Impact of Pre-Pregnancy BMI on Blood Glucose Levels in Pregnancy and on the Anthropometry of Newborns – Preliminary Insights from The Croatian Islands’ Birth Cohort Study (CRIBS)

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ABSTRACT

The aim of this study was to investigate the relationship between pre-pregnancy body mass index (BMI) and fasting blood glucose level in pregnancy on the anthropometry of newborns. The sample consisted of 171 healthy pregnant women and their newborns from the Croatian Islands’ Birth Cohort Study. Peripheral blood of pregnant women was taken in the second trimester and fasting glucose values >5.1 mmol/l were considered elevated. Anthropometric variables (body weight, height and waist circumference) were measured according to the International Biological Program. Pre-pregnancy BMI and fasting glucose levels during pregnancy were significantly positively correlated (p<0.01), as were pre-pregnancy BMI and birth weight (p<0.05), length (p<0.01), and head circumference (p<0.05) of the newborns. Hyperglycaemic women gave birth to significantly heavier newborn girls then normal glycaemic women (p<0.05). In conclusion, there was a positive correlation between pre-pregnancy BMI, fasting glucose during pregnancy and the anthropometry of newborns in this study.

Key words: Croatian Islands’ Birth Cohort Study, pre-pregnancy BMI, fasting glucose in pregnancy, anthropometry, newborns

Introduction

It is well known that the biological, physical and social environment, to which a child is exposed early in life may lead to disease or disability in childhood and adulthood. Various risk factors acting during critical periods of development in pre- and early postnatal life play an important role in the etiology of these non-communicable diseases1–3. It is now widely accepted that an adverse peri-conception (e.g. increased pre gravid weight) and intrauterine environment (e.g. gestational diabetes mellitus, excessive weight gain during pregnancy) are associated with predisposition to chronic metabolic disorders later in life: a phenomenon termed ‘early life programming’4–7. Population-based pregnancy and birth cohort studies are particularly salient for studying early origins of health and disease that begin in fetal life and infancy8–9.

Early identification of all biological, environmental and behavioural risk factors for poor pregnancy outcomes and MetS related disorders is important for the development of preventive and early intervention strategies10. Increased pre-pregnancy body mass index (BMI) and elevated glucose levels are known to independently influence fetal growth and to increase the risk of subsequent development of obesity. A previous systematic review and meta-analysis
of 66 studies suggested a promising strategy to lower over-
weight risk in the long term by adequately managing ma-
ternal overweight11. The main goal of this study was to
investigate the influence of body mass index (BMI) before
pregnancy and glucose levels in the second trimester on
birth weight, birth length, and head circumference of new-
borns and to determine the trend of measured anthropo-
metric variables of pregnant women and derived indices
during pregnancy.

The Study and Sample

The Croatian Islands’ Birth Cohort Study (CRIBS) is
the first birth cohort study in South–Eastern Europe with
the aim of identifying the prevalence of modifiable risk
factors for the development of the metabolic syndrome
(MetS). The total sample of 500 healthy pregnant women
and their offspring were recruited from the Adriatic is-
lands of Hvar and Brač and the adjacent mainland City of
Split and Dalmatian County. The sample for this analysis
consisted of 171 healthy pregnant women and their new-
borns all delivered at the University Hospital Center Split
(Split, Croatia).

The enrollment into the study of pregnant woman and
all scheduled visits (follow-ups) were carried out at doctor’s
office where the pregnancy is routinely monitored and in
the maternity unit in the University Hospital Center Split,
which is the only maternity hospital in the Split-Dalmatia
County. In this study we enrolled pregnant women (age
18 or older), from 12 weeks of gestation onwards. Women
were examined three times during pregnancy. Inclusion
criteria were: 12 weeks or more of single pregnancy, not
assisted with reproductive technology. Exclusion criteria
were: diagnosed acute or chronic medical conditions (can-
cer; renal, endocrinologic, psychiatric, neurological, infec-
tious and cardiovascular diseases), multiple gestations,
persistent second or third trimester bleeding, placenta
praevera after the 26th week of gestation, poorly controlled
hypertension, diabetes mellitus or thyroid gland disease,
as well as incompetent cervix, history of recurrent miscar-
riages.

Methods

Pre-pregnancy BMI was calculated as the ratio of
weight in kg and the square of height in meters based on
pre-pregnancy weight and height both extracted from the
projects’ pregnancy booklet. Extensive medical and bio-
chemical data (medical records, cord blood, serum and
DNA samples – both from pregnant women and newborns)
were collected during pregnancy and after birth. Compre-
sensive questionnaires (including questions on family
data, genealogy, nutrition, health-related behaviour, psy-
chosocial characteristics, etc.) were filled in during preg-
nancy and postnatally at particular child developmental
milestones. Peripheral blood of pregnant women was
taken between the 22nd and 26th week of gestation, fasting
glucose in pregnant women was measured at the licensed
biochemical laboratory at the Dubrava University Hospi-
tal (Zagreb, Croatia). Fasting glucose values >5.1 mmol/L
were considered elevated according to the reference values
of Croatian Society of Medical Biochemistry and Labora-
tory Medicine (CSMBLM). The 75-g oral glucose tolerance
test (oGTT) in pregnancy was analysed according to In-
ternational Association for the Diabetes and Pregnancy
Study Groups12 (IADPSG 2010) and World Health Orga-
nization13 (WHO 2013). Anthropometric variables (body
weight, height and waist circumference) were measured
according to the International Biological Program. An-
thropometry of newbomns (body length, weight, head cir-
cumference) – conversion to Z-scores was done using WHO
Anthro software14 (WHO 2005) Statistical analyses were
performed by SPSS 10.0 for Windows.

Results

There was a significant positive correlation between pre-
pregnancy BMI and fasting glucose levels between the 22nd
and 26th week of gestation (R2=0.056; R=0.236; p<0.01). (Fig.
1.a). Likewise, there was a significant positive correlation
between pre-pregnancy BMI and birth weight (R2=0.066;
R=0.257; p<0.05), birth length (R2=0.038; R=0.196; p<0.01)
and birth head circumference (R2=0.039; R=0.198; p<0.05)
of the newborns (Fig. 1.b).

We also tested the correlation between newborn an-
thropometry (measures z-standardized according to
WHO) between mothers with different levels of glucose in
the second trimester (22nd and 26th week of gestation). The
sample of mothers was defined in two groups according to
the reference values of Croatian Society of Medical Bio-
chemistry and Laboratory Medicine (CSMBLM). The first
group included normal glycaemic mothers (GLUC1) and
the second one included hyperglycaemic mothers (GLUC2).
Although in general no significant differences have been
observed, we however detected that hyperglycaemic wom-
en gave birth to significantly heavier newborn girls than
normal glycaemic women (p<0.05). (Table 1).

Discussion

A limited number of studies has previously focused on
variables of pre-pregnancy BMI, glucose level and new-
born length, weight and head circumference. In studies
where only pre-pregnancy BMI was brought into associa-
tion with newborn birth weight, increased risk of LGA
(large-for-gestational-age) newborns, macrosomia, and
subsequent offspring overweight/obesity was observed in
women with a high pre-pregnancy BMI (overweight or
obese mothers)15–17. Only several previous studies have
focused on the investigation of fasting blood glucose as a
predictor of birth weight among neonates of non-diabetic
mothers18–20 and have detected a positive correlation be-
tween elevated glucose levels of mothers in pre-pregnancy
and increased birth weight of the newborn.

In this study, participants were categorized into two
groups; women with normal glucose (GLUC1) and those
hyperglycaemic (GLUC2) according to CSMBLM reference values. Only the difference in birth weight of newborn girls was statistically significant (Table 1). The results were expected due to a small sample, although the trend of increased birth weight, birth length and head circumference of newborns of hyperglycaemic mothers is

<table>
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<th>Variable</th>
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<th>N</th>
<th>GLUC2</th>
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<td>weight-at-birth (kg)</td>
<td>139</td>
<td>3.55±0.43</td>
<td>32</td>
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<td>50.94±1.91</td>
<td>32</td>
<td>50.78±1.81</td>
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<tr>
<td>head circumference-at-birth (cm)</td>
<td>137</td>
<td>35.14±1.03</td>
<td>32</td>
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<td>Boys</td>
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</tr>
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<td>3.67±0.44</td>
<td>13</td>
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<td>weight-at-birth (kg)</td>
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<td>head circumference-at-birth (cm)</td>
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<td>34.87±1.02</td>
<td>19</td>
<td>35.20±0.97</td>
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</table>
observed. The results of our study were consistent with a similar research involving mothers of increased BMI (excessive weight and obesity) during pregnancy with hyperglycaemia, which showed that there was a trend in the birth of children with increased birth weight, birth length and head circumference when compared to mothers with normal glucose in pregnancy.

Subsequent research on the same sample of mother-child dyads and new cohort studies are necessary to further investigate ‘early life programming’ and importance of pre-pregnancy and pregnancy period for birth outcomes and health of children later in life.

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In conclusion, a growth trend has been observed between pre-pregnancy BMI, fasting glucose during pregnancy and the anthropometry (body length, weight and head circumference) of newborns in the CRIBS study. We can conclude based on our results that there is a minor influence of pre-pregnancy BMI on the anthropometry of newborns.

Acknowledgement
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UTJECAJ INDEKSA TJELESNE MASE (ITM) PRIJE TRUDNOĆE I RAZINE GLUKOZE U TRUDNOĆI NA ANTROPOMETRIJSKA OBILJEŽJA NOVOROĐENČADI – PRELIMINARNI REZULTATI STUDIJE CRIBS

SAŽETAK

U ovoj pilot studiji pod nazivom »Kohortna studija rođenih na istočnojadranским otocima« (CRIBS) koja je još u tijeku, analizirani uzorak je obuhvatio 171 zdravu trudnicu te njihovu novorođenčad s područja Splitska – Dalmatinske županije, točnije hrvatskih otoka Brača i Hvara te područja grada Splita i bliža okolice. Cilj ovog rada bio je istražiti utjecaj indeksa tjelesne mase (ITM) prije trudnoće i razine glukoze u trudnoći na antropometrijska obilježja novorođenčeta (porođajnu težinu, porođajnu duljinu i opseg glave). Antropometrijske varijable majke (tjelesna masa, tjelesna visina i opseg struka) mjerene su prema metodama opisanim u Praktikumu biološke antropometrije (1975.), izrađenima u skladu s protokolom International Biological Programme. U okviru biokemijskih analiza trudnicama su izuzeti uzorci periferne krvi u drugom trimesteru trudnoće. Izmjerene vrijednosti glukoze >5,1 mmol/L smatrane su povišenima. Statističke analize provedene su pomoću programa SPSS10.0 for Windows. Preliminarni rezultati pokazali su značajnu korelaciju porastaa glukoze u krvi trudnica s povećanim indeksom tjelesne mase prije trudnoće (p<0,01) kao i značajnu korelaciju povećanog indeksa tjelesne mase prije trudnoće s većom porođajnom težinom (p<0,05) porođajnom duljinom (p<0,01) i opsegom glave (p<0,05) novorođenčadi. Utvrđena je i povezanost povišene vrijednosti glukoze s povećanom porođajnom težinom ženske novorođenčadi (p<0.05). Iz prikazanih rezultata vidljiv je trend rasta antropometrijskih osobina novorođenčeta s povećanim vrijednostima glukoze u krvi trudnica i indeksom tjelesne mase prije trudnoće. Temeljem dobivenih preliminarnih rezultata moguće zaključiti da postoji utjecaj tjelesnog i zdravstvenog statusa (prehrambenog) trudnica na antropometrijske značajke novorođenčadi.