion was multiple pregnancy.

According to the declared physical activity, students from UPE (n = 69) participated in 6 hours weekly of regular physical education classes and an additional 4–8 hours weekly of recreational or athletic training and were identified as the high physical activity (HPA) group. MCS students (n = 33) participated in physical education classes for 2 hours per week and were not involved in any athletic training, as a low physical activity (LPA) group.

In line with the literature data it was assumed that concentrations of hsCRP below 1 mg/l are a predictor of low cardiovascular risk, 1–3 mg/l moderate risk and concentrations above 3 mg/l considerably increase cardiovascular risk [3, 18].

Participants were informed about the aim and protocol of the study. The research was approved by the local Bioethics Committee of the University.

Measurements

1. *Anthropometric measurements*: Body mass, body height, waist and hip circumferences were measured in a standard way. Body mass (BM) was measured with a weight scale to the nearest 0.1 kg, and body height was measured with a stadiometer to the nearest 0.1 cm. Body mass index (BMI) and whist-to-hip ratio (WHR) were calculated. Body adiposity index (BAI) was calculated following the formula:
   (hip circumference/body height $^{1.5}$) – 18.
2. *hsCRP concentration*. Blood samples were obtained from the participants between 8:00 a.m. and 10:00 a.m. after a 12-h overnight fast. Citrated and EDTA venous plasma samples were centrifuged at 1,500 g for 10 min at 4°C, and stored at –80°C for later analysis with the standard enzyme-linked immunosorbent assay ELISA (method). Participants with any potential inflammatory processes or any injury within 2 weeks prior to recruitment were excluded from study.
3. *Birth body measurements* were obtained from personal medical documentation. Birth body height (BBH) and birth body weight (BBW) were collected. Decreased BBW was defined as values less than –1.0 standard deviation from the average value (BBM < –1 SDS). All other values were defined as normal birth mass.
4. *Statistics*. Analyses were performed using Statistica 8.0 software. Student's t-test was performed for relative samples. The relationship between hsCRP and BBM in compared groups, HPA and LPA, was estimated using Spearman's rank correlation coefficient.
   The level of statistical significance was set at $p < 0.05$.

Results

The anthropometric characteristics of participants assigned to the HPA and LPA groups are presented in Table 1. Most variables did not differ between HPA and LPA groups, except waist circumference and WHR. Average concentrations of hsCRP were not significantly different between groups. 20% (n = 14) of women in the HPA group and 25% of women (n = 8) in the LPA group had low BBM. Cardiovascular risk categories of hsCRP values are shown in Table 2. In the LPA group the percentage of women with a high level of hsCRP ≥ 3 mg/dl, was over 2 times higher than in the HPA group.

Table 1. Selected anthropometric indices in Low Physical Activity and High Physical Activity groups (mean ± SD)

Variable	LPA [n = 33]	HPA [n = 69]
Age [years]	19.4 ± 0.8	19.8 ± 0.7
Body mass [kg]	60.1 ± 9.6	60.3 ± 7.4
Body height [cm]	166.7 ± 5.9	168.5 ± 6.5
BMI [kg/m]	21.5 ± 2.8	21.2 ± 2.2
Waist circumference [cm]	73.9 ± 8.7*	68.9 ± 5.3
Hip circumference [cm]	91.0 ± 7.0	90.3 ± 7.5
WHR	0.81 ± 0.06*	0.77 ± 0.06
BAI	24.3 ± 3.0	23.2 ± 3.5
hsCRP, [mg/l]	1.98 ± 3.3	1.02 ± 1.6
BBM [g]	3297.3 ± 520.1	3348.1 ± 432.3
BBH [cm]	54.2 ± 3.0	54.1 ± 3.1

* – $p < 0.05$

It was found that women with decreased birth body mass and low physical activity had significantly higher concentrations of hsCRP, as compared to women with low birth body mass and high physical activity (Fig. 1). Spearman's rank correlation coefficient for BBM and hsCRP in the LPA group was negative (–0.269).

Table 2. Cardiovascular risk categories of hsCRP values in LPA and HPA groups

Group	Number, %, X ± SD	hsCRP < 1	hsCRP ≥ 1 < 3	hsCRP > 3
LPA [n = 33]	n	23	5	5
	%	70	15	15
	X ± SD	O.53 ± 0.28	1.78 ± 0.52	8.89 ± 4.14
HPA [n = 69]	n	57	13	4
	%	76	18	6
	X ± SD	0.48 ± 0.21	1.43±0.33	6.72 ± 3.08

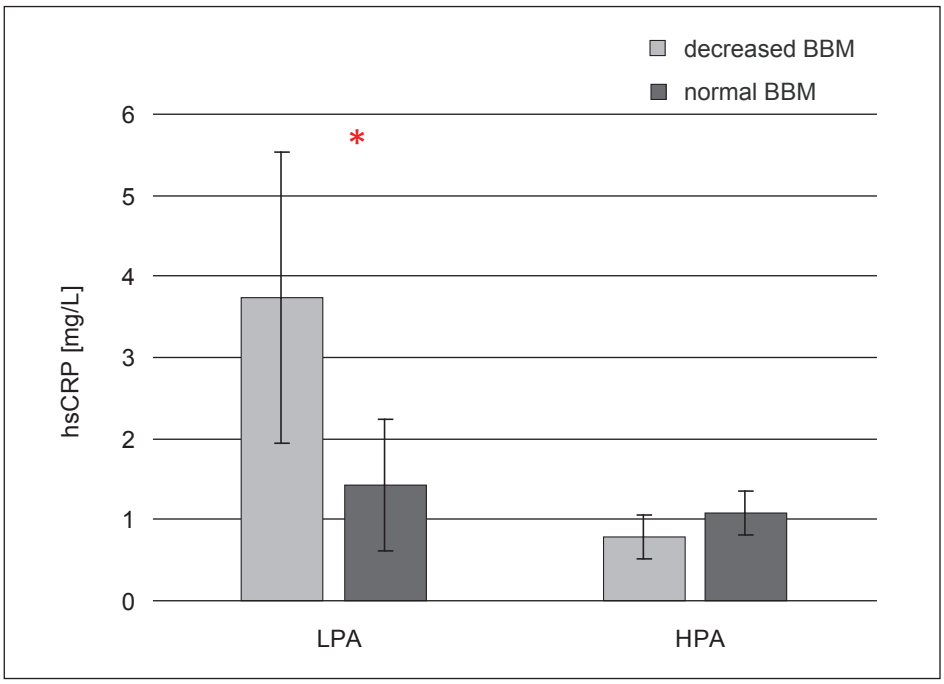

Fig. 1. Average hsCRP (mg/l) concentrations of women with decreased and normal BBM in LPA and HPA groups

Discussion

The aim of the study was to investigate the relationship between low birth body mass and hsCRP concentration values, as an indicator of CVD in young women with diverse physical activity.

In studies concerning relationships between BBM and hsCRP concentration, it was found that among infants with low BBM (small gestation age – SGA) as compared to infants with normal BBM (average gestation age – AGA) higher concentrations of C-reactive protein were observed. This may be explained by the presence of inflammatory processes during fetal life [22, 27].

The results of research on early school children are not conclusive. Rondo et al. (2013) in studies of children aged 5–8 years in Brazil did not show the existence of a correlation between hsCRP and birth weight. A positive correlation was observed only between waist circumference and the concentration of C-reactive protein. In other studies of Brazilian children aged 5–13 years, the authors observed a positive correlation between birth weight and the concentration of C-reactive protein, body mass index, waist circumference and skin folds. The authors suggested that higher birth weight predicted higher risk of overweight and obesity in childhood and higher risk of CVD in adulthood [22]. This was confirmed by a study of European children aged 2–9 years, in whom significant positive correlations between serum hsCRP and BMI and abdominal obesity rates were observed [14].

Studies of young adults present unambiguous results as well. In a study conducted in young Finns of both sexes, there was a positive relationship between low birth weight and the concentration of hsCRP, but only among women. The authors explained the lack of such a relationship in men by sexual dimorphism and diverse adaptation to unfavorable intrauterine conditions [17]. In a study conducted in the United States on a population of more than 20,000

young adults of both sexes, a relationship between BBM and CRP was demonstrated, but the relationship was not linear. It was found that in patients with BBM 2800 g and higher there is a significant negative correlation with CRP. In contrast, in patients with BBM less than 2800g a positive relationship was observed. These results were further enhanced by the results compared to siblings who differed by BBM and breastfeeding period. A lower birth weight and shorter duration of breastfeeding were associated with elevated CRP in young adults [12]. Most of the studies available in the literature confirm the existence of a correlation between hsCRP and birth weight, regardless of the race, body composition and different somatic prevalence of cardiovascular risk factors [23, 28, 29].

A beneficial effect of regular physical activity on plasma hsCRP has been documented in many studies. However, different effects of physical activity depending on age, gender, race and health status were highlighted. [9, 26]. Most studies apply to persons who are overweight or obese and also with underlying metabolic disorders and/or cardiovascular diseases. In contrast, studies in young, healthy, physically active men and women showed no significant correlation between the amount of physical activity as well as between aerobic endurance and the concentration of hsCRP [8, 11]. It was found in people with low BBM that in adulthood they were less physically active as compared to those with normal BBM [15, 21]. It was also found that people with low BBM are less sensitive to insulin, as compared with those of normal BBM. In addition, it was observed that higher levels of physical activity in people with low BBM can have a beneficial impact on insulin resistance [15].

A meta-analysis of the relationship between BBM and physical activity showed a positive impact of physical activity in reducing abnormalities caused by low birth weight [24]. However, it is not the widely presented opinion. Kasewa et al. in a 25-year follow-up of prematurely born and low BBM patients found no significant relationship between physical activity and the concentration of CRP [10].

By comparing groups of young women, we demonstrated that students from the LPA group had significantly higher average waist circumference and WHR, as compared to HPA women. These differences were independent of BBM. It can therefore be attributed to the influence of environmental factors in childhood and early adulthood, especially less energy expenditure on physical activity, recreation and sport, and a positive caloric balance. A higher content of visceral adipose tissue is a source of proinflammatory cytokines and can be a predictor of increased levels of hsCRP. Among women with LPA, we found a significantly higher percentage of subjects with hsCRP > 3 mmol/l, compared to the HPA group, which can be treated as a factor greatly increasing the risk of cardiovascular and metabolic diseases (Table 2, 15% vs. 6%).

Women with normal BBM and different physical activity had similar hsCRP concentration, whereas women with low BBM differed in average values of hsCRP according to physical activity. Women of the LPA group were characterized by significantly higher mean hsCRP concentrations, as compared to HPA women, 3.74 ± 5.8 mg/l vs 0.78 ± 0.6 mg/l, respectively. Analyzing the results obtained with regard to cardiac risk, it should be emphasized that women with low BBM in the LPA group had a mean hsCRP concentrations corresponding to a significantly elevated risk of developing cardiovascular events. Spearman's rank correlation coefficient for BBM and hsCRP in the LPA group was negative (–0.269).

Given the frequent occurrence of high concentrations of hsCRP in women with low BBM, it can be assumed that regular physical activity of these women is a factor beneficial for hsCRP, which in turn may reduce the risk of cardiovascular events in their later life.

The results of our study are the basis for the following conclusions: Low body mass at birth, combined with low physical activity of young women, is a predisposing factor for the occurrence of high concentrations of hsCRP, which is associated with an increased risk of cardiovascular and metabolic diseases. Regular physical activity in women born with low birth mass can be a protective factor, preventing the occurrence of elevated hsCRP levels and reducing the risk of cardiovascular and metabolic diseases.

We recommend the promotion of systematic physical activity in families in which a child is born with a deficiency of body mass.

Limitation

Limitations of our study are the relatively small number of participants, evaluation of their physical activity based on an interview, and non-randomized samples.

Conflict of interest: Authors state no conflict of interest.

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