

Maternal Physical Activity in Pregnancy and Newborns' Anthropometry – Preliminary CRIBS data

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ABSTRACT

Health benefits of physical activity during pregnancy include reduced risk of excessive gestational weight gain and conditions such as gestational diabetes, preeclampsia and preterm birth. The ongoing Croatian Islands Birth Cohort Study (CRIBS) is the first cohort study in the South-Eastern Europe aimed at assessing the prevalence of risk factors (biological, environmental and behavioral) for the Metabolic Syndrome. The participants in the study are pregnant women and their newborns from the Dalmatian islands of Hvar and Brač and the mainland town of Split with its surroundings. At the time of writing, over 350 pregnant women and 220 of their newborns have been involved in the study. Here we present the preliminary results of testing the association of mothers' self-evaluated physical activity during pregnancy with newborns' anthropometric characteristics (birth weight, length and head circumference) using the data from questionnaires and obstetric records of 116 mother – newborn pairs. The difference in weight-at-birth was detected between newborn girls whose mothers were in Low vs. Intensive physical activity categories, as well as from Moderate vs. Intensive physical activity categories. In addition to that, the significant difference in weight-at-birth and height/length-at-birth was detected between newborn boys whose mothers were in Moderate vs. Intensive physical activity categories ($p < 0.01$). No association between self-estimated level of physical activity and mothers' body mass index was found. For women with normal pregnancies, light occupational activities do not cause problems with the fetal growth rate, but the same was not reported for women who maintained high-intensity activities.

Key words: birth cohort, mother, newborn, physical activity, anthropometry

Introduction

Moderate physical activity (exercise) has many health benefits, namely improved physiological and metabolic parameters and reduced risk of morbidity and mortality from several types of noncommunicable diseases, such as cardiovascular diseases, hypertension, type 2 diabetes, osteoporosis and some forms of cancer (colon and breast cancer)^{1,2}. Pregnancy induces specific physiological changes in order to accommodate increased metabolic demands for mothers and fetuses, so in order to meet these demands and avoid risk to their health and fetus' development pregnant women were advised to avoid physical efforts. These recommendations were mostly based on traditional cultural and social beliefs, and not on the scientific evidence³. However, with time scientific data emerged showing that moderate physical activity provided benefits to both maternal and fetal health⁴. It has been shown that regular exercise contributes to better management of gestational

diabetes mellitus⁵, modulates maternal weight gain⁶ and reduces the risk of macrosomia on delivery^{7–9}. Importantly, data from the North Carolina Pregnancy Risk Assessment Monitoring System indicate that hypertensive complications during pregnancy are less likely to occur in physically active women¹⁰, and some data show a trend of preventive effect of exercise on the preeclampsia development¹¹. Physical activity during pregnancy also brings benefits like increased cardiorespiratory fitness and decreased risk for preterm birth^{3,12,13}.

On the other hand, some studies showed a negative effect of intensive exercise on maternal and fetal well-being. The study of Leet *et al.*¹⁴ showed that vigorous exercise is associated with reduced birth weight and Danish authors showed on the sample of 85,139 Danish women that intensive physical activity leads to an increased risk of preeclampsia¹⁵.

The American College of Obstetricians and Gynecologists (ACOG) has therefore issued recommendations for exercise during pregnancy in which they recommend physical activity of moderate intensity, as intensive exercise is associated with some negative trends¹⁶. There are also absolute contraindications to exercise that should be taken into consideration, but in general moderate physical activity is strongly encouraged¹⁶.

The ongoing Croatian Islands Birth Cohort Study (CRIBS) is the first cohort study in the South-Eastern Europe, designed to follow a representative sample of about 500 pregnant women and their children up to two years of age. The aim of the project is to assess the prevalence of risk factors (biological, environmental and behavioral) for the Metabolic Syndrome (MetS) in populations from the Dalmatian islands Hvar and Brač and the mainland town of Split with its surroundings, the Mediterranean area with very high prevalence of the MetS. The purpose of this preliminary study is to assess how mother's physical activity during pregnancy affects anthropometric characteristics of the newborns (birth weight, length and head circumference) and indirectly child's *in utero* growth and development.

Participants and Methods

The study is conducted at gynecological and pediatric clinics in Split and the islands of Hvar, Brač and Korčula. So far, over 350 pregnant women and 220 of their newborns have been involved in the study. Here we present the preliminary results of testing the association of mothers' self-estimated physical activity during pregnancy with newborns' anthropometric characteristics (birth weight, length and head circumference) using data from questionnaires and obstetric records of 116 mother – newborn pairs that had complete set of data necessary for the analysis.

During pregnancy women filled out two questionnaires, reporting about their socioeconomic status (SES) (educational level, marital status and income), lifestyle characteristics (smoking and self-estimated physical activity) and their pre-pregnancy body size parameters (weight, height). Self-estimated physical activity categories were: (1) Low p.a. (including mostly sitting activities, home-based work, avoidance of sports), (2) Moderate p.a. (physical work, housework, light sport), and (3) Intensive p.a. (hard physical work, a job that requires a lot of movement, practicing an intense sport). Information on birth weight, length, head circumference and infant sex were taken from obstetric records.

Evaluation for internal consistency of questionnaire was done using Cronbach's α value. Continuous data was tested for normal distribution using Shapiro-Wilk's test ($p > 0.05$). Differences between groups were tested using One-way ANOVA while checking for homogeneity of the variance with Levene's test ($p > 0.01$). For post-hoc analysis we used Tukey's post-hoc tests.

Results

Pregnant women were aged between 19.6 and 41.7 years (mean age 30.54 ± 4.37 years) and they gave birth to 60 girls and 56 boys. Maternal mean body mass index (BMI) was 26.77 ± 5.01 kg/m², and it did not significantly differ between the islands and the mainland. 45.5% of women constituted a normal weight group according to BMI, while 34.8% and 18.8% constituted pre-obesity and obesity class I groups, respectively (Table 1). 10.8% of women reported low self-estimated level of activity, while 54.1% and 14.4% reported moderate and high levels of self-estimated physical activity (Table 1).

TABLE 1

DISTRIBUTION OF VARIABLES INCLUDED IN THE ANALYSIS

BMI	N	(%)
<18.5 (Underweight)	1	0.9%
18.5-24.9 (Normal weight)	56	45.5 %
25-29.9 (Pre-obesity)	42	34.8%
>30 (Obesity class I)	23	18.8%
Self-estimated level of p.a.	N	(%)
Low p.a.	12	10.8%
Moderate p.a.	60	54.1%
Intensive p.a.	16	14.4%

p.a. – physical activity

Compared to self-estimated level of physical activity before pregnancy, women in pregnancy generally reported lower level of physical activity (Figure 1).

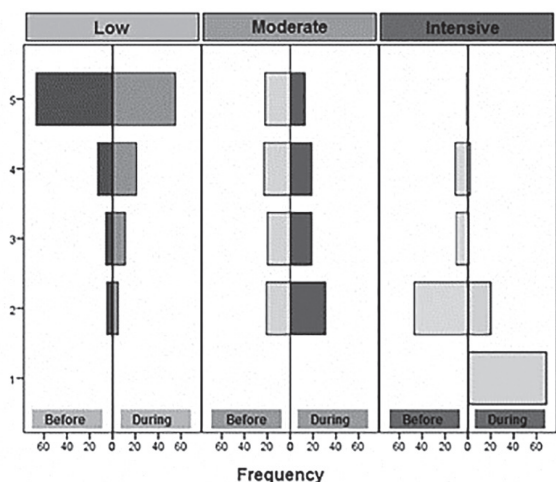


Fig. 1. Decline in physical activity shown as a bar plot with *N* on the x axis and self-assessed scale of physical activity on the y axis.

There was no observed significant difference in measurements between male and female newborns in weight-at-birth category, but height-at-birth and head circumference-at-birth measurements showed significant differences between genders (Table 2).

TABLE 2
MEASUREMENTS BETWEEN MALE AND FEMALE NEWBORNS

	Mean		min		max		Gender diff	
	Female (N=55)	Male (N=56)	Female (N=55)	Male (N=56)	Female (N=55)	Male (N=56)	F	p
Weight-at-birth (g)	3502.55 ±471.62	3651.96 ±471.62	2480	2540	4600	4430	3.024	ns
Height/length-at-birth (cm)	50.45 ±1.864	51.43 ±1.98	46	47	55	56	7.114	<0.05
Head circumference-at-birth (cm)	35.04 ±1.122	35.45 ±0.85	32	34	37	37	4.719	<0.05

When we tested the relationship between three different BMI categories and three different self-estimated levels of physical activity we were unable to find any significant difference (Table 3).

TABLE 3
CROSS TABULATION BETWEEN BMI CATEGORIES AND LEVELS OF PHYSICAL ACTIVITY

Self-estimated level of p.a. in pregnant women		BMI Level		
		Normal weight	Pre-obesity	Obesity class I
Low p.a.	N	5	5	2
	%	41.7%	41.7%	16.7%
Moderate p.a.	N	28	22	10
	%	46.7%	36.7%	16.7%
Intensive p.a.	N	8	4	4
	%	50.0%	25.0%	25.0%

*p<0.869, p.a. – physical activity

Next, we tested the association between the maternal BMI levels and anthropometric characteristics of newborns. The results showed that in our case only newborn girls whose mothers belonged to the normal weight BMI category had larger head circumference-at-birth compared to those in Obesity class I category (Table 4).

However, we were able to find more significant differences when comparing self-estimated level of maternal physical activity to the body size parameters of newborns at birth. The difference in weight-at-birth was detected between newborn girls whose mothers were in Low vs. Intensive physical activity categories, or in Moderate vs. Intensive physical activity categories (Table 5). In addition to that, the significant difference in weight-at-birth and length-at-birth was detected between newborn boys whose mothers were in Moderate vs. Intensive physical activity categories (p<0.01).

Discussion and Conclusion

The CRIBS project is, to the best of our knowledge, the first birth cohort study in the South-Eastern Europe, and therefore of high importance for the region. One of the main aims of the project is to investigate how mother's health, diet and lifestyle (including physical activity) affect children's growth and development and whether they can affect children's health status later in life. The aim of the present work was to investigate the association between physical activity in pregnancy and anthropometric characteristics of the offspring.

TABLE 4
ASSOCIATION BETWEEN THE MATERNAL BMI LEVELS AND NEWBORNS' ANTHROPOMETRIC CHARACTERISTICS

Body size parameters at birth - Females (N=55)	BMI Level			p
	Normal weight (18.5-24.9) (n=12)	Pre-obesity (25-29.9) (n=60)	Obesity class I (>30) (n=16)	
Weight-at-birth (g)	3544.07±466.11	3723.68±503.74	3807.00±389.41	ns
Height/length-at-birth (cm)	50.38±2.07	50.19±1.81	49.70±2.16	ns
Head circumference-at-birth (cm)	35.63±1.30	34.90±1.03	34.44±1.51	<0.05*
Body size parameters at birth - Males (N=56)	BMI Level			Sig.
	Normal weight (18.5-24.9) (n=12)	Pre-obesity (25-29.9) (n=60)	Obesity class I (>30) (n=16)	
Weight-at-birth (g)	3438.33±462.21	3474.00±325.61	3694.55±514.51	ns
Height/length-at-birth (cm)	50.13±1.72	50.35±1.57	51.36±2.46	ns
Head circumference-at-birth (cm)	34.67±1.27	35.10±0.78	35.73±1.01	ns

*difference between Normal weight and Obesity class I

TABLE 5
A COMPARISON OF BODY SIZE PARAMETERS AT BIRTH IN CHILDREN ACCORDING TO THEIR MOTHERS' REPORTED LEVEL OF PHYSICAL ACTIVITY DURING PREGNANCY

Body size parameters at birth	Self-estimated level of p.a. in pregnant women			
	Low p.a. (n=8)	Moderate p.a. (n=42)	Intensive p.a. (n=9)	p
Females (N=60)				
Weight-at-birth (g)	3531.25±528.08	3455.71±453.16	2939.00±703.22	<0.05*
Length-at-birth (cm)	50.38±2.07	50.19±1.81	49.70±2.16	ns
Head circumference-at-birth (cm)	35.63±1.30	34.90±1.03	34.44±1.51	ns
Males (n=56)	Low (n=11)	Moderate (n=31)	Intensive (n=14)	p
Weight-at-birth (g)	3518.18±483.26	3727.10±490.57	3166.43±640.14	<0.01**
Height/length-at-birth (cm)	50.91±2.39	51.61±2.39	49.07±2.46	<0.01**
Head circumference-at-birth (cm)	35.09±0.83	35.48±0.93	35.14±0.95	ns

*difference between low vs. intensive activity and moderate vs. intensive activity

**difference between moderate vs. intensive activity

p.a. – physical activity

As the studied population consisted from pregnant women from the mainland and the islands, to establish how similar the two groups are we compared their BMI. There were no significant differences between the two groups, confirming an observation that was reported in a similar study in 2009 on a general population of women from the area¹⁷.

The level of self-estimated physical activity in pregnancy in the CRIBS sample was lower when compared to the self-estimated physical activity before pregnancy. This observation is in line with previous research of physical activity and exercise levels in pregnancy. A study on Norwegian women showed that they had a low total physical activity level and exceeded the recommended weight gain¹⁸. More detailed studies in the UK and USA showed that levels of activity decrease within pregnancy, as the activity of women included in the studies significantly decreased from second to third trimester^{19,20}. One of the possible explanations might be that pregnant women are advised by their doctors to reduce their physical activity level, because of the concern that exercise would negatively affect pregnancy outcomes by raising core body temperature and by shunting transport of oxygen and nutrients to maternal skeletal muscle rather than to the developing fetus²¹. More current studies demonstrated sufficient evidence which showed positive effects of physical exercise on various aspects of pregnancy²². As in other studies^{23,24} the intensive physical exercise in the CRIBS pregnant women was associated with lower weight-at-birth in both sexes, and with lower length/height-at-birth in males. In line with previous studies the difference in head circumference and height at birth between sexes was significant^{25,26}, although contrary to their findings we did not find any significant sex differences in weight at birth. Our results regarding associa-

tions between maternal BMI levels and newborns' anthropometry are broadly in line with a previous study from China where no significant associations were found between maternal pre-pregnancy BMI and birth length or weight at birth except for head circumference²⁷. These basic findings are consistent with UK research showing that maternal BMI explains a large proportion of the geographical variation in birth weight, length and head circumference²⁸. However, we acknowledge that other factors influencing head circumference should be taken into account, since head circumference and its growth are strongly genetically regulated²⁹ and fetal genes were found as most important for birth length and head circumference³⁰. We were unable to find any significant difference between three different BMI categories regarding self-estimated levels of physical activity. A similar pattern of results was obtained by Lee *et al.* where no significant associations were found between physical activity and obesity by BMI in women³¹. However, although BMI and physical inactivity are viewed as two independent variables, they may be influencing each other³².

For women with normal pregnancies, light occupational activities do not cause problems with the fetal growth rate, but the same was not reported for women who maintained high-intensity activities. Further studies with a larger sample size are required to confirm the association between physical activity in pregnancy and newborns' body size.

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FIZIČKA AKTIVNOST MAJKE TIJEKOM TRUDNOĆE I ANTROPOMETRIJA NOVOROĐENČETA - PRELIMINARNI REZULTATI STUDIJE CRIBS

SAŽETAK

Fizička aktivnost tijekom trudnoće ima pozitivne učinke na zdravlje, kao što su pojačana kardiorespiratorna sposobnost, smanjen rizik od prekomjernog dobivanja na težini tijekom gestacije, gestacijskog dijabetesa, preeklampsije itd. Kohortna studija rođenih na istočno-jadranskim otocima, koja je u tijeku, predstavlja prvu kohortnu studiju u jugoistočnoj Europi. Cilj istraživanja je procijeniti prevalenciju rizičnih čimbenika (bioloških, okolišnih i ponašajnih) za metabolički sindrom (MetS) u populacijama dalmatinskih otoka Hvara i Brača te obalnog grada Splita i njegove okolice, odnosno na mediteranskom području s vrlo visokom prevalencijom MetS-a. Do sada je uključeno preko 350 trudnica i 220 njihove novorođenčadi. Ovdje predstavljamo preliminarne rezultate ispitivanja povezanosti majčine samoprocijenjene fizičke aktivnosti tijekom trudnoće s antropometrijskim značajkama novorođenčeta (porodajna težina, duljina i opseg glave) koristeći se podacima iz upitnika i opstetričkom dokumentacijom za 116 parova majka-novorodenčce. Uočene su razlike u porodajnoj težini ženske novorođenčadi čije majke su pripadale kategorijama Niska vs. Intenzivna fizička aktivnost, kao i Umjerena vs. Intenzivna fizička aktivnost. Dodatno, značajne razlike u porodajnoj težini i porodajnoj duljini uočene su između muške novorođenčadi čije majke su pripadale kategorijama Umjerena vs. Intenzivna fizička aktivnost ($p < 0.01$). Nije pronađena povezanost između samoprocijenjene fizičke aktivnosti i majčinog indeksa tjelesne mase. Za žene s urednom trudnoćom lagane radne aktivnosti ne uzrokuju probleme s fetalnim rastom, ali to nije uočeno za žene koje su održavale aktivnosti visokog intenziteta.