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ORIGINAL RESEARCH

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Does an obesogenic family environment moderate the association between sports participation and body composition in children? The ENERGY project

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Summary

Background: Previous research on the association between sports participation and body composition has shown mixed findings. The family home is considered one of the most influential environments on childhood obesity. Thus, the association between sports participation and body composition in children may be influenced by an obesogenic home environment.

Objectives: To investigate if an obesogenic family environment moderates the association between sports participation and body composition in children.

Methods: A total of 3999 children (54% girls; 11.6 ± 0.7 years) and their parent(s) were included from the ENERGY project. A composite obesogenic family environment risk score was created from 10 questionnaire items. Height, weight (to calculate body mass index), and waist circumference were obtained by trained researchers and used as indicators of body composition.

Abbreviations: BMI, body mass index; CI, confidence interval; ICC, intraclass correlation coefficients; MVPA, moderate-to-vigorous PA; PA, physical activity; SD, standard deviation; SES, socio-economic status; WC, waist circumference.

Results: The composite risk score significantly moderated the association between sports participation and both waist circumference and body mass index. In children from families with moderate and high obesogenic risk, organized sports participation was significantly associated with smaller waist circumference (moderate risk: −0.29, 95% CI −0.45 to −0.14; high risk: −0.46, 95% CI −0.66 to −0.25) and lower body mass index (moderate risk: −0.10, 95% CI −0.16 to −0.04; high risk: −0.14, 95% CI −0.22 to −0.06), but not in children with a low obesogenic family risk score.

Conclusions: Enrolling children in sports activities from an early age can be important for healthy weight maintenance, especially among children from obesogenic family environments.

KEYWORDS

obesity, obesogenic environment, overweight, paediatrics, physical activity

1 | INTRODUCTION

Paediatric obesity is a global public health concern associated with a myriad of adverse health consequences.[1] Physical activity (PA) is important for the maintenance of a healthy weight, in addition to other health benefits.[2] Leisure time sport is one component of PA that can contribute to public health. For instance, children and adolescents participating in sporting clubs are more likely to meet overall PA recommendations of 60 min of moderate-to-vigorous intensity PA (MVPA) daily.[3] Thus, sporting clubs are an important venue for PA and health promotion. Some studies report higher sports participation to be associated with healthier indicators of body composition, such as body mass index (BMI) and waist circumference (WC) among children (i.e., from the ENERGY project).[4] In general, however, the evidence is mixed. In a systematic review by Lee et al.,[5] six out of 17 studies found no statistically significant associations between sports participation and child obesity or only partial or weak associations among subgroups of children. Despite these inconsistent findings, PA is hypothesized to protect against the development of obesity resulting in higher energy expenditure and resting metabolic rate.[6] Obesity is, nevertheless, both a complex and multifactorial condition.

Socio-ecological models can be helpful to understand the complexity of risk factors contributing to childhood obesity.[7,8] Especially among younger children, the home (or family) environment is considered the most important influencing factor.[7] Although there is no consensus regarding the exact risk factors an obesogenic family environment encompasses, researchers have highlighted the importance of factors related to PA, food intake, and media use, which can be expressed in both the physical- (i.e., accessibility to foods and media) and social- (i.e., parental role modelling and rules) family environment.[8]

In the EuropeaN Energy balance Research to prevent excessive weight Gain among Youth (ENERGY) project,[9] data were collected on several physical and social factors in a family environment that have been associated with increased risk of child obesity. Findings from the ENERGY project show that families dinning together and parenting rules regarding media use (e.g., not allowing TV while eating and TV in the child's bedroom) are associated with healthier body composition among children.[10–13] Furthermore, parental socioeconomic status (SES) and BMI,[14,15] in addition toparental behaviours such as daily intake of sugar sweetened drinks, PA levels, and sedentary time,[4,16–18] have been associated with their children's weight-related health behaviours and weight status. Although each of these factors have shown to be associated with weight-related outcomes among children, a composite measure should capture overall obesogenic risk in the family home environment more efficiently than single risk factors.[19]

A better understanding of the mixed findings regarding the associations between child sports participation and body composition is warranted. Some children may benefit more from increased PA and sports participation than others, for instance, children with multiple unhealthy lifestyle behaviours.[20] This reasoning is supported by intervention studies showing that increased sports participation particularly seem to benefit overweight children living in environments with higher obesogenic risk (e.g., low-income families and obese parents).[21,22] Based on previous research it is reasonable to assume that different risk (i.e., obesogenic family environment risk) and protective factors (i.e., sports participation) may interact in their influence on child body composition.[23] More specifically, the protective effect of sports participation against obesity might be more pronounced among children with an increased risk of developing excessive weight due to an obesogenic family environment. Therefore, the present study aims to examine whethera composite obesogenic family environmental risk score, based on factors related to both the physical and social environment in the family, moderates the association between sports participation and body composition in 10-to-12-year-old children across Europe. We hypothesize that the association between sports participation and body composition is stronger in children from high obesogenic risk environments compared to children from low obesogenic risk environments.

2 | METHODS

2.1 | Procedure and sample

The current study used data from the ENERGY (European Energy balance Research to prevent excessive weight Gain among Youth) project, more specifically from the cross-sectional study conducted in seven European countries (Belgium, Greece, Hungary, The Netherlands, Norway, Slovenia, and Spain).[9] Each country was represented by a local research institute or university department, being responsible for the data collection in the respective country. Ethical approval was obtained in all seven participating countries from Medical Ethical review committees and all participants and legal guardians provided informed consent prior to commencement of investigation. The standardized sampling procedures, data collection, data handling, and ethical approval in the separate countries are described in detail elsewhere.[9] Briefly, the cross-sectional survey was carried out in primary schools among 10–12-year-old children. The study aimed to include a minimum sample of 1000 school children from each participating country and one parent/caretaker for each child. The recruitment and data collection took place from March–July 2010. Nationally representative samples were obtained from Greece, Hungary, The Netherlands, and Slovenia. In Belgium, schools were selected from Flanders (i.e., the northern Dutch-speaking part of Belgium), Norway selected schools from the southern regions of the country, and Spain selected schools in the region of Aragón. Between 15 (Slovenia) and 37 (Greece) schools participated, with a response rate at the school level between 5% (The Netherlands) and 100% (Slovenia). Response rates were in general high at the child level (<85%); however, lower in Hungary (33%) and Norway (45%), primarily due to a lack of completed parental consent forms. At the parental level, general response rates were also relatively high (80%).

In total, 7234 children and 6002 parents completed the questionnaires. Children completed the child questionnaire during class-time with guidance from a research assistant or project worker, and each child brought home a parental questionnaire to be completed by one of the parents.[9]

2.2 | Measures

2.2.1 | Child sports participation

Children were asked how many hours per week they participated in one or two sports ($ICC_{test-retest} = 0.74$ for sport 1; 1.00 for sport 2).[24] Total hours of sport participation per week was calculated for each child.[4]

2.2.2 | Child body composition

Body height, weight, and WC were measured by trained research assistants according to standardized protocols ($ICC_{test-retest} = 1.00$ for weight and height; 0.99 for WC).[9,24] The children were measured in light clothing without shoes. Body height was measured with a SECA Leicester Portable stadiometer (accuracy of 0.1 cm) and weight measured with a calibrated electronic scale SECA 861 (accuracy of 0.1 kg). Waist circumference was measured with a SECA 201 measuring band (accuracy of 0.1 cm). Two readings of each measurement (height, weight, and WC) were obtained. A third measure was taken if the two readings differed more than 1%.[9] Body mass index (kg/m^2) was calculated as weight (kg) divided by height squared (m^2), and weight categories based on the International Obesity Task Force criteria (IOTF).[25]

2.2.3 | Ethnicity

Ethnicity was assessed in the child questionnaire and operationalized as a distinction between children of immigrant origin (non-native) and of native origin, based on the primary language spoken at home. The answering categories were tailored to the different countries. This included the official language or languages of the specific country or region, the native languages of the largest ethnic minorities, and a category 'other'. A dichotomous variable was created that distinguished children for whom the official language of the country of administration was the main language spoken at home (native) coded 0, from those where another language was the main language spoken at home (non-native) coded 1.[26]

2.2.4 | Parental marital status

Parental marital status was assessed in the parental questionnaire. The answer 'married' or 'living with my partner but not married' was considered a dual marital status (coded 0), and the answers 'single', 'divorced', or 'separated' as single status (coded 1).[9]

2.2.5 | Obesogenic family environment variables

Parental education levels

Educational level was assessed in the parental questionnaire by asking how many years of education both parents had. In line with previous publications from the ENERGY project,[13,26] educational level was dichotomized as follows: if both parents had <14 years of education each, corresponding to high school across countries as the highest education level, parental educational level was determined as low (coded 1), and if at least one parent had >14 years of education, parental educational level was categorized as high (coded 0).

Parental anthropometrics

Parental BMI was calculated from self-reported weight and height obtained in the parental questionnaire.[9] The BMI variable was dichotomized into normal weight (including underweight) <25 (coded as 0) and overweight/obese ≥25 (coded as 1) according to cut-offs by the IOTF criteria.[25]

Parental physical activity

In the parental questionnaire, active commuting by bicycle to work was assessed by asking how many days a week the parent usually biked. Response categories were between 0 to 5 days/week.[9]

Dichotomization was done according to earlier used cut-offs in the ENERGY study for active commuting to work. Four days or more of bicycling to work was considered a regular routine in weekdays and defined as a high mode (coded as 0), while <4 days was considered as a low mode (coded 1).[27]

Parental leisure time PA was assessed separately for weekdays and weekend days by asking how many days the parents usually participated in physical activities/sports in their leisure time. Response categories were between 0 and 5 days for weekdays, and between 0 and 2 days for weekends.[9] Total days of leisure time PA/sports participation per week was calculated. In the lack of an official recommendation or reference to guide our decision of a cut-off point, we based our decision on the median split similar to how other composite risk scores have been created.[28] The central tendency for the sample was 2 days/week, thus, parental PA/sports participation >2 days per week was defined as high (coded as 0), and weekly PA/sports participation ≤2 days defined as low (coded as 1).

Parental screen time

Parents were asked about the average time spent daily watching TV (including video and DVD) and time spent on the computer in their leisure time, separately for weekdays and weekend days.[9] Total hours of parental screen time per week (weekday and weekend days) from both TV and computer was calculated by summing up the average reported hours. No official recommendations of total screen time exist, thus the median split was used to categorize parental screen time into low levels (coded 0) if the weekly average was <5 h of total screen time, while ≥5 h of total screentime was categorized into high levels (coded 1).

TV during meals and TV in child bedroom

Parents were asked how often they watched TV during meals (breakfast, lunch and dinner) and reported on a 5-point scale from never to always. According to earlier used cut-offs in the ENERGY project the answer 'never' or 'not often' was considered as a low occurrence and recoded as 0, and 'sometimes, often or always' was recoded 1.[10] The parents were also asked if the child had a TV in the bedroom. The answer 'no' was coded 0 and 'yes' coded 1.[9]

Parental intake of sugared drinks

Parents were asked how many times a week they drank sweetened beverages and reported on a 7-point scale from never to more than once a day.[9] In lack of official recommendations, the median split was used to categorize the variable into low intake of sugared drinks (coded 0) representing 'never or less than once a week' and high intake of sugared drinks (coded 1) 'once a week, 2–4 days a week, 5–6 days a week, every day (once a day), and every day (more than once a day)'.

Eating breakfast together as a family

Parents were asked how often at least one of the parents were eating breakfast together with the child, answering on a 5-point scale from never to everyday. According to earlier used cut-offs in the ENERGY project, the answers were dichotomized into 5–7 days representing 'every day' (coded 0) and 2–4 days or less as 'not every day' (coded 1).[13]

2.3 | Statistical analysis

Descriptive statistics were performed to present the sample characteristics. Results are presented as mean and standard deviation (SD) or numbers and percentage (%). In addition, bivariate correlations coefficients between the single obesogenic family environment variables, WC, BMI, and sports participation can be found in the supplementary material (Table S1).

The composite obesogenic family environment risk score was defined per child by summing up the dichotomized obesogenic family environment variables, where 0 represented 'low risk' and 1 'high risk'. Thus, a composite risk score was generated with a possible score between 0 (lowest risk) and 9 (highest risk). The composite risk score was normally distributed (mean 4.5 (SD ±1.9)).

The analytical sample included children with complete data on each obesogenic family environment variable, covariates, and dependent variables ($n = 3999$). Compared to those excluded, the analytical sample had slightly lower child sports participation (−0.14 h, 95% CI (−0.27 to −0.01), $p < 0.050$), lower child WC (−0.43 cm, 95% CI (−0.85 to −0.02), $p < 0.050$), more often parents with partners/married (X^2 (1) ≥ 801.946, $v = 0.37$, $p < 0.001$), and parents with higher education levels (X^2 (1) ≥ 5.501, $v = 0.03$, $p < 0.050$), whereas no statistically significant differences were found between groups in child BMI, ethnicity, parental PA levels, or parental weight status.

Linear regression analysis was used to explore the association between the main variables of interest. A significant inverse association between sports participation and both WC and BMI have been reported earlier,[4] thus only the association between the obesogenic composite risk score and body composition was presented in this study.

Path analysis and cluster-robust standard error estimation,[29] to account for a potential clustering effect by school, was used to investigate the moderating effect of the composite obesogenic family environment risk score on the association between sports participation and body composition. *First*, the interaction term (sports participation*composite risk score) was calculated, after mean centring the variables. Path models included the interaction term *sports participation*composite risk score* to investigate the moderation effect of the composite obesogenic family environment risk score on the association between sports participation and both measures of body composition (WC and BMI). The school intraclass correlation coefficients were low (all ICC <0.03), in line with what have been reported earlier from the ENERGY study.[4] Thus, sensitivity analysis was performed to investigate the degree of influence by school clustering, comparing models with and without school as a cluster variable. Very small or no changes in coefficients were observed between the two models, thus no cluster adjustment for school was included in the final model (see model output including clustering by school in the

TABLE 1 Descriptive statistics of the included study sample by sex ($N = 3999$).

	Girls	Boys
N children (%)[a]	2162 (54)	1837 (46)
Age (mean (SD) yrs)	11.6 (0.7)	11.7 (0.7)
Ethnicity (% native)	1765 (81)	1478 (80)
WC (mean (SD) cm)	**65.4 (8.4)**	**67.7 (9.4)**
BMI (kg/m^2)	19.0 (3.3)	19.2 (3.3)
Normal weight (%)[a]	**1734 (80)**	**1353 (74)**
Overweight (%)[a]	**355 (16)**	**403 (21)**
Obese (%)[a]	73 (3)	81 (4)
Sports participation (% yes)[a]	1553 (71)	1510 (81)
Sports participation (mean (SD)) hours/week)	**3.5 (2.7)**	**4.3 (2.8)**
TV on bedroom (% yes)	692 (32)	663 (36)
Composite risk score (mean (SD))	4.6 (1.9)	4.5 (1.9)
Parental measures		
Marital status (% married)	2066 (95)	1774 (95)
Parental education (% with ≥14 years)	1475 (68)	1284 (69)
Parental BMI ((mean SD) kg/m^2)	24.6 (4.3)	24.5 (4.2)
Overweight/obese (% yes)[a]	840 (39)	701 (38)
Leisure time activity (% yes)	1401 (64)	1250 (67)
Leisure time PA (mean (SD)) days/week)	2.0 (2.0)	2.0 (2.1)
Screen time (mean (SD) hours/day)	5.1 (2.6)	5.1 (2.6)

Note: Numbers in bold represent significant differences between sex ($p \le 0.05$).
Abbreviations: BMI, body mass index; *N*, number; PA, physical activity; SD, standard deviation; WC, waist circumference; yrs, years.
[a]*N* (%), number (percentage).

supplementary material Table 1). Further, differences between countries in the magnitude of the association(s) was examined using multi-group analysis. Models with these associations forced to equality between countries was compared to models where they were freely estimated. The unconstrained models had lower Bayesian information criteria (BIC) values than the constrained models, thus indicating better model fit. However, since the difference in BIC values between the constrained and unconstrained models were very small (BIC difference <1%),[30] path models were run with and without country as a fixed effect to further investigate the influence by country on these associations. The sensitivity analyses confirmed the small differences in BIC values and country was excluded from the final models (see output for models adjusting for country in Table S2). Thus, the final path models, did not adjust for clustering within school and country. If a statistically significant moderation was observed by the composite obesogenic family risk score, the difference in magnitude of the association between sports participation and body composition variable was further explored in tertiles (low, moderate, and high composite risk score). *Second*, regions of significance were calculated using the Johnson-Neyman technique[31] to derive points along the continuum of the moderator where the regression coefficients of the predictor transitions between statistically significant and non-significant. All analyses were adjusted for age, sex, ethnicity of the child, and parental marital status that earlier have shown an association with sports participation and body composition.[32–34] Results are presented with beta-coefficients and 95% confidence intervals (95% CI).

An alpha-level of $p \le 0.05$ was considered statistically significant. IBM SPSS version 23 (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp.) was used to perform the descriptive statistics, whereas the main analyses were conducted using MPlus version 8 (Muthén and Muthén, 1998–2017).

3 | RESULTS

3.1 | Descriptive statistics

Out of the total of 7234 children (52% girls; 11.6 ± 0.7 years) that participated in the ENERGY school-based survey, 3999 children (54% girls; 11.6 ± 0.7 years) had valid data on all variables in the main analysis and thus eligible for the present study.

Compared to girls, boys had higher WC and were more often categorized as overweight according to their BMI; however, boys spent more time participating in sports than did girls (Table 1), as also reported earlier in the ENERGY project.[4]

3.2 | Association analyses

A statistically significant positive association was found between the composite obesogenic family environment risk score and both WC (β 1.11, 95% CI 0.97 to 1.25, $p < 0.001$) and BMI (β 0.36, 95% CI 0.31 to 0.41, $p < 0.001$) (Table S3). For every one unit increase in the composite risk score, WC increased by 1.11 cm and BMI by 0.36.

The moderation analyses showed that the association between sports participation and WC (−0.10, 95% CI (−0.15 to −0.05), $p < 0.001$) as well as the association between sport participation and BMI (−0.04, 95% CI (−0.06 to −0.02), $p < 0.001$) were moderated by the composite risk score. The beta-coefficients for the interaction terms are the difference in 'effect' of sports participation on body composition per one unit increase in the composite score. Thus, the inverse association between sports participation and body composition was stronger in participants with a higher composite obesogenic family environment risk score.

To further examine these associations, we created tertiles of the composite risk score and examined the association between sports participation and body composition within each tertile (Table 2, see also Figures S1 and S2 in the supporting information). Neither the association between sports participation and WC nor the association between sports participation and BMI was statistically significant in the lowest tertile of the composite risk score. However, for the moderate and highest tertile of the risk score, the association between sports participation and WC (moderate risk: −0.29, 95% CI (−0.45 to −0.14); high risk: −0.46, 95% CI (−0.66 to −0.25)) and BMI (moderate

TABLE 2 Association between weekly sports participation and body composition by tertiles of the composite risk score.

	Low risk ($n = 1269$)		Moderate risk ($n = 1504$)		High risk ($n = 1226$)	
	β (95% CI)	*p*-value	β (95% CI)	*p*-value	β (95% CI)	*p*-value
WC						
Unadjusted	0.06 (−0.09 to 0.21)	0.446	−0.12 (−0.28 to 0.04)	0.134	**−0.33 (−0.53 to −0.14)**	**0.001**
Adjusted[a]	−0.01 (−0.16 to 0.15)	0.947	**−0.29 (−0.45 to − 0.14)**	**<0.001**	**−0.46 (−0.66 to −0.25)**	**<0.001**
BMI						
Unadjusted	0.02 (−0.04 to 0.08)	0.508	**−0.06 (−1.12 to −0.01)**	**0.034**	**−0.13 (−021 to −0.06)**	**0.001**
Adjusted[a]	0.01 (−0.04 to 0.07)	0.667	**−0.10 (−0.16 to −0.04)**	**<0.001**	**−0.14 (−0.22 to −0.06)**	**<0.001**

Note: Numbers in bold represent significant associations between sports participation and body composition by each tertile ($p \le 0.05$).
Abbreviations: β, beta-coefficients; CI, confidence interval.
[a]Adjusted for age, sex, ethnicity, and marital status.

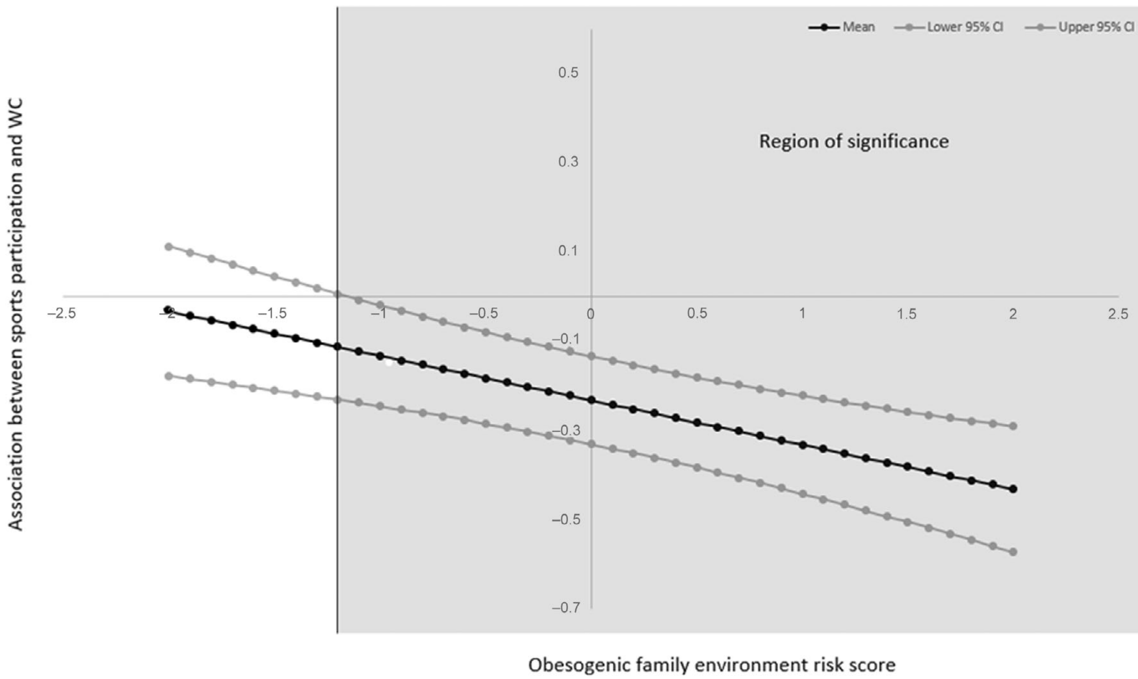

FIGURE 1 Region of significance for the association between sports participation and waist circumference depending on levels of the composite obesogenic family environment risk score.

risk: −0.10, 95% CI (−0.16 to −0.04); high risk: −0.14, 95% CI (−0.22 to −0.06)), increased with higher obesogenic family risk. For example, for every one-hour increase in weekly sports participation, WC decreased approximately 0.3 cm in children from moderate obesogenic environments and 0.5 cm if the child were living in a high obesogenic family environment.

3.3 | Regions of significance

Figures 1 and 2 shows the point along the continuum of the composite risk score where the association between sports participation and WC or BMI transit between statistically non-significant and significant. The distribution of participants along the moderator was 4.4% (−2 SD), 27.4% (−1 SD), 37.6% (mean), 25.9% (1 SD), and 4.7% (2 SD), respectively. With regards to the association between sports participation and WC, the transitional point was −1.15 SD from the mean of the composite risk score, corresponding to a composite risk score of 2.4. The point where the association between sports participation and BMI transitions between non-statistically and significant was −0.8 SD from the mean, equivalent to a composite risk score of 3. Thus, sports participation was only associated with WC when the composite risk score was equal to or higher than 2.4, and only significantly associated with BMI when the composite risk score equalled or was higher than 3.

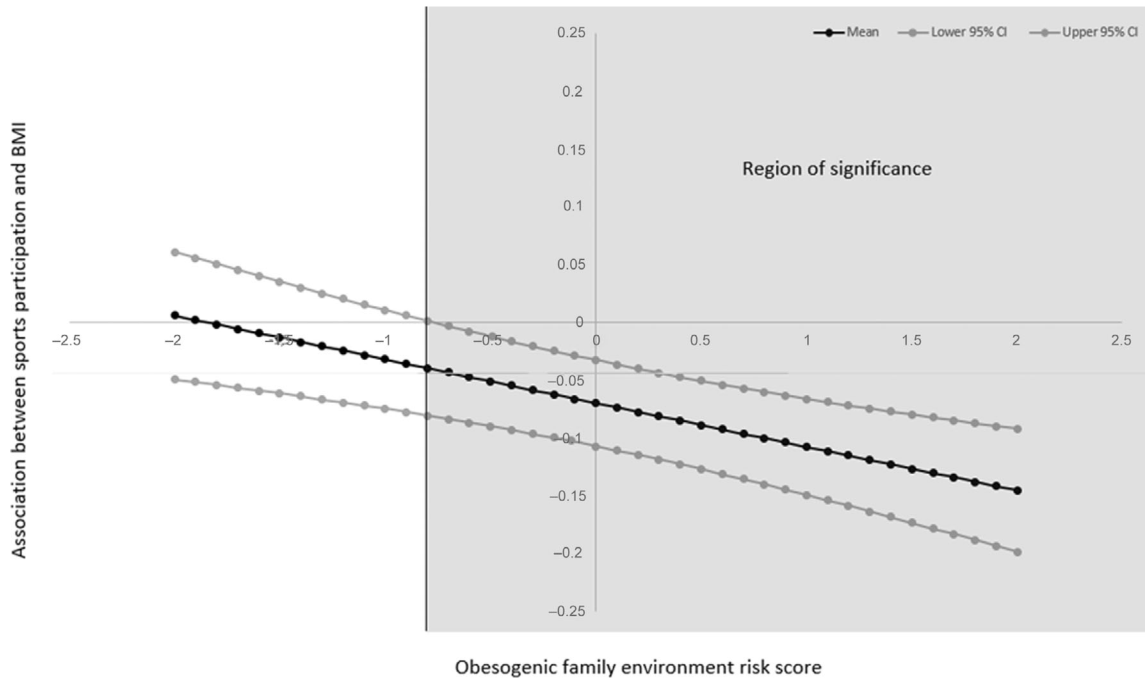

FIGURE 2 Region of significance for the association between sports participation and body mass index depending on levels of the composite obesogenic family environment risk score.

4 | DISCUSSION

To our knowledge, this is the first study to investigate the moderating effect of the obesogenic level of the family environment on the association between sports participation and body composition in children. We observed a statistically significant moderating effect of the obesogenic family environment on the association between sports participation and both WC and BMI, respectively. More specifically, sports participation was inversely associated with WC and BMI only among children living in a moderate-to-high risk obesogenic family environment. Furthermore, the strength of the inverse association between sports participation and body composition increased with higher obesogenic family risk score. The results suggest that sports participation may protect against obesity among those children more vulnerable or at higher risk of developing excessive weight, supporting earlier findings in the literature.[21]

An inverse association between sports participation and both WC and BMI have previously been demonstrated in the ENERGY project.[4] However, the literature has overall demonstrated ambiguous results regarding the relation between sports participation and body composition,[5] suggesting that this association is complex. Our main analysis showed no associations between sports participation and body composition among those children living in a low-risk obesogenic home environment. One explanation could be that a low obesogenic family home environment protects against developing overweight, independently of participating or not in sports. This would comply with previous findings indicating that the most influencing environment in regards to childhood obesity often is the home environment.[7] Indeed, sport programmes for children and adolescents are not necessarily designed to prevent obesity; however, children who participate in organized sports are often more active and active at higher levels of intensities than non-participants.[3] Importantly, participating in sports can be beneficial for children's general physical, psychological, and social health,[35,36] and should be encouraged for all children.

Previous studies examining the association between an obesogenic family environment and childhood obesity have found conflicting results.[8] The heterogeneity of study outcomes might be a result of methodological differences in how family environmental risk factors are operationalized and measured, hampering direct comparisons between studies. Most studies have investigated only few factors or domains in the family environment related to excessive weight in children.[8] The present study used a composite risk score consisting of nine items primarily related to the PA, food, and media environment in the home. As also argued by others,[37] a composite risk score should capture the overall obesogenic family environment better than single risk factors alone. For instance, some families may exhibit both unfavourable and favourable health behaviours simultaneously, such as high levels of time in sedentary behaviours concurrently with high levels of physical activity.[38] A systematic review by Kininmonth et al.[8] investigated the association between different aspects in the home environment (related to food, PA, and media use) and child obesity, found that most studies investigated the influence of the media environment only (23 out of 62). Consequently, this could increase the risk of misclassification when defining the degree of an obesogenic family environment as well as hampering the relationship with obesity. Some of the inconsistency observed in the literature could also be attributed to the age of the included samples and individual variation in susceptibility to an obesogenic environment. For instance, the prevalence of overweight increases with age[39] as well as BMI heritability.[40,41] This might explain why some studies in children as young as 5–6 years have not found an association between an obesogenic family environment and BMI,[37] compared to positive associations found in older children.[42] The relative contributions of genetic and social-environmental factors to body composition are controversial. Some studies indicate that obesity-related genes are more strongly associated with BMI in more obesogenic environments,[19] thus indicating that the observed variation in BMI heritability (31%–90%)[43] might be attributed to environmental characteristics. Several surveys have been utilized to assess the degree of an obesogenic family environment and how it relates to child obesity.[44–46] For instance the Family Nutrition and Physical Activity (FNPA) screening tool has been associated with obesity[46] and one-year change in BMI in children.[47] Both studies used the originally FNPA questionnaire based on 21 questions related to parental behaviours, rules, and support of PA, food intake, and media use in the home. Recently, the FNPA questionnaire was reworded and updated to ensure its continued relevance,[48] showing similar associations with BMI.[49] However, both the old and new version of the FNPA questionnaires also features child behaviours, like child PA levels, diet intake and sleep[46] and thus does not represent the obesogenic environment alone. The composite risk score used in the present study was based on fewer variables than the FNPA screening tool. However, the score was still sensitive enough to capture higher levels in WC and BMI and importantly, the variables represented aspects of the family home environment only.

There is an urgent need for effective interventions that can curb and reverse the obesity trend among children. The importance of such strategies has become even more crucial as a part of the COVID-19 pandemic recovery. Emerging studies reveals that more children has become affected by overweight and obesity during the COVID-19 lockdown,[50] despite recent years of stagnation in BMI trends among children in many countries.[51] In addition to the importance of family-based interventions to support healthy lifestyle habits for child weight management,[52] the present study indicates that enrolling children in sports, and especially groups of children at increased risk of overweight, should be a public health priority. Children participating in sports from an early age are not only more active, but also more prone to persist in sports and keep a lifelong interest in PA.[5] Thus, developing effective strategies of how to ease enrolment in sports among subgroups of children with different family backgrounds and experiences with sports, as well as reduce the high levels of drop out from sports reported with increasing age, are important from a public health perspective. In addition, we need more prospective observational and experimental studies that investigate the preventive effect of youth sports participation on obesity, especially among children at increased risk of developing overweight or obesity, for example due to their obesogenic family environment.

4.1 | Strengths and limitation

Strengths of the present study include a large multinational sample from different regions across Europe, standardized data collection protocols, and objectively measured weight, height, and waist circumference among children. We included two indicators of body composition and found the same results independent of measure used, which strengthens the conclusions of the current study.

Limitations include the cross-sectional design of the study, thus implying that causal inferences cannot be made. Further, the majority of variables were collected through questionnaires, which might have introduced bias. The obesogenic risk score is limited to nine variables and other important risk factors in an obesogenic environment might have been missed out. For instance, some studies find an association between the physical activity environment, such as sports equipment and garden space, to be related to unhealthy weight in children.[53] However, since this study used data from the ENERGY project, we could only use the variables that were available in the dataset. Parental BMI was, on the other hand, incorporated in the composite risk score and evaluated as a part of healthy parental role modelling. Body composition underlies a genetic influence as earlier discussed, which may have strengthened the associations with child body composition (Table S1). Another limitation is that BMI and WC are only indicators of body composition and more complex and precise methods (e.g., bioelectrical impedance, dual-energy x-ray absorptiometry, and total body water estimates) exist.[54] Furthermore, a summed risk score weights the variables equally, which might not need to be the case, because some variables may be more strongly related to obesity than others. Also, the obesogenic risk score was based on dichotomized variables which, together with choice of cut point, might have resulted in loss of precision. When no official recommendations were available to guide our decision of a cut-off point, we used the same cut-offs as in previous studies from the ENERGY project or based our decision on the median split. One variable, parental sugared drinks, was not correlated to either child WC or BMI (Table S1). However, since the variables were included in our composite risk score a posteriori, based on earlier findings linking the variables to increased risk of child obesity, we choose to keep this variable in the composite risk score. Adjustment for child total PA levels was not possible due to lack of information but could have revealed a more specific association between sports participation and body composition.

The generalizability of the results may have been influenced by the differences between participants included and those not included in the analysis. However, differences were small and most likely of minor importance. Finally, data was obtained in 2010 and some measures, such as screen time, lacks current popular screen use such as smart phones.

5 | CONCLUSION

The present study found that an obesogenic family environment modified the association between children's sports participation and body composition. Sports participation was inversely associated with WC and BMI only among children living in more obesogenic family environments, suggesting that sports participation might protect against unfavourable weight gain in this group of children. In addition to strategies aiming to improve family environments from obesogenic to healthy, we recommend initiatives to increase interest and participation in sports from an early age, especially among subgroups of children at increased risk of excessive weight gain.

AUTHOR CONTRIBUTIONS

Mai J.M. ChinAPaw, Yannis Manios, Dénes Molnár, Maïté Verloigne, Germàn Vicente-Rodríguez and Elling Bere contributed to the development of measurement protocols and instruments, and coordinated or supervised the data collections in the participating countries. Elling Bere, Mette Stavnsbo, and Mai J.M. ChinAPaw conceived the original idea for the manuscript and details were discussed with all authors. Mette Stavnsbo conducted the analyses with supervision from Andreas Stenling. All authors assisted in the interpretation of the results. Mette Stavnsbo drafted the manuscript, and all authors critically reviewed all drafts and have approved the submitted manuscript.

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CONFLICT OF INTEREST STATEMENT

No conflict of interest was declared.

DATA AVAILABILITY STATEMENT

The dataset used and analysed during the current study are available from the corresponding author on reasonable request.

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