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Association of pre-pregnancy physical activity with obesity in offspring: The Japan Environment and Children's Study (JECS)

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-What is already known?

- Childhood obesity starts early and may persist into adulthood; therefore, more early intervention to prevent childhood obesity is significantly meaningful.
- Physical activity is a modifiable factor that reduces insulin resistance and excess body weight gain during pregnancy and affects the birthweight of their newborns; however, how pre-pregnancy physical activity in women affects obesity in offspring remains to be clarified.

-What does this study add?

- Maternal pre-pregnancy physical activity is not associated with overweight/obesity or obesity in three-year-old children.

-How might these results change the direction of research or the focus of clinical practice?

- Further studies are needed to evaluate the association between maternal pre-pregnancy physical activity and childhood obesity using fat mass and lean body mass measurement in addition to body mass index.

Abstract

Objective: To investigate the association between maternal pre-pregnancy physical activity (PA) and overweight/obesity in three-year-old children.

Methods: Using data from the Japan Environment and Children's Study, a birth cohort study, maternal pre-pregnancy PA was categorized into low, moderate, and high with the International Physical Activity Questionnaire. The reference group was defined as children born to mothers with moderate PA. We investigated the association between pre-pregnancy PA and overweight/obesity or obesity in children using univariable and multivariable logistic regression analyses.

Results: Of the 65,245 participants, 48.7%, 32.7%, and 18.6% were born to mothers in the low, moderate, and high PA groups, respectively. Furthermore, 24.9%, 24.6%, and 25.9% of children with overweight/obesity and 9.4%, 9.2%, and 10.4% of children with obesity were born to mothers in the low, moderate, and high PA groups, respectively. The adjusted odds ratios for overweight/obesity in the low and high PA groups were 1.02 (95% confidence intervals (CI): 0.98–1.06) and 1.04 (95% CI: 0.98–1.09), and those for obesity were 1.03 (95% CI: 0.97–1.09) and 1.08 (95% CI: 0.99–1.16), respectively.

Conclusions: Maternal pre-pregnancy PA was not associated with overweight/obesity or obesity in three-year-old children.

Introduction

Overweight and obesity confer an increased risk of all-cause mortality in adults (1,2) and is a major health concern among children worldwide (3). Childhood obesity that negatively affects the health or well-being of a child starts at a very early stage, and it may persist into adulthood. Over the past 25 years, the prevalence of obesity has doubled in children and adults in over 70 countries (4), and childhood overweight/obesity in Japan has doubled likewise in three decades (5). It has been reported that overweight in early childhood is associated with four- to five-fold increased risks of obesity in adolescence and adulthood, respectively, when compared with normal-weight children of the same age (6-8). Maternal obesity has been shown to increase the risk of obesity in offspring at 2 to 4 years old (9). Therefore, more early intervention before birth to prevent childhood obesity may be significantly meaningful.

Physical activity (PA) is a modifiable factor that reduces insulin resistance and excess body weight gain during pregnancy, which may also affect the birth weight of the offspring by influencing glucose metabolism (10). Additionally, an intergenerational epigenetic effect between maternal PA and newborn DNA methylation has been shown (11). Studies have also provided evidence for the association between maternal PA during pregnancy and obesity in offspring. For instance, randomized controlled studies have reported that maternal PA during pregnancy reduces the risk of complications of gestational diabetes mellitus (GDM) in women (12) and obesity/overweight in their offspring (13). However, several studies have also reported that PA during pregnancy is not

associated with a reduced risk of obesity in children (14-17). The inconsistency in the findings of previous studies could be attributed to the different methods used for measuring PA. The association between pre-pregnancy PA and obesity in offspring has also been reported (18); however, reports on the effects of maternal pre-pregnancy PA on the prevention of childhood obesity are lacking.

We hypothesized that maternal pre-pregnancy PA is associated with obesity risk in the offspring in a dose-dependent manner. To prove this hypothesis, we assessed maternal pre-pregnancy PA using the International Physical Activity Questionnaire (IPAQ) (19) and evaluated the association between maternal pre-pregnancy PA and overweight or obesity in children at three years of age.

Methods

Design and setting

The data used in this study were obtained from the Japan Environment and Children's Study (JECS), a large-scale epidemiological research study. The JECS is a nationwide birth cohort study that includes approximately 100,000 pregnant women and their offspring. The recruitment of the participants for this study started in January 2011 and ended in March 2014. The JECS is a survey of environmental factors that may affect children's health and is registered in the University hospital Medical Information Network Clinical Trials Registry (number: UMIN000030786). The protocol and details of the JECS have been previously reported (20). The JECS protocol was approved by the Institutional Review Board on Epidemiological Studies of the Ministry of the Environment and the

Ethics Committees of all participating institutions. The JECS followed the principles of the Declaration of Helsinki and other internationally recognized regulations. Written informed consent was obtained from all participants in the JECS.

The JECS included participants from 15 Regional Centres chosen to broadly cover the geographical areas in Japan. The Regional Centres, set in universities, were responsible for recruiting participants into this study with their local governments' cooperation and follow-up management. Pregnant women were recruited by Co-operating health care providers. The demographics of the mothers and children included in the JECS were similar to those reported in the national survey (21). The JECS includes data obtained from self-administered questionnaires and medical records transcripts. The questionnaires were collected in the first and second or third trimester of pregnancy, one month after birth, and every six months up to the age of three years of the child. The questionnaire items included parental information, such as medical history, obstetric history, anthropometry, lifestyle, educational status, socioeconomic status, and child information, such as medical history, anthropometry, and lifestyle. Child anthropometric data for each age group were obtained from the Maternal and Child Health Handbook or home measurements (22). Under the Maternal and Child Health Act, pre- and post-natal care of women and child health checkups are mandatory in Japan (23). Medical records, including perinatal data, were obtained from the medical records transcripts during the first trimester of pregnancy, at birth, and one month after birth. The datasets have been updated regularly, and we specifically used the dataset fixed in October 2019

("jecs-ta-20190930" dataset).

Selection of participants

Of all fetuses and their mothers' records, we excluded multiple gestations from the study. Children who were born to mothers with missing information on maternal pre-pregnancy PA, whose height or weight at three years of age was missing or measured out of range between 34–38 months of age; were diagnosed with chromosomal anomalies, congenital anomalies of the eye, ear, heart, head, brain, or spine (24), chromosomal disorders, or congenital metabolic disorders by one month of age; were diagnosed with severe diseases, such as congenital metabolic disorders, brain tumors, encephalitis, bacterial meningitis, cerebral palsy, spinal cord disorders, hearing loss, cataracts, and chromosomal disorders by the age of three were excluded from this study.

Exposure

Maternal pre-pregnancy PA information during the past year was derived from the short version of the IPAQ, which was validated in Japan (19,25,26), and completed by the mother during the first trimester of pregnancy. The intensity of PA (metabolic equivalent of task (MET)-minutes/week) was calculated and categorized as low, moderate, and high, according to the "Guidelines for the data processing and analysis of the IPAQ" (25).

Outcome

The child's body weight and height at three years of age were measured using calibrated instrumentation and registered in the Maternal and Child Health Handbook by Co-operating health care providers. Height and weight were measured at 0.1 cm and 0.1 kg, respectively, by trained staff. Child body mass index (BMI) (kg/m^2) was calculated based on height (m) and weight (kg). Children were categorized as underweight ($\text{BMI} < 5^{\text{th}}$ percentile), normal weight ($5^{\text{th}} \leq \text{BMI} < 85^{\text{th}}$ percentile), overweight ($85^{\text{th}} \leq \text{BMI} < 95^{\text{th}}$ percentile), and obesity ($\text{BMI} \geq 95^{\text{th}}$ percentile) according to the BMI percentiles for Japanese children (27,28); these cut-off criteria were consistent with the Centers for Disease Control and Prevention and the Institute of Medicine recommendations (29,30). The 5^{th} , 85^{th} , and 95^{th} percentile BMI in 3-year-old children in Japan were 13.7, 16.8, and 17.6 kg/m^2 in boys, and 13.5, 16.7, and 17.6 kg/m^2 in girls, respectively (28).

Variables

The following variables were treated as categorical data: maternal age at pregnancy (years) (<20 , $20-34$, ≥ 35); pre-pregnancy maternal BMI (kg/m^2) (<18.5 , $18.5-24.9$, ≥ 25); parity (first birth, second birth, third or higher birth); maternal calorie intake during the past year using food frequency questionnaires (kcal/day) (31) ($<25^{\text{th}}$ percentile, $25^{\text{th}}-75^{\text{th}}$ percentile, $\geq 75^{\text{th}}$ percentile); maternal educational status (years) (≤ 12 , $13-15$, ≥ 16); household income (million Japanese Yen) (<4 , $4-5.99$, ≥ 6 ; Yen/USD was 82 in 2011); smoking status in the first trimester of pregnancy (none, past,

current); and alcohol consumption in the first trimester of pregnancy (none, past, current). The following variables were treated as binary data: sex of the child; excess body weight gain during pregnancy (yes: body weight gain beyond the Institute Of Medicine recommendations stratified by pre-pregnancy BMI (32), no: other than “yes”); maternal comorbidities and pregnancy-related complications (hypertension, DM, hypertensive disorders of pregnancy, GDM); small for gestational age (SGA); large for gestational age (LGA), breastfeeding for at least six months; television (TV) or digital versatile disc (DVD) viewing time (hours) in children at 3-year-old (two hours or more in a day; yes, no); outdoor playing time (hours) in children at 3-year-old (one hour or more in a day; yes, no). SGA was defined as birth weight <10th percentile for gestational age and LGA was defined as birth weight >90th percentile (33).

Statistical analysis

Continuous variables are presented as the mean (standard deviation; SD) or median (interquartile range; IQR), and categorical variables or binary data are presented as frequencies and proportions. Univariable and multivariable logistic regression analyses were performed to analyze the association between maternal pre-pregnancy PA and overweight/obesity and obesity in children and reported odds ratios, 95% confidence intervals (CIs), and *P*-values.

For the main analysis, we used the following six regression models: 1) an unadjusted model, 2) a model adjusted for the sex of the child, maternal age, parity, pre-pregnancy maternal BMI, and

maternal comorbidities (hypertension, DM), 3) a model adjusted for maternal smoking habits, drinking habits, calorie intake, maternal educational status, household income, in addition to the variables listed in model 2, 4) a model adjusted for pregnancy-related complications (hypertensive disorders of pregnancy, GDM), and excess body weight gain during pregnancy in addition to the variables listed in model 3, 5) a model adjusted for SGA, LGA, and breastfeeding for at least 6 months in addition to the variables listed in model 4, and 6) a model adjusted for outdoor playing time, TV viewing time, and DVD viewing time, in addition to the variables listed in model 5. Additionally, we performed a stratified analysis based on maternal pre-pregnancy obesity ($\text{BMI} \geq 30$).

For sensitivity analysis, we performed multivariable logistic regression of overweight and obesity defined by the International Obesity Task Force's cut-off (34). Additionally, we described the maternal baseline characteristics before exclusion except for missing pre-pregnancy PA data. The child BMI-SD scores for each sex were calculated following the methods described previously (28). Then we performed multivariable quantile regression analyses to evaluate the association between maternal PA and quantiles of child BMI-SD scores (10th, 25th, 50th, 75th, and 90th). This method has been shown to effectively compare the effect of maternal PA on specific quantiles of BMI-SD scores even if the distribution of parameters differs (35). We performed multiple imputations for missing covariates using the chained equation procedures. All statistical analyses were performed using the STATA statistical software (version 13.1; STATA Corp LP, College Station, TX, USA). A *P*-value of <0.05 was considered statistically significant. This study's statistical analysis codes exist at

osf.io/kew78 on the Open Science Framework (<https://osf.io/kew78/>).

Results

Figure 1 shows the flowchart of the study participants. Of the total 104,062 fetal and mother's records, 1,260 women with abortion, 1,927 women with multiple pregnancies, and 4,542 women with missing information on pre-pregnancy PA were excluded. Additionally, 23,544 children with missing data of height or body weight at the age of 3, 6,683 children with data not measured within 34–38 months of age, 254 children with congenital disorders, and 567 children with a severe disease until the age of three were excluded. The final analysis included 65,245 children, of whom 31,781 (48.7%); 21,337 (32.7%); and 12,127 (18.6%) were born to mothers with low, moderate, and high pre-pregnancy PA levels, respectively. The numbers of children with overweight in the low, moderate, and high maternal pre-pregnancy PA groups were 4,937 (15.5%); 3,292 (15.4%); and 1,883 (15.5%), respectively, and those of children with obesity were 2,991 (9.4%); 1,965 (9.2%); and 1,217 (10.4%), respectively (Table 1).

The maternal baseline characteristics are described in Table 2, and perinatal information is presented in Table 3. The parents in the low and moderate pre-pregnancy PA groups tended to have a slightly higher socioeconomic status than those in the high PA group. The parents' educational status and household income were longer and higher in the low and moderate PA groups in the three groups (Table 2). Most of the perinatal information among the three groups was similar, although

breastfeeding for at least six months was higher in the moderate pre-pregnancy PA group than in the other groups (Table 3). Child PA tended to correlate with maternal PA. The outdoor playtime of 3-year-old children was shorter in the low pre-pregnancy PA group compared to that in the moderate and high pre-pregnancy PA groups. In contrast, TV and DVD viewing times were slightly longer in the low pre-pregnancy PA group than in the moderate and high pre-pregnancy PA groups (Table 4).

The results of the univariable and multivariable logistic regression analyses are presented in Table 5. Compared to the moderate pre-pregnancy PA group, low PA did not contribute to an increased risk of overweight/obesity or obesity at three years of age, and high PA did not decrease the risk of overweight/obesity or obesity (low PA: adjusted odds ratio (aOR) 1.02 [95% CI: 0.98–1.06]; high PA: aOR 1.04 [95% CI: 0.98–1.09] in overweight/obesity; low PA: aOR 1.03 [95% CI: 0.97–1.09]; high PA: aOR 1.08 [95% CI: 0.99–1.16] in obesity) (Model 2 in Table 5). These results were unaltered after adjusting for perinatal variables, socioeconomic status, and child lifestyle (Models 3, 4, 5, and 6 in Table 5). In the stratified analysis by maternal obesity, the results of the multivariable logistic regression for maternal PA and overweight/obesity in children were similar to those of the primary analysis in all models. Maternal obesity was associated with an approximately 2-fold increased risk for overweight/obesity in children in all groups (Tables 6)

In sensitivity analysis using the International Obesity Task Force's definition, the numbers of children with overweight/obesity in the low, moderate, and high maternal pre-pregnancy PA groups were 2,547 (8.0%); 1,681 (7.9%); and 1,014 (8.4%), respectively, and those of children with

obesity were 235 (0.7%), 169 (0.8%), and 110 (0.9%), respectively; however, the results did not change considerably in multivariable logistic regression analyses (Table S1). The maternal baseline characteristics without exclusion were similar to those of the main analysis (Table S2). The distribution of child BMI-SD scores at three years old was almost equal in each PA group (Table S3). In the multivariable quantile analyses, coefficients in low and high PA groups were positively correlated in 50th percentiles of BMI-SD scores, and these tendencies were seen in almost other percentiles of BMI-SD scores, though they were not significant (Table S4).

Discussion

The present study demonstrated that maternal pre-pregnancy PA level was not associated with offspring overweight/obesity or obesity risk at three years of age. These results remained unaltered after adjusting for maternal comorbidities, maternal lifestyle, socioeconomic status, postnatal perinatal information, and child lifestyle.

Our study further supports existing data showing no association between maternal pre-pregnancy PA and childhood obesity from a cohort study conducted in the United States, in which approximately 5,000 children participated (18). Similarly, another cohort study from the United States also reported no association between maternal PA before pregnancy and child adiposity at the age of 7–10 years (17). In contrast, one cohort study with approximately 25,000 participants showed an association between maternal PA and childhood obesity (36). The discrepancy in the results

between the latter and our study might be due to the different measuring methods or exposure timings. The latter study measured maternal PA when their offspring were aged 9–14 years, not pre-pregnancy. Notably, Dahna et al.'s study (18) and our study indicated that the moderate PA group had the lowest risk of obesity in children among the stratified PA groups, like a U shape, although PA measurements in these studies were different. The stratified analysis demonstrated that maternal obesity before pregnancy was significantly associated with overweight or obesity in children, which is consistent with the results of former studies (9,37), and this association is unaffected by the maternal pre-pregnancy PA level.

Contrary to our hypothesis, high or low pre-pregnancy PA did not decrease or increase the risk of overweight/obesity or obesity in children in our study; these associations were unaltered even if the definition of overweight/obesity was changed. Furthermore, the results did not change when the low PA group was defined as the reference group. In addition, multivariable quantile analysis showed that the effects of maternal low PA and high PA on childhood obesity were not much different among the upper half of the BMI-SD percentile, consistent with the primary analysis.

Physical inactivity has been reported to cause coronary heart disease, type 2 diabetes, breast cancer, and colon cancer (38). Since the PA measurement in each report did not follow a standardized approach (39), the heterogeneity of PA measurements makes it difficult for global surveillance and international comparison. Hence, the International Consensus Group of the World Health Organization was established and followed from 1998, and the IPAQ was developed as a global

measurement that contains multiple domains of PA (40). A surveillance study conducted using the IPAQ short version between 20 countries demonstrated different PA prevalence in these countries. In that study, Japanese women had a low prevalence of high PA (16.7%) and over 40% of low PA (45.6%) (40), consistent with those of the categorized PA level in our study, suggesting that the PA measurement in our study is reliable. Unexpectedly, low and moderate pre-pregnancy PA groups have a slightly higher socioeconomic status than the high PA group in this study. This tendency is different from Western countries but consistent with a Japanese study (41,42). Those differences in the association between socioeconomic status and PA in Japan and overseas might arise from sociocultural aspects.

The discrepancy between our hypothesis and our finding that maternal pre-pregnancy PA was not associated with the risk of childhood obesity may be partly explained by the limitation of BMI evaluation. BMI is a simple and useful screening method, even in children (43). However, as BMI measurement relies on body weight and height without considering the body composition, a definition of obesity based solely on BMI assessment may not completely reflect or predict a healthy condition. For instance, it was reported that higher lean body mass was negatively associated with insulin resistance, plasma glucose, and non-high-density cholesterol in 6–18-year-old children. Furthermore, children with obesity and a high lean BMI did not have an increased cardiometabolic risk compared to normal-weight children without a high lean BMI (44). Hence, BMI may underestimate adiposity. In addition, it may be overestimated in children with short stature or high

muscle mass (43). As we could not obtain information on body fat mass for the 3-year-old children in our study, we may have misclassified children with the healthy condition, short stature, or high muscle mass as overweight/obese.

Recently, joint associations between the overall healthy lifestyle in mothers before pregnancy, including diet, BMI, smoking, drinking, PA, and childhood obesity, have been reported (36). Unlike PA during pregnancy, maternal pre-pregnancy PA is a more modifiable behavior, which may also contribute to a healthy lifestyle in their offspring. Outdoor playtime was longer and TV or DVD viewing time was shorter in children born to mothers with high or moderate PA than in those born to mothers with low PA in our study, indicating that a healthy lifestyle in mothers might confer a healthy lifestyle in their offspring. Although we could not evaluate a child's health condition, including fat mass or lean body mass, the positive impact of a maternal healthy lifestyle on a child's anthropometry cannot be ignored. Further studies are needed to evaluate the association between maternal PA and childhood obesity, considering not only BMI but also anthropometric data, including body fat mass and lean body mass.

The present study has several strengths. First, maternal pre-pregnancy PA was assessed using the IPAQ, which has high reliability and validity and is used worldwide, and the measurement level was categorized into three groups according to the IPAQ scoring protocol (25). Therefore, the measurement was standardized and comparable to that of other studies. Furthermore, PA throughout the year before pregnancy may reflect the actual daily maternal PA. Second, this study was

performed using the JECS dataset, which is a nationwide birth cohort study that is properly operated and managed in Japan. The dataset includes large sample size and a vast amount of information on parents and children from Japan's broad regional area. In addition, perinatal data were transcribed from the medical records of Co-operating health care providers. Therefore, the data used in this study are reliable.

There are several limitations to our study. First, this was an observational study, and although a multivariable logistic analysis adjusting for several confounding factors was performed, unmeasured confounding factors, such as genetic factors or child calorie intake contributing to overweight/obesity, were not considered. Furthermore, living with older siblings may affect the intensity of maternal PA and child overweight; however, we could not acquire accurate sibling information and perform analyses adjusting for parity, which might have caused information bias. Second, this study was limited by the caregiver-reported nature of the questionnaire. Not all questionnaire results were confirmed by medical professionals. Furthermore, some validation studies have shown only a slight correlation with objective measures for PA (45). Although a validated questionnaire measured maternal PA in this study, it was self-reported and was not measured by instruments or objectively measured. These might have led to information biases. Furthermore, the height and weight of 3-year-old children reported by the caregiver might have caused information bias. However, the original information is considered accurate because it was registered in the Maternal and Child Health Handbook by either public health nurses, midwives, or nurses. Third,

approximately 30,000 children were excluded from this study because their age was not within the target age for BMI when the questionnaire was completed, or some information regarding the child's height or weight was missing. This might have led to selection bias, although the characteristics of maternal information before exclusion were similar to those of the primary analysis. Finally, as the findings of this study were based on datasets from a cohort study in Japan, the generalizability of these results may be limited; because the prevalence of childhood and maternal obesity in other countries differs from Japan, and the distribution of intensity of maternal PA also differs in different countries (40).

Conclusion

Maternal pre-pregnancy PA is not associated with overweight/obesity or obesity in 3-year-old children. Further studies are needed to provide evidence to prevent overweight/obesity in children.

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Data availability: The data are unsuitable for public deposition due to ethical restrictions and the legal framework in Japan. It is prohibited by the Act on the Protection of Personal Information (Act No. 57 of 30 May 2003, amendment on 9 September 2015) to publicly deposit data containing personal information. The Ethical Guidelines for Medical and Health Research Involving Human Subjects enforced by the Japan Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Health, Labor and Welfare also restrict the open sharing of epidemiologic data. All inquiries about data access should be sent to: jecs-en@nies.go.jp. The person responsible for handling enquiries sent to this e-mail address is Dr. Shoji F. Nakayama, JECS Program Office, National Institute for Environmental Studies.

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Figure Legends

Figure 1: Flow chart of study participant selection.

Of 104,062 fetal and mother's records, 1,260 women with abortion, 1,927 women with multiple pregnancies, and 4,542 women with missing information on pre-pregnancy PA were excluded. Additionally, 23,544 children with missing data of height or body weight at the age of 3, 6,683 children with data not measured within 34–38 months of age, 254 children with congenital disorders, and 567 children with a severe disease until the age of three were excluded. The final analysis included 65,245 children, of whom 31,781 (48.7%); 21,337 (32.7%); and 12,127 (18.6%) were born to mothers with low, moderate, and high pre-pregnancy PA levels, respectively.

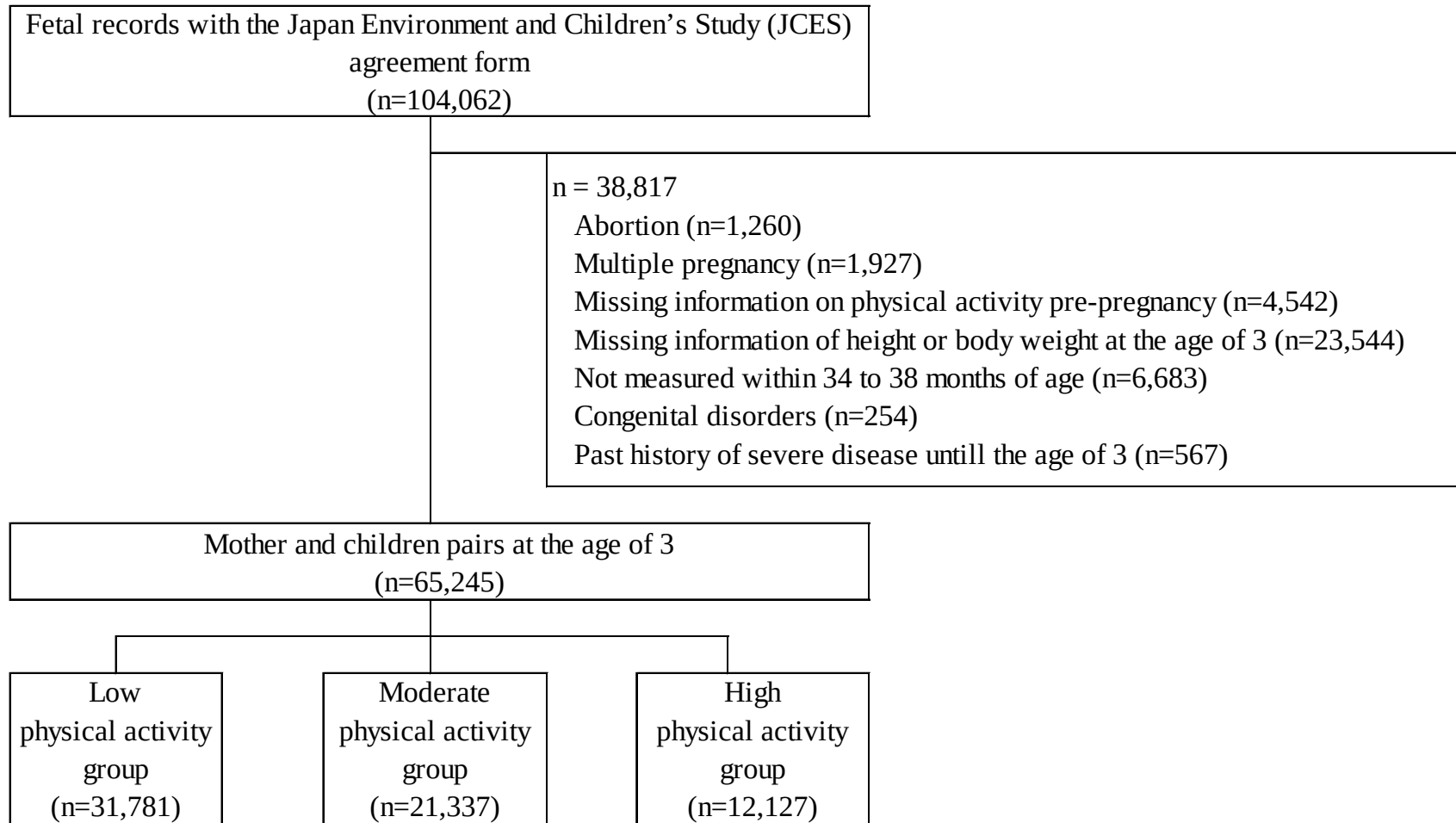


Figure 1.

Table 1. Distribution of child BMI at the age of three according to the maternal physical activity pre-pregnancy (n = 65,245)

Characteristics	Low PA (n = 31,781)		Moderate PA (n = 21,337)		High PA (n = 12,127)	
BMI at 3-year of age, median [IQR]	15.9	[15.2–16.8]	15.9	[15.2–16.7]	15.9	[15.2–16.8]
≥95 th , n (%)	2,991	(9.4)	1,965	(9.2)	1,217	(10.4)
85 th – 94.9 th , n (%)	4,937	(15.5)	3,292	(15.4)	1,883	(15.5)
5 th – 84.9 th , n (%)	23,300	(73.3)	15,656	(73.4)	8,756	(72.2)
< 5 th , n (%)	553	(1.7)	424	(2.0)	271	(2.2)

Physical activity categories refer to maternal physical activity pre-pregnancy.

BMI, body mass index; PA, physical activity; IQR; Interquartile range.

Table 2. Parental characteristics according to the maternal physical activity pre-pregnancy

Characteristics	Low PA (n = 31,781)		Moderate PA (n = 21,337)		High PA (n = 12,127)	
Maternal age at delivery (years), mean [SD]	32.0	[4.8]	31.7	[4.8]	30.5	[5.0]
<20, n (%)	114	(0.4)	75	(0.4)	112	(0.9)
20–34, n (%)	21,602	(68.0)	15,031	(70.4)	9,280	(76.5)
≥35, n (%)	10,065	(31.6)	6,231	(29.2)	2,735	(22.6)
Missing, n (%)	0		0		0	
BMI at pre-pregnancy, median [IQR]	20.5	[19.1–22.4]	20.4	[19.1–22.3]	20.5	[19.1–22.6]
<18.5, n (%)	5,238	(16.5)	3,345	(15.7)	1,896	(15.6)
18.5–24.9, n (%)	23,475	(73.9)	16,013	(75.0)	8,908	(73.5)
25.0–29.9, n (%)	2,378	(7.5)	1,569	(7.3)	1,002	(8.3)
≥30, n (%)	681	(2.1)	399	(1.9)	317	(2.6)
Missing, n (%)	9	(0.0)	11	(0.1)	4	(0.0)
Parity						
First, n (%)	13,079	(41.1)	8,719	(40.9)	5,141	(42.4)
2nd, n (%)	12,030	(37.9)	8,361	(39.2)	4,247	(35.0)
3rd or more, n (%)	5,933	(18.7)	3,727	(17.4)	2,428	(20.0)
Missing, n (%)	739	(2.3)	530	(2.5)	311	(2.6)
Maternal comorbidity						
Hypertension, n (%)	363	(1.1)	239	(1.1)	159	(1.3)
Thyroid disease, n (%)	449	(1.4)	313	(1.5)	152	(1.3)
DM, n (%)	332	(1.0)	219	(1.0)	144	(1.2)
Heart disease, n (%)	97	(0.3)	61	(0.3)	51	(0.4)
Renal disease, n (%)	112	(0.4)	60	(0.3)	49	(0.4)
Mental disorder, n (%)	219	(0.7)	142	(0.7)	75	(0.6)
Maternal smoking status						
Never, n (%)	19,734	(62.1)	13,592	(63.7)	6,761	(55.8)
Past, n (%)	10,885	(34.3)	7,033	(33.0)	4,722	(38.9)
Current, n (%)	990	(3.1)	605	(2.8)	574	(4.7)
Missing, n (%)	172	(0.5)	107	(0.5)	70	(0.6)
Maternal drinking status						
None, n (%)	11,543	(36.3)	7203	(33.8)	3,992	(32.9)
Past, n (%)	16,830	(53.0)	11,751	(55.1)	6,959	(57.4)

Current, n (%)	3,282	(10.3)	2,327	(10.9)	1,132	(9.3)
Missing, n (%)	126	(0.4)	56	(0.3)	44	(0.4)
Maternal educational status						
≤12 years, n (%)	10,285	(32.4)	5,980	(28.0)	4,464	(36.8)
13–15 years, n (%)	13,554	(42.6)	9,212	(43.2)	5,479	(45.2)
≥16 years, n (%)	7,705	(24.2)	5,958	(27.9)	2,105	(17.4)
Missing, n (%)	237	(0.8)	187	(0.9)	79	(0.6)
Paternal educational status						
≤12 years, n (%)	12,795	(40.2)	7,980	(37.4)	5,492	(45.3)
13–15 years, n (%)	7,174	(22.6)	4,732	(22.2)	2,957	(24.4)
≥16 years, n (%)	11,429	(36.0)	8,369	(39.2)	3,511	(29.0)
Missing, n (%)	383	(1.2)	256	(1.2)	167	(1.3)
Household income						
<4,000,000 yen, n (%)	10,929	(34.4)	7,020	(32.9)	4,972	(41.0)
4,000,000–5,999,999 yen, n (%)	10,231	(32.2)	6,976	(32.7)	3,520	(29.0)
≥6,000,000 yen, n (%)	8,659	(27.2)	6,097	(28.6)	2,814	(23.2)
Missing, n (%)	1,962	(6.2)	1,244	(5.8)	821	(6.8)

Physical activity categories refer to maternal physical activity pre-pregnancy.

PA, physical activity; SD, Standard deviation; BMI, body mass index; IQR, Interquartile range; DM, diabetes mellitus.

Table 3. Perinatal information according to the maternal physical activity pre-pregnancy

Characteristics	Low PA (n = 31,781)		Moderate PA (n = 21,337)		High PA (n = 12,127)	
Increased body weight during pregnancy (kg), median [IQR]	10.1	[7.9–12.4]	10.0	[7.9–12.2]	10.5	[8.2–13]
Excess body weight gain beyond the IOM recommendations	2,008	(6.3)	1,318	(6.2)	1,078	(8.9)
Missing, n (%)	671	(2.1)	594	(2.8)	265	(2.2)
Pregnancy-related complication						
HDP	949	(3.0)	623	(2.9)	397	(3.3)
GDM, n (%)	845	(2.7)	567	(2.7)	331	(2.7)
Boys, n (%)	16,210	(51.0)	10,932	(51.2)	6236	(51.4)
Missing, n (%)	0		0		0	
Gestational age (week), median [IQR]	39.4	[38.4–40.3]	39.4	[38.4–40.3]	39.4	[38.4–40.3]
≥37, n (%)	30,297	(95.3)	20,407	(95.6)	11,571	(95.4)
34–36, n (%)	1,147	(3.6)	726	(3.4)	433	(3.6)
28–33, n (%)	239	(0.8)	132	(0.6)	78	(0.7)
<28, n (%)	32	(0.1)	28	(0.1)	13	(0.1)
Missing, n (%)	66	(0.2)	44	(0.2)	32	(0.3)
Birth height (cm), median [IQR]	49.0	[48.0–50.2]	49.0	[48.0–50.3]	49.0	[48.0–50.1]
Missing, n (%)	135	(0.4)	97	(0.5)	65	(0.5)
Birth weight (g), mean [SD]	3,025	[407]	3,031	[404]	3,032	[408]
≥4000, n (%)	264	(0.8)	178	(0.8)	115	(0.9)
2500–3999, n (%)	28,960	(91.2)	19,502	(91.3)	11,069	(91.3)
1500–2499, n (%)	2,350	(7.4)	1,524	(7.1)	853	(7.0)
<1500, n (%)	130	(0.4)	87	(0.4)	54	(0.5)
SGA, n (%)	2,294	(7.2)	1,532	(7.2)	878	(7.2)
LGA, n (%)	3,027	(9.5)	2,104	(9.8)	1,212	(9.9)
Missing, n (%)	77	(0.2)	46	(0.2)	36	(0.3)
Breast feeding for at least 6 months	23,750	(74.7)	16,457	(77.1)	8,827	(72.8)
Missing, n (%)	333	(1.1)	240	(1.1)	178	(1.5)

Physical activity categories refer to maternal physical activity pre-pregnancy.

PA, physical activity; IQR, Interquartile range; IOM, Institute Of Medicine; HDP, hypertensive disorder of pregnancy; GDM, gestational diabetes mellitus; SD, Standard deviation; SGA, small for gestational age; LGA, large for gestational age.

Table 4. Child lifestyle at the age of three according to the maternal physical activity pre-pregnancy

	Low PA		Moderate PA		High PA	
Characteristics	(n = 31,781)		(n = 21,337)		(n = 12,127)	
Outdoor play one hour or more a day						
Summer						
Yes, n (%)	21,880	(68.9)	15,910	(74.6)	9,482	(78.2)
No, n (%)	9,051	(28.4)	5,026	(23.5)	2,400	(19.8)
Missing, n (%)	850	(2.7)	401	(1.9)	245	(2.0)
Winter						
Yes, n (%)	12,457	(39.2)	10,043	(47.1)	6,077	(50.1)
No, n (%)	18,148	(58.1)	10,696	(50.1)	5,629	(46.4)
Missing, n (%)	1,176	(3.7)	598	(2.8)	421	(3.5)
Watch TV or DVD over 2 hours a day						
Yes, n (%)	9,374	(29.5)	6,005	(28.1)	3,397	(28.0)
No, n (%)	22,291	(70.1)	15,248	(71.5)	8,690	(71.7)
Missing, n (%)	116	(0.4)	84	(0.4)	40	(0.3)

Physical activity categories refer to maternal physical activity pre-pregnancy.

PA, physical activity; TV, television; DVD, digital versatile disc.

Table 5. Logistic regression models for the maternal physical activity pre-pregnancy and child overweight/obesity at the age of three (n = 65,245)

Regression model	No. of cases	Model 1 ^a		Model 2 ^b		Model 3 ^c		Model 4 ^d		Model 5 ^e		Model 6 ^f	
		OR (95% CI)	<i>P</i> -value	OR (95% CI)	<i>P</i> -value	OR (95% CI)	<i>P</i> -value	OR (95% CI)	<i>P</i> -value	OR (95% CI)	<i>P</i> -value	OR (95% CI)	<i>P</i> -value
Overweight/obesity													
Low PA	7,928	1.02 (0.98–1.06)	0.421	1.02 (0.98–1.06)	0.383	1.02 (0.98–1.06)	0.300	1.02 (0.98–1.06)	0.300	1.02 (0.98–1.07)	0.247	1.03 (0.99–1.07)	0.164
Moderate PA, reference	5,257	1		1		1		1		1		1	
High PA	3,100	1.05 (0.99–1.11)	0.060	1.04 (0.98–1.09)	0.172	1.03 (0.98–1.09)	0.180	1.03 (0.98–1.09)	0.246	1.04 (0.98–1.09)	0.199	1.03 (0.98–1.09)	0.248
Obesity													
Low PA	2,991	1.02 (0.96–1.09)	0.433	1.03 (0.97–1.09)	0.396	1.03 (0.97–1.09)	0.415	1.03 (0.97–1.09)	0.414	1.03 (0.97–1.09)	0.371	1.03 (0.97–1.10)	0.330
Moderate PA, reference	1,965	1		1		1		1		1		1	
High PA	1,217	1.10 (1.02–1.19)	0.013	1.08 (0.99–1.16)	0.052	1.06 (0.99–1.15)	0.108	1.06 (0.98–1.14)	0.154	1.06 (0.98–1.15)	0.130	1.06 (0.98–1.14)	0.143

Physical activity categories refer to maternal physical activity pre-pregnancy.

The reference group was defined as children born to mothers with moderate physical activity pre-pregnancy.

^aUnadjusted model.

^bMultivariable logistic models were adjusted for maternal age, maternal BMI at pre-pregnancy, maternal comorbidities (HT, DM), parity, and sex of the child.

^cMultivariable logistic models were adjusted for maternal age, maternal BMI at pre-pregnancy, maternal comorbidities (HT, DM), parity, sex of the child, smoking habit, alcohol drinking, calorie intake, maternal education status, and household income.

^dMultivariable logistic models were adjusted for maternal age, maternal BMI at pre-pregnancy, maternal comorbidities (HT, DM), parity, sex of the child, smoking habit, alcohol drinking, calorie intake, maternal education status, household income, obstetrical complications (HDP and GDM), and excess body weight gain during pregnancy.

^eMultivariable logistic models were adjusted for maternal age, maternal BMI at pre-pregnancy, maternal comorbidities (HT, DM), parity, sex of the child, smoking habit, alcohol drinking, calorie intake, maternal education status, household income, obstetrical complications (HDP and GDM), excess body weight gain during pregnancy, breastfeeding for at least 6 months after birth, SGA, and LGA.

^fMultivariable logistic models were adjusted for maternal age, maternal BMI at pre-pregnancy, maternal comorbidities (HT, DM), parity, sex of the child, smoking habit, alcohol drinking, calorie intake, maternal education status, household income, obstetrical complications (HDP and GDM), excess body weight gain during pregnancy, breastfeeding for at least 6 months after birth, SGA, LGA, outdoor play in summer or winter, and TV or DVD viewing.

OR, odds ratio; CI, confidence interval; PA, physical activity; HT, hypertension; DM, diabetes mellitus; HDP, hypertensive disorder of pregnancy; GDM, gestational diabetes mellitus, SGA, small for gestational age; LGA, large for gestational age; TV, television; DVD, digital versatile disc.

Table 6. Logistic regression models for the maternal physical activity pre-pregnancy and overweight/obesity in children at the age of three, stratified by maternal obesity (n = 65,221)

Regression model	n	No. of children with overweight/obesity	Model 1 ^a		Model 2 ^b		Model 3 ^c		Model 4 ^d		Model 5 ^e		Model 6 ^f	
			OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Low PA														
Maternal obesity +	681	275 (40.4%)	2.11 (1.80–2.46)	<0.001	2.10 (1.79–2.46)	<0.001	2.11 (1.80–2.47)	<0.001	1.97 (1.68–2.31)	<0.001	1.82 (1.55–2.14)	<0.001	1.83 (1.56–2.15)	<0.001
Maternal obesity -	31,091	7,650 (24.6%)	1.02 (0.97–1.06)	0.460	1.02 (0.97–1.06)	0.467	1.02 (0.98–1.06)	0.383	1.02 (0.98–1.06)	0.368	1.02 (0.98–1.06)	0.307	1.03 (0.99–1.07)	0.204
Moderate PA														
Maternal obesity +	399	164 (41.1%)	2.17 (1.78–2.66)	<0.001	2.17 (1.77–2.66)	<0.001	2.18 (1.78–2.67)	<0.001	2.06 (1.68–2.52)	<0.001	1.88 (1.53–2.31)	<0.001	1.89 (1.54–2.33)	<0.001
Maternal obesity -, reference	20,927	5,090 (24.3%)	1		1		1		1		1		1	
High PA														
Maternal obesity +	317	131 (41.3%)	2.19 (1.75–2.75)	<0.001	2.18 (1.74–2.74)	<0.001	2.18 (1.74–2.74)	<0.001	2.02 (1.60–2.54)	<0.001	1.83 (1.45–2.31)	<0.001	1.83 (1.45–2.31)	<0.001
Maternal obesity -	11,806	2,966 (25.1%)	1.04 (0.99–1.10)	0.100	1.04 (0.99–1.10)	0.114	1.04 (0.99–1.10)	0.151	1.03 (0.98–1.09)	0.236	1.04 (0.98–1.09)	0.188	1.03 (0.98–1.09)	0.243

Physical activity categories refer to maternal physical activity pre-pregnancy.

The reference group was defined as children born to non-obese mothers with moderate physical activity pre-pregnancy.

^aUnadjusted model.

^bMultivariable logistic models were adjusted for maternal age, maternal comorbidities (HT, DM), parity, and sex of the child.

^cMultivariable logistic models were adjusted for maternal age, maternal comorbidities (HT, DM), parity, sex of the child, smoking habit, alcohol drinking, calorie intake, maternal education status, and household income.

^dMultivariable logistic models were adjusted for maternal age, maternal comorbidities (HT, DM), parity, sex of the child, smoking habit, alcohol drinking, calorie intake, maternal education status, household income, obstetrical complications (HDP and GDM), and excess body weight gain during pregnancy.

^eMultivariable logistic models were adjusted for maternal age, maternal comorbidities (HT, DM), parity, sex of the child, smoking habit, alcohol drinking, calorie intake, maternal education status, household income, obstetrical complications (HDP and GDM), excess body weight gain during pregnancy, breastfeeding for at least 6 months after birth, SGA, and LGA.

^fMultivariable logistic models were adjusted for maternal age, maternal comorbidities (HT, DM), parity, sex of the child, smoking habit, alcohol drinking, calorie intake, maternal education status, household income, obstetrical complications (HDP and GDM), excess body weight gain during pregnancy, breastfeeding for at least 6 months after birth, SGA, LGA, outdoor play in summer or winter, and TV or DVD viewing.

OR, odds ratio; CI, confidence interval; PA, physical activity; HT, hypertension; DM, diabetes mellitus; HDP, hypertensive disorder of pregnancy; GDM, gestational diabetes mellitus, SGA, small for gestational age; LGA, large for gestational age; TV, television; DVD, digital versatile disc.

Supplemental Content

Association of pre-pregnancy physical activity with obesity in offspring: The Japan Environment and Children's Study (JECS)

Table S1: Logistic regression models for the maternal physical activity pre-pregnancy and child overweight/obesity at the age of three using IOTF's definition (n = 65,245)

Table S2: Parental characteristics according to the maternal physical activity pre-pregnancy before exclusion (n = 100,718)

Table S3: Distribution of child BMI-SDS at the age of three according to the maternal physical activity pre-pregnancy (n = 65,245)

Table S4: Multivariable quantile regression analyses for the association of child BMI-SD score and maternal physical activity pre-pregnancy (n = 65,245)

Table S1. Logistic regression models for the maternal physical activity pre-pregnancy and child overweight/obesity at the age of three using IOTF's definition (n = 65,245)

Regression model	No. of case	Model 1 ^a		Model 2 ^b		Model 3 ^c		Model 4 ^d		Model 5 ^e		Model 6 ^f	
		OR (95% CI)	<i>P</i> -value	OR (95% CI)	<i>P</i> -value	OR (95% CI)	<i>P</i> -value	OR (95% CI)	<i>P</i> -value	OR (95% CI)	<i>P</i> -value	OR (95% CI)	<i>P</i> -value
Overweight/obesity													
Low PA	2,547	1.02 (0.96–1.09)	0.571	1.02 (0.96–1.09)	0.569	1.02 (0.95–1.09)	0.583	1.02 (0.95–1.09)	0.590	1.02 (0.96–1.09)	0.519	1.02 (0.96–1.09)	0.471
Moderate PA, reference	1,681	1		1		1		1		1		1	
High PA	1,014	1.07 (0.98–1.16)	0.118	1.05 (0.96–1.13)	0.290	1.03 (0.95–1.12)	0.487	1.02 (0.94–1.11)	0.596	1.03 (0.95–1.12)	0.524	1.03 (0.94–1.11)	0.552
Obesity													
Low PA	235	0.93 (0.77–1.14)	0.494	0.93 (0.76–1.14)	0.479	0.91 (0.75–1.12)	0.381	0.91 (0.75–1.12)	0.380	0.92 (0.75–1.12)	0.399	0.91 (0.74–1.11)	0.336
Moderate PA, reference	169	1		1		1		1		1		1	
High PA	110	1.15 (0.90–1.46)	0.266	1.11 (0.87–1.41)	0.399	1.07 (0.84–1.36)	0.590	1.06 (0.83–1.36)	0.626	1.07 (0.84–1.36)	0.596	1.08 (0.84–1.37)	0.552

Physical activity categories refer to maternal physical activity pre-pregnancy.

The reference group was defined as children born to mothers with moderate physical activity pre-pregnancy.

^aUnadjusted model.

^bMultivariable logistic models were adjusted for maternal age, maternal BMI at pre-pregnancy, maternal comorbidities (HT, DM), parity, and sex of the child.

^cMultivariable logistic models were adjusted for maternal age, maternal BMI at pre-pregnancy, maternal comorbidities (HT, DM), parity, sex of the child, smoking habit, alcohol drinking, calorie intake, maternal education status, and household income.

^dMultivariable logistic models were adjusted for maternal age, maternal BMI at pre-pregnancy, maternal comorbidities (HT, DM), parity, sex of the child, smoking habit, alcohol drinking, calorie intake, maternal education status, household income, obstetrical complications (HDP and GDM), and excess body weight gain during pregnancy.

^eMultivariable logistic models were adjusted for maternal age, maternal BMI at pre-pregnancy, maternal comorbidities (HT, DM), parity, sex of the child, smoking habit, alcohol drinking, calorie intake, maternal education status, household income, obstetrical complications (HDP and GDM), excess body weight gain during pregnancy, breastfeeding for at least 6 months after birth, SGA, and LGA.

^fMultivariable logistic models were adjusted for maternal age, maternal BMI at pre-pregnancy, maternal comorbidities (HT, DM), parity, sex of the child, smoking habit, alcohol drinking, calorie intake, maternal education status, household income, obstetrical complications (HDP and GDM), excess body weight gain during pregnancy, breastfeeding for at least 6 months after birth, SGA, LGA, outdoor play in summer or winter, and TV or DVD viewing.

IOTF, International Obesity Task Force; OR, odds ratio; CI, confidence interval; PA, physical activity; BMI, body mass index; HT, hypertension; DM, diabetes mellitus; HDP, hypertensive disorder of pregnancy; GDM, gestational diabetes mellitus, SGA, small for gestational age; LGA, large for gestational age; TV, television; DVD, digital versatile disc.

Table S2. Parental characteristics according to the maternal physical activity pre-pregnancy before exclusion (n = 100,718)

Characteristics	Low PA (n = 49,504)		Moderate PA (n = 31,815)		High PA (n = 19,399)	
Maternal age at delivery (years), mean [SD]	31.5	[5.0]	31.3	[5.0]	30.1	[5.1]
< 20, n (%)	359	(0.7)	237	(0.7)	249	(1.3)
20–34, n (%)	34,330	(69.4)	22,564	(70.9)	14,974	(77.2)
≥35, n (%)	14,415	(29.1)	8,723	(27.4)	4,024	(20.7)
Missing, n (%)	400	(0.8)	291	(0.9)	152	(0.8)
BMI at pre-pregnancy, median [IQR]	20.5	[19.1–22.6]	20.5	[19.1– 22.5]	20.6	[19.1–22.6]
< 18.5, n (%)	8,218	(16.6)	5,011	(15.8)	3,061	(15.8)
18.5–24.9, n (%)	35,935	(72.6)	23,554	(74.0)	14,058	(72.5)
25.0–29.9, n (%)	4,070	(8.2)	2,491	(7.8)	1,708	(8.8)
≥30, n (%)	1,258	(2.5)	738	(2.3)	568	(2.9)
Missing, n (%)	23	(0.1)	21	(0.1)	4	(0.0)
Parity						
First, n (%)	19,557	(39.5)	12,427	(39.1)	7,755	(40.0)
2nd, n (%)	18,795	(38.0)	12,547	(39.4)	6,948	(35.8)
3rd or more, n (%)	10,001	(20.2)	6,044	(19.0)	4,234	(21.8)
Missing, n (%)	1,151	(2.3)	797	(2.5)	462	(2.4)
Maternal comorbidity						
Hypertension, n (%)	604	(1.2)	364	(1.1)	265	(1.4)
Thyroid disease, n (%)	654	(1.3)	452	(1.4)	244	(1.3)
DM, n (%)	537	(1.1)	336	(1.1)	209	(1.1)
Heart disease, n (%)	143	(0.3)	94	(0.3)	64	(0.3)
Renal disease, n (%)	175	(0.4)	97	(0.3)	74	(0.4)
Mental disorder, n (%)	420	(0.9)	231	(0.7)	143	(0.7)
Maternal smoking status						
Never, n (%)	28,990	(58.6)	19,108	(60.1)	10,063	(51.9)
Past, n (%)	17,887	(36.1)	11,215	(35.3)	7,874	(40.6)
Current, n (%)	2,234	(4.5)	1,290	(4.1)	1,297	(6.7)
Missing, n (%)	393	(0.8)	202	(0.6)	165	(0.9)
Maternal drinking status						
None, n (%)	17,800	(36.0)	10,590	(33.3)	6,265	(32.3)
Past, n (%)	26,577	(53.7)	17,779	(55.9)	11,295	(58.2)

Current, n (%)	4,856	(9.8)	3,316	(10.4)	1,758	(9.1)
Missing, n (%)	271	(0.6)	130	(0.4)	81	(0.4)
Maternal educational status						
≤12 years, n (%)	17,729	(35.8)	9,935	(31.2)	7,850	(40.5)
13–15 years, n (%)	19,896	(40.2)	13,114	(41.2)	8,106	(41.8)
≥16 years, n (%)	10,442	(21.1)	7,862	(24.7)	2,919	(15.1)
Missing, n (%)	1,437	(2.9)	904	(2.8)	524	(2.7)
Paternal educational status						
≤12 years, n (%)	21,128	(42.7)	12,461	(39.2)	9,268	(47.8)
13–15 years, n (%)	10,583	(21.4)	6,852	(21.5)	4,438	(22.9)
≥16 years, n (%)	16,038	(32.4)	11,450	(36.0)	5,015	(25.9)
Missing, n (%)	1,755	(3.6)	1,052	(3.3)	678	(3.5)
Household income						
< 4,000,000 yen, n (%)	17,611	(35.6)	10,948	(34.4)	8,187	(42.2)
4,000,000–5,999,999 yen, n (%)	15,126	(30.6)	9,763	(30.7)	5,340	(27.5)
≥6,000,000 yen, n (%)	12,018	(24.3)	8,368	(26.3)	4,046	(20.9)
Missing, n (%)	4,749	(9.6)	2,736	(8.6)	1,826	(9.4)

Physical activity categories refer to maternal physical activity pre-pregnancy.

PA, physical activity; SD, Standard deviation; BMI, body mass index; IQR, Interquartile range; DM, diabetes mellitus.

Table S3. Distribution of child BMI-SDS at the age of three according to the maternal physical activity pre-pregnancy (n = 65,245)

	Low PA		Moderate PA		High PA	
BMI-SDS at 3 year of age	(n = 31,781)		(n = 21,337)		(n = 12,127)	
$\geq +2.0$ SD, n (%)	1,318	(4.2)	867	(4.1)	530	(4.4)
+1.0 SD – +2.0 SD, n (%)	7,055	(22.2)	4,693	(22.0)	2,740	(22.6)
–1.0 SD – +1.0 SD, n (%)	21,223	(66.8)	14,263	(66.9)	7,987	(65.9)
< -1.0 SD, n (%)	2,185	(6.9)	1,514	(7.1)	870	(7.2)

Physical activity categories refer to maternal physical activity pre-pregnancy.

BMI-SDS, body mass index standard deviation scores; PA, physical activity; SD; standard deviation.

Table S4. Multivariable quantile regression analyses for the association of child BMI-SD score and maternal physical activity pre-pregnancy (n = 65,245)

Quantiles of BMI-SD score	0.1		0.25		0.5		0.75		0.9	
	β (95% CI)	<i>P</i> -value	β (95% CI)	<i>P</i> -value	β (95% CI)	<i>P</i> -value	β (95% CI)	<i>P</i> -value	β (95% CI)	<i>P</i> -value
Adjusted model ^a										
Low PA	0.007 (−0.023, 0.038)	0.635	0.004 (−0.018, 0.027)	0.709	0.019 (0.001, 0.039)	0.046	0.020 (−0.002, 0.041)	0.072	0.013 (−0.016, 0.041)	0.383
High PA	−0.001 (−0.041, 0.038)	0.947	0.005 (−0.023, 0.034)	0.714	0.025 (0.001, 0.049)	0.048	0.020 (−0.008, 0.048)	0.158	0.036 (−0.001, 0.072)	0.054
Adjusted model ^b										
Low PA	0.018 (−0.013, 0.049)	0.245	0.008 (−0.014, 0.030)	0.451	0.025 (0.005, 0.044)	0.013	0.020 (−0.001, 0.042)	0.067	0.014 (−0.014, 0.042)	0.327
High PA	0.012 (−0.027, 0.052)	0.543	0.009 (−0.019, 0.038)	0.526	0.027 (0.002, 0.052)	0.037	0.017 (−0.011, 0.045)	0.238	0.020 (−0.016, 0.056)	0.280

Physical activity categories refer to maternal physical activity pre-pregnancy.

Moderate physical activity group is defined as a reference among low, moderate, and high physical activity group.

^aMultiple quartile regression models were adjusted for maternal age, maternal BMI at pre-pregnancy, maternal comorbidities (hypertension, diabetes mellitus), parity, and sex of the child.

^bMultiple quartile regression models were adjusted for maternal age, maternal BMI at pre-pregnancy, maternal comorbidities (hypertension, diabetes mellitus), parity, sex of the child, smoking habit, alcohol drinking, calorie intake, maternal education status, and household income.

BMI-SD, body mass index standard deviation; CI, confidence interval; PA, physical activity