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Maternal lifestyle during pregnancy and child psychomotor development — Polish Mother and Child Cohort study

Kinga Polańska [a,*], Paweł Muszyński [a], Wojciech Sobala [a], Emila Dziewirska [a], Dorota Merecz-Kot [b], Wojciech Hanke [a]

[a] Department of Environmental Epidemiology, Nofer Institute of Occupational Medicine, 8 Teresy Street, 91-348 Lodz, Poland
[b] Department of Health and Work Psychology, Nofer Institute of Occupational Medicine, 91-348 Lodz, Poland

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ABSTRACT

Background: Nowadays special attention is paid to prenatal exposures to maternal lifestyle factors and their impact on a child development.
Aim: The objective of this study was to evaluate the impact of modifiable maternal lifestyle factors on child neurodevelopment based on the Polish Mother and Child Cohort study.
Material and methods: The current analysis included 538 mother–child pairs. The following factors related to maternal lifestyle were considered: smoking and environmental tobacco smoke (ETS) exposure (based on the cotinine level in maternal saliva measured using LC-ESI + MS/MS method), alcohol consumption and leisure-time physical activity (LTPA) in pregnancy, pre-pregnancy BMI, and folic acid supplementations before and during pregnancy based on questionnaire data. Psychomotor development was assessed in children at the ages of one and two by the Bayley Scales of Infant and Toddler Development.
Results: Significant association was observed between prenatal exposure to tobacco constituents and a decreased child motor development in assessments performed at both ages ($\beta = -0.8$, $p = 0.01$; $\beta = -1.4$, $p < 0.001$). Maternal pre-pregnancy underweight was associated with decreased language abilities at 12 months of age ($\beta = -5.2$, $p = 0.01$) and cognitive and motor development at 24 months of age, for which the associations were of borderline significance ($p = 0.06$). The recommended level of LTPA during pregnancy was beneficial for child language development at two years of age ($\beta = 4.8$, $p = 0.02$). For alcohol and folic acid consumption there were no significant associations with any of the analyzed domains of child neurodevelopment.
Conclusions: Children prenatally exposed to tobacco compounds and those of underweight mothers had a decreased psychomotor development. The recommended level of LTPA during pregnancy had positive impact on child development. These results underscore the importance of policies and public health interventions promoting healthy lifestyle among women in reproductive age and during pregnancy.

1. Introduction

Child neurodevelopment is determined by genetic, environmental and social factors interacting in complex ways. Except for single-gene disorders, heredity accounts for about 50% of the variance of cognitive, behavioral and personality traits among individuals [1]. This, of course, implies that other 50% of variability must be due to environmental and/or lifestyle influences. In general, fetal development is regarded as the most vulnerable period in which major neurodevelopmental events, such as proliferation, differentiation and migration of neurons, occur. Among a variety of factors related to lifestyle, alcohol consumption and active or passive smoking during pregnancy and their impact on child psychomotor development are those which are the most frequently investigated, whereas studies assessing association between maternal weight, physical activity and folic acid supplementation are less common.

Previously published literature reviews have indicated that maternal smoking during pregnancy may be associated with neurobehavioral and cognitive outcomes, although not all research supports this statement [2–5]. The subject of impact of environmental factors, including tobacco constituents, on child development based on the Polish Mother and Child Cohort (REPRO_PL) has been previously published [6]. As smoking and environmental tobacco smoke exposure (ETS) are one of the most important lifestyle factors they are also included in the current analysis performed on a much bigger sample size compared to the previous one, which guarantees statistical power to detect the effect of exposure of interest on child development.

Nowadays, it is not under discussion that heavy alcohol consumption during pregnancy can result in fetal alcohol syndrome (FAS), but the effects of drinking at low-to-moderate levels on child neurodevelopment are much less clear with some studies

* Corresponding author. Tel.: + 48 42 314 569.
E-mail address: kinga@imp.lodz.pl (K. Polańska).

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indicating that such exposure may adversely affect children IQ, mental health, memory and verbal or visual performance [2,3].

Both underweight and obese mothers have an increased risk of adverse offspring outcomes. Several studies have examined the association between pre-pregnancy body mass index (BMI) and children's neurodevelopment. As a result some of them have indicated that adverse intrauterine environment may directly damage the developing fetal brain resulting in offspring cognitive, behavioral and motor development delays [7–9].

Impact of physical activity during pregnancy depends on its intensity and duration. Both sedentary mode of life and excessively intensive and long-lasting activity during pregnancy period, exert a negative effect on pregnant women, development of the fetus, and delivery as well as the state of the baby after birth [10,11]. Based on the Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and postpartum period, in the absence of either medical or obstetric complications, 30 min or more of moderate exercise a day on most, if not all, days of the week is recommended for pregnant women [12,13]. That level of leisure-time physical activity (LTPA) during pregnancy can be associated with many positive outcomes including: a decreased blood pressure and a reduced risk of gestational diabetes, but its long-term consequences for the children, such as improved psychomotor development, have been less frequently investigated [14].

Majority of the recently published data on maternal folate status or use of folic acid supplements during pregnancy and subsequent child neurodevelopment have found a positive association between these supplement use and motor, language and cognitive development [15–21]. The studies have also indicated that low maternal folate status may be associated with emotional and behavioral problems in the offspring.

The most frequently pointed limitations of the studies which evaluate the impact of lifestyle factors on child neurodevelopment are related to the study design, exposure assessment and adequate control for confounding factors. The current study contributes to elimination of these obstacles. The prospective cohort study design allows for a reliable assessment of a variety of maternal lifestyle factors that may influence a child's neurodevelopment. Additionally, inclusion of potential confounding factors and the use of a well-standardized test evaluating neurodevelopmental effects in young children are advantages of the current analysis. A better understanding of the relationship between maternal modifiable factors and child neurodevelopment may further strengthen the scientific base for policies and interventions promoting healthy lifestyle during pregnancy as crucial not only for the course and pregnancy outcomes but also for the long-term consequences including child psychomotor development.

The aim of this study was to evaluate the impact of selected maternal lifestyle factors, including active and passive smoking, alcohol consumption and LTPA during pregnancy, pre-pregnancy BMI and folic acid supplementations, before and during pregnancy on child neurodevelopment based on the prospective Polish Mother and Child Cohort study (REPRO_PL).

2. Material and methods

2.1. Study design and population

The Polish Mother and Child Cohort study (REPRO_PL) was established in 2007 with the purpose of evaluating environmental factors contributing to the pregnancy outcomes, children's health and neurodevelopment. The study procedures have been described in detail elsewhere [22,23]. Shortly, women were recruited during the first trimester of pregnancy at maternity units in selected regions of Poland provided they fulfilled the following inclusion criteria: single pregnancy up to 12 weeks of gestation, no assisted conception, no pregnancy complications and no chronic diseases as specified in the study protocol. Questionnaires and biological samples were applied for collection of data during pregnancy (weeks: 8–12, 20–24 and 30–34) and at birth. The questionnaires covered socio-demographic data, medical and reproductive history, information about environmental, occupational and lifestyle factors. Each child's exposure to environmental factors, health status and neurodevelopment was assessed twice i.e., a year after the child's birth and when the child was 2 years old.

The current analysis is restricted to 538 children among whom 500 were examined at the 12th month of age, 302 had repeated examination and 38 were examined only at the 24th month of age. The response rate was 75% for the first and 64% for the second examination.

The study was approved by the Ethical Committee of the Nofer Institute of Occupational Medicine, Lodz, Poland and a written consent was obtained from all the subjects before commencement of the study.

2.2. Information about lifestyle factors

In the current analysis the following factors related to maternal lifestyle were considered: smoking, ETS, alcohol consumption and LTPA during pregnancy, pre-pregnancy BMI as well as folic acid supplementations before and during the pregnancy.

Prenatal exposure to tobacco constituents was assessed based on an interview and was verified by determining the cotinine level in saliva collected three times during the pregnancy period. The cotinine level was measured using the high performance liquid chromatography coupled with tandem mass spectrometry/positive electrospray ionization (LC-ESI + MS/MS) and isotope dilution method as described by Stragierowicz et al. [24]. All the women with cotinine levels above 10 ng/mL were considered smokers [25]. If the self-reported smoking and cotinine measurements were not in agreement (which was observed in the case of 3% of the study participants) information regarding smoking status was based on the cotinine level in the saliva. As the cotinine levels in each trimester of pregnancy were highly correlated (the 1st with the 2nd trimester: $r = 0.8$; the 1st with the 3rd trimester: $r = 0.7$; the 2nd with the 3rd trimester: $r = 0.8$, $p < 0.001$) the samples from between the 8th and 12th weeks of gestation were used as a biomarker of active and passive smoking.

Alcohol consumption during pregnancy was assessed based on information from the pregnant women collected between the 20th and 24th weeks of gestation. The mother was asked about the types of alcoholic drinks (bear, wine, spirit) and frequency of their drinking (with possible answers: a) never (340 women), b) less than once per month (96 women), c) 1–3 times per month (46 women), d) 1–3 times per week (2 women), e) 4–5 times per week (no such women), and f) everyday (no such women)). Taking into account percentages of drinkers, in the current assessment the women were divided into two categories 1) no alcohol consumption during pregnancy if for each category of alcoholic drinks the frequency was indicated as a) or b) and 2) alcohol consumption during pregnancy if for any of each category of alcoholic drinks the frequency was indicated as c) to f).

The pre-pregnancy BMI was calculated and categorized according to the WHO [26]. Height was measured by a midwife between the 8th and 12th weeks of gestation and at the same time information about pre-pregnancy weight was collected during the interview. The categories of BMI indicating overweight and obesity were combined into one category (BMI ≥ 25 kg/m^2).

Three times during the pregnancy, each woman was asked about her LTPA including the type of activity and hours per week spent on the activity. For each activity metabolic equivalent (MET) value was assigned [27,28]. Before the analysis LTPA index (MET multiplied by time spent on each activity) was calculated for each trimester of pregnancy to see whether any changes in physical activity pattern were observed across pregnancy. As the LTPA indexes in each trimester of pregnancy were moderately correlated (the 1st with the 2nd trimester: $r = 0.4$; the 1st with the 3rd trimester: $r = 0.4$; the 2nd with the 3rd trimester: $r = 0.5$, $p < 0.05$) the core analysis focuses on the measures from the