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Maternal Education Level but not Physical Activity in Pregnancy was Associated with Fitness and Fatness in Childhood

Konstantinos D. Tambalis[1,2,*], Labros S. Sidossis[1,3]

[1]Department of Nutrition and Dietetics, Harokopio University, Athens, Greece
[2]Department of Physical Education and Sport Science, National and Kapodistrian University of Athens, Greece
[3]Department of Kinesiology and Health, Rutgers University, New Brunswick, NJ 08901, USA
*Corresponding author: dp425603@hua.gr

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Abstract The aim was to investigate the association between parental education level and physical activity (PA) in pregnancy with offspring's physical fitness (PF) and obesity status in childhood considered several covariates. Population-based data were obtained from a national database that included anthropometric and PF (cardiorespiratory fitness, speed, and body strength) data of almost all Greek children 8 to 9 years. A random sample of 5,125 dyads of mothers-children was evaluated. Telephone interviews were carried out with the use of a standardized questionnaire for the collection of maternal lifestyle factors. Children whose mothers had secondary/tertiary educational levels had higher odds of overweight/obesity by 30% in boys and 44% in girls and increased odds for low performances in CRF and upper body explosive strength tests, in boys (OR=1.73, 95%CI: 1.24-1.43 and OR=1.29, 95%CI: 1.07-1.72, respectively) and girls (OR=1.62, 95%CI: 1.15-2.27 and OR=1.73, 95%CI: 1.23-2.25, respectively) than their peers with mothers of basic educational level. Maternal PA levels in pregnancy did not found to significantly associate either to child's obesity status neither to PF. Considerable variation in BMI and PF status in association with maternal education has been demonstrated, but no association was found for PA in pregnancy.

Keywords: *physical activity, education, pregnancy, physical fitness, childhood*

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1. Introduction

Obesity in childhood is a worldwide epidemic that has gained tremendous proportions. [1] It is estimated that worldwide more than 124 million children and adolescents were obese in 2016, including 41 million children under the age of 5 years. [2] Childhood obesity has been associated with the development of cardiovascular diseases, diabetes, metabolic syndrome, and excess weight status in adult life, and it influences the social and psychological functioning of children. [3,4] Extensive epidemiological findings support the notion that improved physical fitness (PF), especially cardiovascular fitness (CRF), was associated with a decreased risk of cardiovascular disease (CVD), all-cause mortality and obesity, among healthy individuals. [5] PF is the central indicator of cardiovascular health in childhood and it is considered that an adequate level of PF in childhood is essential to transfer beneficial biological and behavioral effects into later life, in a dose-response fashion. [6,7] On the other hand, lower levels of PF in childhood are associated with adverse health effects such as obesity, hypertension, and hyperlipidemia. [6] A PF evaluation includes measures of body composition, cardiorespiratory endurance, muscular fitness, and musculoskeletal flexibility. [8] Because obesity and PF are significant health-related predictors, it is of resonance to recognize their common factors. Considering that genetics strongly determines both PF and obesity, fewer are well-established about the effect of environmental factors on it. [9] Among numerous environmental factors, the parental educational status could play a central role by influencing the family's lifestyle. Parental education status is usually used to assess socio-economic status (SES). The available data on the associations between SES and PF in children and adolescents are deteriorate and inconsistent, while, review studies indicated that different SES groups are at different risks, and the association between childhood obesity and SES varies by gender, age, and country. [10-15] Moreover, important findings are suggesting that the perinatal period and its characteristics such as physical activity (PA) may contribute positively to the prevention of childhood obesity. [16] Conversely, a pregnant woman's physical inactivity may contribute to excessive weight gain, an increased risk of gestational diabetes or hypertension, and also, the fetus may experience changes in muscular development or maturation and be born prematurely. [17] Except for children's body mass index (BMI), several perinatal factors such as maternal's pre-pregnancy BMI, breastfeeding, smoking in pregnancy, etc., could influence PF in childhood. [18,19,20] To the best of our knowledge there are no epidemiological data concerning the link between maternal's PA and PF status of the offspring in childhood.

Thus, the present study aimed to determine how the education levels of mothers and fathers and PA in pregnancy are related to PF (i.e. CRF, speed, and musculoskeletal fitness) and obesity of the offspring in childhood taken into consideration several covariates. The findings of this analysis will provide evidence supporting interventions could be planned so that low PF levels can be prevented before adulthood.

2. Materials and Methods

2.1. Study Design

Population-based data derived from a national school-based health survey was obtained from a database that included PF and anthropometric data, as well as contact details and information (age, gender, city and area of living, etc.) of almost all Greek children 8 to 9 years old who attended primary school during 2017. The national database was in almost all schools of Primary Education (roughly 85%); schools that did not participate were from borderland areas, with small numbers of children. Thus, a total of 65,828 8- to 9-year-old children (51% boys and 49% girls, over 95% of the total student population) participated in the study. Measurements were performed by two trained Physical Education (PE) teachers in each school. PE teachers followed a specific protocol taught in corresponding seminars held by the Greek General Secretariat of Sports (GSS). The same protocol was employed in all schools.

2.2. Data Extraction

For this work, and feasibility reasons, a sample of 5,500 children (0.8% of the entire population) was randomly extracted from the database and their mothers were contacted by telephone. Random extraction was performed through statistical software. The number of 5,500 subjects was adequate to achieve statistical power greater or equal to 99% for evaluating a 0.10±0.05 change in the regression coefficients at a 5% significance level of two-sided tested hypotheses. The random sampling was stratified according to the region and place of living (e.g., rural/urban), according to the National Statistical Agency. The sample of 5,125 mother-father-child triads covered all geographical regions of Greece (e.g., mainland and the islands). The information of the proposed protocol was collected through telephone interviews based on the Computer-Aided Telephone Interviews (CATI) method. To validate the process, 100 face-to-face interviews were conducted to check for discrepancies with the information collected by telephone. No such discrepancies were noted in any of the variables measured.

2.3. Measurements

All the necessary information was collected using a standardized questionnaire, named the Childhood Obesity Pregnancy Determinants (ChOPreD) questionnaire, designed and developed with the collaboration of the Harokopio University Department of Nutrition & Dietetics and Department of Geography and the University of Texas Medical Branch Department of Internal Medicine-Geriatrics, Sealy Centre on Aging. The ChOPreD questionnaire was tested and internally revised by the study's investigators during a pilot study, which confirmed its construct validity. During data collection, the mothers were asked to provide information on their educational level (e.g., primary, secondary, tertiary) as well as the educational level of the father and their PA engagement during pregnancy. Thus, several potential confounders related to offspring's PF and obesity statuses, such as breastfeeding, paternal and maternal BMI, and maternal pregnancy conditions (i.e. smoking) were considered. Furthermore, mothers were asked whether their child was born on the projected birth date or not, whether the pregnancy was the result of an IVF (In Vitro Fertilization) or not, etc. As far as the offspring is concerned, all children born in Greece receive a health book from the state that records their birth weight and height and is subsequently filled with additional details by pediatricians during routine checkups or visits due to illness. Only children that had a full set of records (e.g., health books) were included in the study, which finalized the sample of 5,125 mother-father-child triads. The BMI data for the offspring at the ages of 8 were calculated based on data retrieved from the national database. The BMI status of the offspring at childhood was determined based on cut-off points suggested by Cole and his colleagues. [21] For the current study, PA is defined as any form of bodily movement produced by skeletal muscles that increase energy expenditure over the level of physical rest, thereby offering numerous benefits for the human body. This can include a wide range of activities, such as leisure activities, participation in organized sports, exercise, physical work, etc. [22] The assessment of PA was based on frequency (e.g., Never 0 times/wk, Rare 1-3 time/wk, Often 4-5 times/wk, Very often 6 times/wk, Daily 7 times/wk), and duration (e.g., exercise more than the recommended 30 minutes per day) of PA. The questionnaire did not evaluate the intensity, as only mild intensity exercise is recommended during pregnancy. [23] The questionnaire took into account activities undertaken during recreation, exercise, or sport, as well as daily activities (e.g., activities one does at work, as part of house and yard work, etc.). Mothers were instructed to refer to all domains of PA during their pregnancy. Mothers classified as having inadequate PA status if they engaged in physical activities less than 150 min per week. [23]

2.4. Fitness Tests

The Eurofit PF test battery was used to evaluate children's PF levels, initially proposed by the Council of Europe, and used systematically from many European countries. [24] Specifically, for the current study, four fitness tests were administered by two trained PE professionals in each school: a) Vertical jump (VJ; jump from a squatting position at the start) assess lower-body explosive power; b) Small ball throw (SBT; 1 kg with both hands in a standing position), to assess upper body explosive strength; c) 30-meter sprint (30mS; from a standing start), to evaluate speed; and d) Multi-stage 20-meter shuttle run, (20mSRT), to estimate CRF. The 20mSRT test consists of measuring the number of laps completed by subjects running up and down between two lines, set 20 meters apart, at an initial speed of 8.5 km/h which increases by 0.5 km/h every minute, using a pre-recorded audiotape. The above widely-used five PF tests were selected as being representative of explosive, anaerobic, and aerobic performance. Repeat tests (2 trials) were allowed for the VJ, SBT, and 30mS, with the best performance of each recorded. Students' performance in PF tests was evaluated based on the PF normative age- and sex-specific values for 8- to-10-year-old Greek boys and girls. Particularly, for each of the five PF tests applied, a performance ≤25th percentile was considered as low, between the 25th and 75th as average and ≥75th as high. [25]

2.5. Study Approval

The study was approved by the Bioethics Committee of Harokopio University. Oral approval was obtained from all mothers who agreed to participate in the study and written informed consent was obtained from those participants who took part in the validation process of the study. The study also had the approval of the relevant department of the Ministry of Education.

2.6. Data analysis

Categorical variables were presented as absolute and relative frequencies. Continuous variables were presented as mean values ± standard deviations (SD). Histograms and P-P plots were applied to evaluate the normality of the distribution of the continuous variables. Comparisons between differences of mean values of normally distributed variables between groups of educational level and PA status were tested using the analysis of covariance (ANCOVA), after adjustment for several potential confounders (i.e. birth weight, child's BMI at 8 to 9 years, parental BMI, breastfeeding, smoking in pregnancy, maternal's age, etc.). Results from ANCOVA are presented as the mean and standard error of the mean (SEM). Considering the days of PA in pregnancy as a continuous variable, we conducted bivariate correlations between it and the parameters of PF (including BMI) and we calculated the Pearson's r coefficient. To evaluate the differences among educational status groups (i.e. primary, secondary and tertiary), we applied post hoc analysis using the Bonferroni correction rule to adjust for the inflation of Type I error. Moreover, to assess the potential effect of parental educational levels (i.e. primary vs. secondary/tertiary) and PA in pregnancy (adequate vs inadequate) on obesity status (e.g., normal-weight vs. overweight/obese) and PF tests performances (average/high vs. low) of the offspring, binary logistic regression analysis was applied and odds ratios (ORs) with the corresponding 95% confidence intervals (CIs) were calculated. The Hosmer and Lemeshow's goodness-of-fit test was calculated to evaluate the model's goodness-of-fit and residual analysis was implicated using the dbeta, the leverage, and Cook's distance D statistics to identify outliers and influential observations. All analyses were performed using the SPSS version 18.0 software for Windows (SPSS Inc., Chicago, IL, USA). Statistical significance level from two-sided hypotheses was accepted at the 5% level ($p \leq 0.05$).

3. Results

The characteristics of mothers, fathers, and their offspring are presented in Table 1. The majority of mothers were educated at the secondary (43.7%) or tertiary (42.8%) level, while a percent of 13.5% completed primary education. Also, most fathers were educated to secondary (51.7%) or tertiary (38.7%) level, and only 9.6% completed primary education. The analysis showed that the mean frequency of PA (≥30 min/day) in pregnancy was 0.6 ± 0.9 days/wk. A large proportion of mothers did not exercise (≥30 min/day) during pregnancy (64.5%), while the proportion of 16.7% exercised moderately (1-3 days/wk), 13.8% sometimes (4-5 days/wk), and only 3.2% very often (6 days/wk) and 1.8% daily. More mothers belonging to the secondary/tertiary educational levels reported adequate PA in pregnancy than those with basic educational levels (19.8% vs. 12.7%, $p=0.003$).

We found significant differences in children's BMI across maternal educational status, in both genders ($p<0.05$), after adjustment for birth weight, parental BMI, gestational weight gain, breastfeeding, and maternal age (Table 2). Moreover, we revealed significant differences in CRF test and lower body explosive power and upper body explosive strength tests among maternal educational levels ($p<0.05$) (Table 2), while, we additionally incorporated significant differences among paternal educational categories in the lower body explosive power test ($p<0.05$), in both genders, after adjustment for birth weight, child's BMI, parental BMI, gestational weight gain, breastfeeding, smoking during pregnancy, and maternal age. The correlations between days of PA in pregnancy and the parameters of PF (including BMI), by gender, did not show statistically significant results, except for a negative correlation of girls' BMI with the days of recommended PA in pregnancy ($r=-0.07$, $p=0.01$). Also, we did not observe significant differences in BMI and PF test performances between mothers with adequate PA in pregnancy (>150 min/wk) as compared to those with inadequate PA (<150 min/wk).

Given that significant differences in PF tests and BMI were considered between maternal primary and secondary or/and tertiary educational levels, we applied binary logistic regression analysis (basic vs. secondary/tertiary educational level as a whole) to investigate its effect on PF tests performances (average/high vs. low) and in BMI categories (normal-weight vs. overweight/obese). Children whose mothers had secondary/tertiary educational levels had higher odds of overweight/obesity by 30% and 44% in boys and girls, respectively, as compared to their peers with basic educational levels after adjustment for birth weight, parental BMI, breastfeeding, smoking during pregnancy, and maternal age (Table 3). In parallel, children with mothers belonging to the secondary/tertiary educational level groups had increased odds for low performances in CRF and upper body explosive strength tests, in boys (OR=1.73, 95%CI: 1.24-1.43 and OR=1.29, 95%CI: 1.07-1.72, respectively) and girls (OR=1.62, 95%CI: 1.15-2.27 and OR=1.73, 95%CI: 1.23-2.25, respectively) after adjustment for birth weight, child's BMI, parental BMI, gestational weight gain, breastfeeding, smoking during pregnancy, and maternal age. In contrast, children with parents with higher educational levels had lower odds of having a low performance in lower body explosive power, in both genders, compared to those with low basic educational levels. Maternal PA levels in pregnancy were not significantly associated either to child's obesity status neither to PF measurements. Those participants with both parents with basic educational levels did not significantly differed in obesity status or/and in PF status compared with those with both parents with secondary/tertiary educational levels, in both genders.

Table 1. Descriptive characteristics of the sample

	All (n=5125)	Boys (n=2686)	Girls (n=2439)
Maternal characteristics			
Age (years)	34.9 (4.8)	34.9 (4.8)	34.8 (4.8)
Pre-pregnancy BMI, kg/m^2	22.4 (3.2)	22.5 (3.2)	22.4 (3.1)
BMI after pregnancy, kg/m^2	26.0 (4.5)	26.1 (4.5)	25.8 (4.5)
Gestational weight gain, kg	14.1 (5.0)	14.2 (4.9)	14.1 (5.0)
Breastfeeding, months	3.2 (3.8)	3.1 (3.8)	3.2 (3.8)
Smoking in pregnancy, n (%)	588 (11.5)	302 (11.2)	286 (11.8)
Maternal education, n (%)			
Basic (≤6 years) (%)	696 (13.5%)	357 (13.3%)	339 (13.9%)
Secondary (≤12 years) (%)	2230 (43.6%)	1159 (43.2%)	1070 (44.0%)
Higher (> 12 years) (%)	2191 (42.8%)	1168 (43.5%)	1023 (42.1%)
PA in pregnancy, d/wk	0.6 (0.96)	0.6 (0.95)	0.6 (0.97)
Inadequate PA (<150 min/wk)	4161 (81.2%)	2178 (81.0%)	1971 (81.1%)
Adequate PA (>150 min/wk)	964 (18.8%)	508 (19.0%)	457 (18.9%)
Paternal characteristics			
Age (years)	38.6 (4.7)	38.6 (4.6)	38.7 (4.7)
BMI, kg/m^2	27.7 (3.7)	27.8 (3.7)	27.6 (3.7)
Paternal education, n (%)			
Basic (≤6 years) (%)	494 (11.8%)	273 (12.6%)	221 (11.0%)
Secondary (≤12 years) (%)	1703 (40.8%)	891 (41.3%)	811 (40.2%)
Higher (> 12 years) (%)	1981 (47.5%)	996 (46.1%)	985 (48.8%)
Offspring characteristics			
Age (years)	8.5 (0.5)	8.4 (0.5)	8.5 (0.5)
Area of living (urban), n (%)			
Birth weight (kg)	3.4 (0.5)	3.4 (0.5)	3.3 (0.5)
Fatness (8 to 9 years old)			
BMI (kg/m^2)	17.6 (3.0)	17.7 (3.0)	17.6 (3.0)
Normalweight, n (%)	3581 (69.9%)	1868 (69.6%)	1709 (70.3%)
Overweight/obese, n (%)	1539 (30.1%)	816 (30.4%)	722 (29.7%)
Physical fitness			
Vertical jump (cm)	20.3 (5.2)	20.9 (5.2)*	19.6 (5.1)
Small ball throw (m)	4.5 (1.9)	4.8 (2.0)*	4.2 (1.7)
30-meter sprint (s)	6.5 (0.7)	6.4 (0.7)*	6.6 (0.7)
20-meter shuttle run (laps)	3.2 (1.9)	3.3 (2.0)*	3.0 (1.8)

The values are means ± standard deviation unless otherwise indicated; PA, physical activity; BMI, body mass index; *P-values<0.05 for differences between boys and girls.

Table 2. Differences (Mean ± SEM) in fitness and fatness measurements across parental educational and physical activity status in children 8 to 9 years old

	BMI (kg/m^2)	20mSRT (laps)	30m sprint (s)	Vertical jump (cm)	Ball throw (m)
			Boys		
Maternal educational status					
Basic (≤6 years)	17.4 (0.16) [a, b]	3.7 (0.07) [a, b]	6.4 (0.03)	20.2 (0.3)[a, b]	5.7 (0.1) [a, b]
Secondary (≤12 years)	17.7 (0.09)	3.2 (0.04)	6.3 (0.02)	20.9 (0.2)	4.7 (0.06)
Higher (>12 years)	17.7 (0.09)	3.3 (0.04)	6.4 (0.02)	21.0 (0.2)	4.9 (0.06)
Overall p-value	**0.033**	**0.01**	0.099	**0.003**	**<0.001**
Maternal physical activity status					
Inadequate (<150 min/wk)	17.7 (0.11)	3.2 (0.06)	6.3 (0.01)	20.8 (0.2)	4.8 (0.07)
Adequate (>150 min/wk)	17.7 (0.10)	3.5 (0.05)	6.2 (0.06)	21.0 (0.3)	4.6 (0.08)
P-value	0.637	0.207	0.105	0.808	0.273
Paternal educational status					
Basic (≤6 years)	17.3 (0.15)	3.1 (0.07)	6.3 (0.02)	20.7 (0.3) [b]	4.2 (0.1)
Secondary (≤12 years)	17.8 (0.10)	3.2 (0.05)	6.4 (0.01)	21.1 (0.2)	4.2 (0.07)
Higher (>12 years)	17.6 (0.09)	3.3 (0.05)	6.3 (0.01)	21.5 (0.2)	4.3 (0.07)
Overall p-value	0.079	0.173	0.909	**0.046**	0.576

	BMI (kg/m^2)	20mSRT (laps)	30m sprint (s)	Vertical jump (cm)	Ball throw (m)
			Girls		
Maternal educational status					
Basic (≤6 years)	17.2 (0.16) [a, b]	3.4 (0.06) [a, b]	6.8 (0.04)	18.3 (0.3)[a, b]	5.7 (0.09) [a, b]
Secondary (≤12 years) (%)	17.5 (0.09)	2.9 (0.04)	6.7 (0.02)	19.6 (0.1)	3.7 (0.05)
Higher (>12 years)	17.8 (0.09)	3.0 (0.04)	6.7 (0.02)	20.1 (0.2)	3.9 (0.05)
Overall p-value	**0.02**	**<0.001**	0.193	**<0.001**	**<0.001**
Maternal physical activity status					
Inadequate (<150 min/wk)	17.5 (0.11)	3.0 (0.06)	6.6 (0.03)	19.6 (0.2)	4.2 (0.05)
Adequate (>150 min/wk)	17.3 (0.10)	3.0 (0.05)	6.4 (0.06)	19.7 (0.3)	4.0 (0.06)
P-value	0.125	0.650	0.191	0.882	0.102
Paternal educational status					
Basic (≤6 years)	17.3 (0.13)	3.0 (0.07)	6.7 (0.02)	18.9 (0.3) [b]	3.7 (0.09)
Secondary (≤12 years)	17.6 (0.09)	3.0 (0.05)	6.6 (0.02)	19.6 (0.2)	3.7 (0.08)
Higher (>12 years)	17.6 (0.10)	2.9 (0.05)	6.6 (0.01)	20.2 (0.2)	3.7 (0.08)
Overall p-value	0.269	0.480	0.477	**0.001**	0.141

BMI, body mass index; [a]P-values<0.05 for differences between basic and secondary educational levels; [b]P-values<0.05 for differences between basic and tertiary educational levels; Values are adjusted for birth weight, child's BMI, parental BMI, gestational weight gain, breastfeeding, smoking during pregnancy, and maternal age.

Table 3. Results (OR, 95%CI) from logistic regression models that used to evaluate the association of parental educational and physical activity status with offspring BMI (normal weight vs. overweight/obesity) and physical fitness tests performances (average/high vs. low) in childhood

	BMI status (normalweight vs. overweight/obese) OR (95% CI)	20mSRT	30m sprint (average/high vs. low performance) OR (95% CI)	Vertical jump	Ball throw
			Boys		
Model 1 (unadjusted)					
Maternal educational status (basic vs. secondary/tertiary)	**1.28 (1.01-1.56)**	**1.63 (1.17-2.28)**	1.07 (0.80-1.44)	**0.64 (0.44-0.90)**	**1.30 (1.08-1.74)**
Maternal physical activity status (inadequate vs. adequate)	0.95 (0.65-1.41)	0.92 (0.58-1.47)	0.60 (0.36-1.09)	1.05 (0.67-1.63)	0.78 (0.47-1.30)
Paternal educational status (basic vs. secondary/tertiary)	1.13 (0.45-1.89)	1.09 (0.41-1.93)	1.01 (0.72-1.42)	0.99 (0.71-1.38)	0.97 (0.70-1.33)
Model 2 (adjusted)					
Maternal educational status (basic vs. secondary/tertiary)	**1.30 (1.03-1.67)**	**1.73 (1.23-2.43)**	1.05 (0.77-1.42)	0.62 (0.42-1.89)	**1.29 (1.07-1.72)**
Maternal physical activity status (inadequate vs. adequate)	1.00 (0.67-1.48)	0.97 (0.60-1.55)	0.60 (0.34-1.04)	1.06 (0.66-1.64)	0.74 (0.44-1.25)
Paternal educational status (basic vs. secondary/tertiary)	1.28 (0.96-1.61)	1.07 (0.42-1.47)	0.96 (0.68-1.36)	0.97 (0.69-1.36)	1.01 (0.73-1.40)
Girls					
Model 1 (unadjusted)					
Maternal educational status (basic vs. secondary/tertiary)	**1.35 (1.04-1.76)**	**1.61 (1.15-2.26)**	0 0.79 (0.30-1.26)	**0.65 (0.51-0.83)**	**1.61 (1.25-2.09)**
Maternal physical activity status (inadequate vs. adequate)	0.68 (0.45-1.05)	1.09 (0.69-1.71)	0.64 (0.35-1.08)	0.89 (0.59-1.33)	0.82 (0.56-1.20)
Paternal educational status (basic vs. secondary/tertiary)	1.28 (0.93-1.77)	0.98 (0.67-1.40)	0.88 (0.66-1.19)	**0.67 (0.50-0.90)**	1.15 (0.86-1.55)
Model 2 (adjusted)					
Maternal educational status (basic vs. secondary/tertiary)	**1.44 (1.10-1.89)**	**.1.62 (1.15-2.27)**	0.80 (0.32-1.21)	**0.64 (0.50-0.82)**	**1.73 (1.33-2.25)**
Maternal physical activity status (inadequate vs. adequate)	0.73 (0.47-1.12)	1.14 (0.72-1.80)	0.65 (0.36-1.06)	0.95 (0.63-1.43)	0.79 (0.54-1.27)
Paternal educational status (basic vs. secondary/tertiary)	1.36 (0.97-1.89)	0.99 (0.69-1.42)	0.90 (0.66-1.22)	**0.66 (0.49-0.89)**	1.23 (0.92-1.66)

4. Discussion

The current study is the first one aimed to investigate the association of PA during pregnancy and parental educational levels on a wide range of PF components in childhood. Findings from this extensive, representative cohort revealed that: (a) children whose mothers had secondary/tertiary educational levels had higher odds of overweight/obesity compared to their peers with basic educational levels; (b) Similarly, children with mothers with secondary/tertiary educational levels had higher odds of low performances in CRF and upper body explosive strength tests; (c) Participants with parents with high educational levels performed better in the lower body explosive power test; (d) We did not incorporate differences either in offspring's PF indicators or fatness among father's educational levels, except for lower body explosive power test; (e) PA in pregnancy did not associate with offspring's PF (including BMI) in childhood; All the above-mentioned associations remained statistically significant after adjustment for several covariates in both genders.

The education level of a mother was associated with the obesity status of the offspring at childhood. The evidence that was gathered concerning the educational level of the mothers showed that the more educated mothers have a higher incidence of their children overweight/obesity. In line with our findings, a study among 507 Spanish schoolchildren aged 8 to 16 years old concluded that boys and girls from high SES groups had higher BMI than their peers from low SES groups. [10] A cross-sectional study conducted in the USA, China, and Russia which used family income as an indicator of SES, showed that in the USA low SES groups had a higher risk of childhood obesity, while, in China and Russia high SES groups were at an increased risk of obesity as compared to lower SES group. [14] Previous review study published studies on the relation between SES and obesity reported inconsistent findings among children in developed societies, while, in developing societies, a strong direct relation was observed for children, with a higher likelihood of obesity among persons in higher SES status. [26] Another review indicated that there is a gradual reversal of the social status in body weight and as one moved from high- to low-SES countries, the percentage of positive associations between SES and obesity increased and the proportion of negative associations decreased, while, these finding masked nuances by gender and indicator of SES. [27] Possible explanations for these inconsistencies could include different SES definitions and the influence of SES on children's area of living, lifestyle such as PA and dietary habits, health services, etc. [14] For example, it is considered that in some countries richer people could have easier access to food consumption patterns such as meat and energy-dense foods than the poorer, while in other countries higher SES groups consume more fishes and vegetables and fruits (less energy-dense foods) than low SES groups. [28]

In the present study, we observed that children of mothers belonging to the secondary/tertiary educational level groups had increased odds for low performances in CRF and upper body explosive strength tests, in both genders, even after adjustment for several covariates. Additionally, we found that children with parents with higher educational levels had lower odds of having a low performance in lower body explosive power, in both genders, compared to those with low basic educational levels. To the best of our knowledge, very few studies have examined the effect of a mother's education level on PF among children. [11,12] In line with our findings, a study among 507 Portuguese children and adolescents revealed that boys from the low SES group performed better for muscular and aerobic endurance (20m SRT) whereas girls from the high SES group performed better for muscle power test. [11] Moreover, in South America (Brazil and Colombia) studies among children and adolescents, indicated that family SES is inversely associated with physical fitness measures. [10,29,30] On the contrary, in a study including 358 Swiss children (aged 7.3 ± 0.4 years) the authors speculated that participants with both parents having primary education had low performances in CRF test as compared to the group with highly educated parents. [12] Moreover, results including 5,251 German adolescents reported that a higher parental education level was associated with better aerobic fitness for girls and boys. [13] In our study, we did not found significant differences in PF tests comparing children 8 to 9 years old from both parents belonging to the basic educational level with those with both parents with secondary or/and tertiary educational levels, in both genders. The reason for these inconsistent results remains almost unclear. The inconsistencies could be attributed to differences in the measurement and definitions of SES and PF, but they also could be connected to differences in age groups (children and adolescents), PA levels, social and cultural environments. The inconsistency of the relationship between parental SES and a child's PF across studies calls for more scientific research across countries and world regions and underscores the need to examine the contextual factors that may clarify variations in this association.

Even in light of the scientific data that support the safety and health benefits of maternal PA during pregnancy, our data revealed that only a percent of 17.8% of mothers reported adequate PA levels (>150 min/wk of moderate-intensity) in pregnancy. In line with our findings review studies reported that only 15-20% of women adhere to the current recommendations concerning PA in pregnancy, globally. [16,31] The current findings proposed that maternal's PA levels in pregnancy did not associate with child's obesity status. In a similar study conducted on 40,280 Danish mother-child pairs, recreational PA during pregnancy did not associate with children's risk of overweight, after adjustment for SES, smoking habits, and maternal pre-pregnancy BMI. [32] Also, in line with our findings, a study concluded that the offspring (1-year-old) of 52 women who exercised when compared with those of 52 control subjects had similar body weight. [33] On the other hand, a case-control study among 40 physically active mothers, where 20 of them voluntarily stopped all PA during pregnancy found that weight-bearing exercise in pregnancy at a moderate intensity, compared to inactivity, was associated with lower body weight in 5-year-old children. [34] Moreover, a study that examined exercise interventions during pregnancy between 20–36 weeks of gestation among 84 mothers concluded that the offspring of mothers who exercised during pregnancy had increased total body fat and greater abdominal adiposity than control children. [35] Among potential reasons for these discrepancies could be the type of the study (epidemiological, case-control), the sample size, the child's age, the choice of women who were physically active before pregnancy, which may modify the association between maternal PA in pregnancy and the offspring's obesity status, etc. However, in our analyses, we have included several potential confounders such as pre-pregnancy BMI, gestational weight gain, smoking in pregnancy, area of living, gestational age, birth weight, etc, had no noteworthy effect on the estimates.

The current results proposed that maternal PA levels in pregnancy did not associate with the child's PF status. Following our findings, a study on 20 mother/child pairs, 8-10 years postpartum showed that third trimester maternal's PA was not related to child aerobic fitness. [36] Scientific pieces of evidence proposed that lower fetal heart rate and increased heart rate variability persist after birth in the offspring of women who were physically active during pregnancy, proposing a potential impact on cardiovascular health promotion and thus may be the earliest intervention to improve offspring cardiovascular health. [37] Also, it is considered that prenatal PA could create an advantageous fetal milieu and decrease the risk of obesity and metabolic syndrome for the offspring by regulating body weight and cardiometabolic factors at birth and later in childhood. [38]

4.1. Strengths and Limitations

The main strength of this study was the objective measurement of PF and anthropometric indices in a very large, representative sample of children of the same age, taken into consideration several covariates. Among potential limitations included that the perinatal information was collected during the telephone interviews to some extent was self-reported. Consequently, although mothers could provide information derived from health records for themselves, this consists of a limitation of the study. Particularly, this could be attributed to deliberate over-reporting, under-reporting, or recall bias for the self-reported pre-pregnancy data. Moreover, though a common, validated protocol was used to evaluate PF tests in all children, a large number of experienced, PE teachers participated as evaluators in the study. To diminish the variability among the different experimenters (motivation etc.), all PE teachers received a 30-min lecture with specific instructions before every battery of tests. Also, the impact of possible confounders such as maternal nutrition, sexual maturity, and fat-free mass, and PA status of children, e.t.c., were not included in the analysis.

5. Conclusions

In summary, our research analysis revealed that the mother's education level was associated with offspring's overweight/obesity and PF in childhood, even after adjustment for several covariates. Father's educational level was only associated with lower body explosive power. We did not find any significant association between maternal PA in pregnancy and a child's overweight/obesity or/and PF. Concerning the relationship between maternal's PA in pregnancy and PF, more research is required. Since childhood overweight and PF are partly linked to genetic factors and prenatal characteristics our findings possibly support early preventive strategies to optimize body weight to target later PF and especially cardiovascular health and reducing health disparities among children of differing SES.

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