Gundersen *et al. BMC Public Health* (2026) 26:1931
https://doi.org/10.1186/s12889-026-27519-6

BMC Public Health

RESEARCH

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Physical activity in infancy is associated with body composition at age three

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Abstract

Background The prevalence of obesity in the pediatric population is increasing, driven by a multifactorial etiology that includes genetic predisposition as well as both prenatal and postnatal influences. We aimed to explore associations between child physical activity (PA) at ages one and three years and body composition at age three. Furthermore, we investigated associations between maternal PA during pregnancy and child body composition at age three.

Methods Mother-child pairs ($n = 68$) from a pregnancy PA intervention study were included. Children's PA was assessed at one- and three-year follow-ups using 7-day accelerometry and categorized into 24-hour PA and daytime PA (6 a.m. – 8 p.m.). Child body composition was measured by Dual-energy X-ray absorptiometry and expressed as fat-free mass (FFM) and body fat percentage (BF%). Maternal moderate-to-vigorous intensity PA (MVPA) was measured using a commercial activity tracker. Associations between maternal and child PA and child body composition were examined using linear regression. Variables used for model adjustment included maternal pre-pregnancy body mass index, gestational weight gain, maternal educational level at baseline, parity, maternal age at baseline, child walking status at age one, child sex, and child age at the three-year follow-up.

Results We found a positive association between daytime PA at age one and child FFM at age three. Daytime PA at age three was positively associated with FFM, and 24-hour PA at age three was negatively associated with BF% and positively associated with FFM. A 10% increase in 24-hour PA was associated with approximately 400 g higher FFM. Maternal MVPA during pregnancy showed no association with child body composition at age three.

Conclusion More daytime PA at ages one and three was associated with higher FFM at age three in children. These findings highlight the importance of research focusing on early PA habits to support healthy body composition in young children.

Keywords Physical activity, early childhood, body composition, FitMum, FitBaby, FitKids

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Introduction

Worldwide, the prevalence of overweight and obesity among children and adolescents is increasing [1]. The etiology of childhood overweight and obesity is multifactorial, involving prenatal exposures, postnatal environmental factors, and shared parental–fetal genetics [2].

Current knowledge about prenatal factors indicates that being exposed to an adverse fetal environment, including maternal obesity and inactivity, enhances the risk of childhood obesity [3–5]. The association between maternal obesity during pregnancy and the risk of childhood obesity has been explored in cohort studies [6, 7]. A strong association between maternal pre-pregnancy Body Mass Index (BMI) and child weight and BMI has been found in 4–6-year-old children [8, 9]. Along the same lines, correlations have been observed between gestational weight gain and children's birth weight, adiposity, and BMI in childhood [10–12]. Another important factor seems to be maternal glucose metabolism, since maternal hyperglycemia and gestational diabetes are associated with childhood obesity [13, 14].

Physical activity (PA) interventions during pregnancy, particularly those targeting gestational diabetes mellitus, have shown that PA during pregnancy has positive effects on fasting glucose, postprandial glucose, and glycated hemoglobin [15–17]. Likewise, PA during pregnancy has been shown to lower gestational weight gain [18, 19]. Maternal PA may positively influence the intrauterine environment, potentially affecting offspring weight development and obesity risk [20]. Some studies found that maternal PA, specifically during late pregnancy, has lasting benefits for the children's body composition; however, these studies are based on self-reported PA [21, 22]. Although several studies have examined associations between PA-focused or broader lifestyle interventions during pregnancy and childhood anthropometric outcomes, the overall evidence is inconsistent with mixed findings [5, 23–25]. As examined in a systematic review from 2022, some of the existing literature combines PA with dietary or other lifestyle components, making it difficult to isolate the specific contribution of PA [26].

Postnatally, higher levels of childhood PA, measured by accelerometry and the doubly-labeled water method, have been associated with lower body fat percentage (BF%) and higher fat-free mass (FFM) in children aged 1.5–6 years [27–30]. Thus, children's PA during early childhood may improve body composition, and consequently may play a role in the risk of becoming overweight.

Body composition in young children can be assessed using different techniques ranging from basic anthropometrics to advanced imaging modalities. BMI is a simple and widely used method; however, it does not differentiate between fat mass and lean tissue mass. This limitation is particularly relevant during childhood, as fat and lean tissue mass proportions vary with age, sex, and hormonal maturation [31]. Dual-energy X-ray Absorptiometry (DXA) is a three-compartment model that separates body mass into fat mass, non-osseous lean body mass, and bone mass. As the gold standard for body composition assessment, DXA avoids the limitations of BMI and is especially suitable for pediatric assessment [32].

Taken together, existing evidence suggests that PA during pregnancy and early childhood is associated with body composition in children and might decrease the risk of overweight and obesity. However, longitudinal studies using objective measures of PA and detailed assessments of body composition are still limited.

The primary aim of this study was to explore the association between children's PA at ages one and three years and their body composition at age three. A secondary aim was to explore the association between maternal PA during pregnancy and child body composition at age three.

We hypothesized that higher child, and maternal PA would be associated with improved body composition at age three, with differences between 24-hour and daytime PA, and that higher maternal pre-pregnancy BMI would be associated with higher child BMI Z-score.

Methods

Study design and participants

The FitKids study is an observational study of the three-year-old children of 220 pregnant women who participated in the randomized controlled trial, FitMum [33]. FitMum was conducted at North Zealand Hospital, Denmark, from October 2018 to May 2021. The purpose of the FitMum study was to explore the effect of two different exercise interventions on PA during pregnancy in healthy, inactive women, who were included before gestational age (GA) week 15 + 0. Of the 220 women included, 178 women participated until delivery. All 178 women and their children were invited to participate in the one-year follow-up study FitBaby conducted from April 2019 to May 2022. Three years after delivery, the 178 women who participated until birth were contacted again by e-mail to invite their children's participation in the three-year follow-up study FitKids. Non-responders received the e-mail up to three times to enhance the participation rate. Oral and written information about the study was provided to both parents or custody holders, and a clinical examination at North Zealand Hospital was scheduled if the parents or custody holders remained interested in participating. Written consent was obtained from 68 parent pairs or custody holders. The follow-up visits were conducted from October 2022 to October 2024.

Children with eligible data from both the one- and three-year follow-up and children with eligible data from the three-year follow-up and their mothers were included in this study (Fig. 1).

The analyses of the association between maternal PA during pregnancy and child body composition at age three included 53 mother–child dyads with valid DXA measurements at age three. Analyses of the association between child PA at age one and body composition at age three included 47 children with valid PA data at age one and DXA measurements at age three. Finally, analyses of the association between child PA and body composition at age three included 41 children with valid PA and DXA data at age three.

Maternal and child data

Maternal physical activity

All pregnant women wore a Garmin Vívosport activity tracker from randomization to delivery, measuring maternal heart rate every 15 s. The amount of PA was expressed as minutes (min) per week of moderate-to-vigorous intensity PA (MVPA) [34]. MVPA was defined as time with a heart rate equivalent to ≥ 64% of the theoretical maximum heart rate [35].

Child physical activity

Child PA was assessed for seven consecutive days at both the one- and three-year follow-up using the Actigraph wGT3XBT, a research-grade accelerometer. Participants were instructed to wear the device continuously on their presumed non-dominant wrist. PA was calculated as counts per minute (CPM) for the vector magnitude (VM) as derived from acceleration in the three axes ($VM=\sqrt{x^2+y^2+z^2}$). Presenting PA data expressed as CPM was done for transparency and because no consensus exists on age-appropriate cut-points [36]. Non-wear time was defined as 60 min or more of consecutive zeros. Days with more than 10 h of wear time were considered valid, including at least one night with valid data (8 p.m. – 6 a.m.) [37, 38]. Nighttime was defined using an empirical, data-driven approach. Independent t-tests were performed to compare average CPM between adjacent hourly intervals around expected sleep onset (7–8 pm vs. 8–9 pm) and wake time. Significant changes in activity levels at these transitions supported defining nighttime as 8 p.m.–6 a.m. Children with less than two valid days were excluded [39]. Child PA was categorized into 24-hour PA and daytime PA, where daytime was defined as the hours between 6 a.m. and 8 p.m.

Child anthropometry

At age three, height was measured to the nearest 0.1 cm using a wall stadiometer (Seca 216). Weight in underwear or a clean diaper was measured to the nearest 0.1 kg using a standard balance beam scale (Seca 799). The beam scale was calibrated according to hospital standards. Abdominal and waist circumference were measured to the nearest millimeter with a non-stretchable tape measure. Abdominal circumference was measured at the umbilical level, and hip circumference was measured at the widest diameter of the buttocks. BMI Z-scores at both ages one and three years were calculated based on the child's BMI and predefined Danish growth standard scores based on age and sex [40, 41].

Child body composition

At age three, children were DXA-scanned. The DXA scans were performed at the Department of Radiology

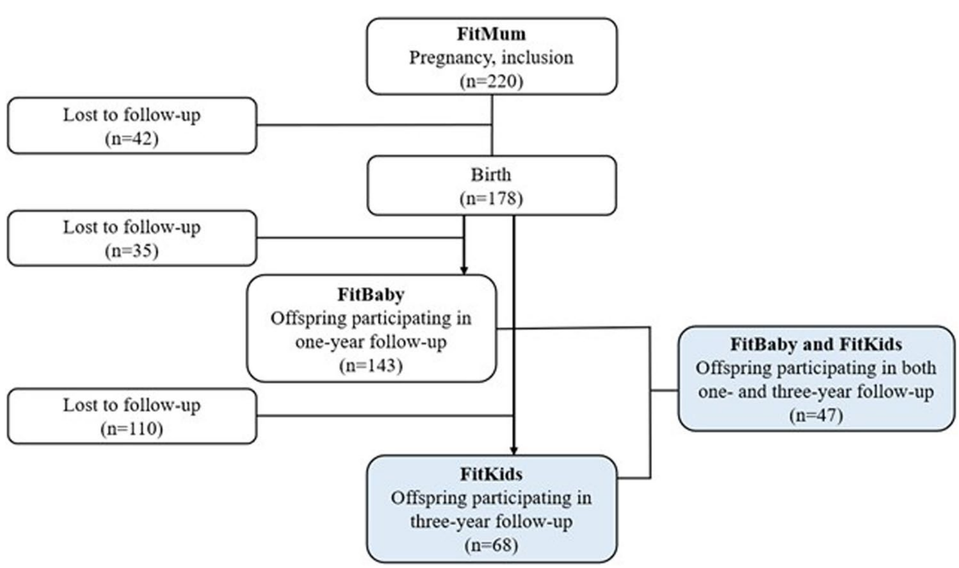

Fig. 1 Flowchart of participants in the FitMum, FitBaby, and FitKids studies

by a trained bioanalyst. A GE Lunar Prodigy (GE Medical Systems, Madison, WI, USA) with Encore software (Version 14.1, Prodigy; Lunar Corp, Madison, WI, USA) was used to assess estimates of BF% and FFM defined as total body mass (kg) – fat mass (kg). The child's height and weight were entered into the system, which subsequently determined the appropriate scanning mode from two predefined options (standard or thick). Daily machine quality assurance procedures were conducted in accordance with the manufacturer's instructions. The children wore light clothing during the scan. The children were positioned on the scanner and guided to lie still in a supine position. In case of too much movement during the scan, a second attempt was made. All scans were reviewed by a medical doctor specialized in Clinical Physiology and Nuclear Medicine. Scans with too much movement were discarded.

Covariates

Data on maternal pre-pregnancy BMI (calculated based on self-reported pre-pregnancy weight), educational level at baseline (a bachelor's degree or higher, yes/no), parity (nullipara: yes/no), and age at baseline (self-reported) were collected from the original FitMum study. Information was obtained by asking participants orally at inclusion. Their weight gain during pregnancy was measured at four FitMum visits, and based on these measurements, their gestational weight gain (GWG) was calculated [42]. Child walking status at age one year (yes: corresponding to 3 steps or more/no) was obtained by asking the parents at the one-year FitBaby follow-up visit.

Statistical analyses

Data are presented as mean ± standard deviation (SD) for equally distributed data and frequencies with proportions for categorical data. Differences in baseline characteristics between non-FitKids participants and FitKids participants, including the mother and her child, were analyzed using Student's unpaired t-test or Mann-Whitney U test for continuous variables, and Chi^2 test for categorical variables. Child anthropometrics are presented as descriptive statistics. PA data from the mothers' activity trackers were derived as a mean of 25 imputed datasets for missing data due to non-wear time [42]. Maternal PA was analyzed across the full cohort, irrespective of intervention group, as we aimed to explore the potential physiological associations between any maternal PA and child body composition. Linear regression analyses were used to examine associations between child PA (both 24-hour and daytime PA) at ages one and three and child body composition (BF% and FFM) at age three, as well as PA during pregnancy and child body composition (BF% and FFM) at age three. Covariates were selected a priori based on existing literature and established theoretical considerations [4, 22, 24, 27]. The final set of covariates included child sex, child age, parent-reported walking status at age one (corresponding to 3 steps or more), gestational weight gain, maternal age at baseline, parity (nullipara, yes/no), pre-pregnancy BMI, and maternal educational level. All covariates were retained in the models regardless of statistical significance to ensure consistent adjustment across analyses. The linear regression analyses exploring the association between child PA at age one and child body composition at age three were adjusted for maternal education, child sex, and parent-reported walking status at age one. The linear regression analyses exploring the association between child PA at age three and child body composition at age three were adjusted for maternal education, child sex, and child age at the three-year follow-up. We included an interaction term in the adjusted models to assess effect modification by sex and found no statistical evidence of interaction. We did not adjust for smoking since only one mother smoked at the beginning of pregnancy. Nor did we adjust for birth weight Z-scores since 92.1% of the children had a birth weight corresponding to the average weight for GA. Regression coefficients were scaled to represent the estimated change in FFM associated with a 10% increase in mean daily CPM at age 3 years. Corresponding 95% confidence intervals were derived using the standard error of the regression coefficient. Differences in FFM were estimated by scaling the regression coefficient to the difference in PA between the 10th and 90th percentiles. The linear regression analyses examining the association between maternal PA and child body composition at age three were adjusted for potential confounders, including maternal age, pre-pregnancy BMI, gestational weight gain, parity, and maternal educational level. Both total pregnancy PA and trimester-specific PA were examined; however, the first trimester was not included separately since most participants were included in FitMum early in their second trimester. Statistical analyses were performed using R (Version 2025.05.0) and the significance level was set at 5%.

Results

Participants

68 children participated in FitKids. The children's mean age at the three-year follow-up was 3.3 years (range 2.9–3.8 years). Maternal baseline and neonatal characteristics for both FitKids participants and non-participants are presented in Table 1.

In total, 54 children (female, $n = 32$) were DXA scanned. One scan was excluded because of poor quality. Means of all anthropometric measures, including DXA, are presented in Table 2.

Table 1 Maternal and neonatal characteristics of FitMum and FitKids participants, including the statistical differences between the two groups

	Participants in FitMum only[a] ($n=110$)	Participants in FitKids[b] ($n=68$)	*P*-value
Maternal Characteristics			
Age at baseline (years)	31.5 ± 4.2	31.4 ± 4.3	0.807
Pre-pregnancy BMI (kg/m^2)	24.0 (18.5, 44.4)	25.2 (18.5, 43.0)	0.144
Further education ≥ 3 years*	89 (80.9%)	59 (86.8%)	0.419
Nullipara	42 (38.2%)	28 (41.2%)	0.811
GA at inclusion (weeks)	12.8 (6.1, 14.9)	12.7 (7.0, 14.9)	0.648
Daily MVPA (minutes) during pregnancy	17.7 (12.7, 23.3)	16.5 (10.8, 24.6)	0.403
Gestational weight gain (kg)	15.2 ± 5.3	15.2 ± 6.0	0.984
Neonatal Characteristics			
Sex (female)	64 (58.2%)	29 (42.6%)	0.062
GA at birth (days)	281 (225, 294)	283 (256, 294)	0.118
Premature (GA < 37 + 0)	5 (4.5%)	1 (1.5%)	0.409
Birth weight (g)	3598 ± 561	3676 ± 469	0.316
Birth weight Z-score	0.11 ± 1.04	0.09 ± 0.92	0.866

Participants in the FitKids study did not differ from those who only participated in the FitMum study in terms of maternal or neonatal characteristics

BMI Body mass index, *GA* gestational age, *MVPA* moderate-to-vigorous intensity physical activity, *n* number

[a]Participants in FitMum only refer to the women and offspring who participated in the FitMum study until birth ($n=178$) but who declined the invitation to participate in the FitKids three-year follow-up

[b]Participants in FitKids refer to the women and their 3-year-old children who participated in both the FitMum and FitKids study

[*]a bachelor's degree or higher. Data are presented as mean ± standard deviation, median (interquartile range), and *n* (%)

Table 2 Mean anthropometric outcomes and body composition at three years of age (FitKids participants)

Anthropometry	$n=68$
Height (cm)	98.5 ± 3.6
Weight (kg)	15.8 ± 1.6
BMI Z-score	0.39 ± 0.98
DXA	$n=53$
Total fat (kg)	4.20 ± 0.762
Fat-free mass (kg)	12.1 ± 1.3
Total body fat (%)	25.8 ± 3.5

Data are presented as mean ± standard deviation

BMI Body mass index, *DXA* Dual-energy X-ray Absorptiometry, *n* number

Physical activity and child body composition

Only children with both valid PA and DXA data were included, resulting in 47 one-year-old children and 41 three-year-old children. At one year of age, children had a mean daily PA of 1714 ± 276 CPM, calculated as the hourly average over a full 24-hour period (19 children, corresponding to 40.4%, were walking). Children in the 10th percentile of PA had an approximate mean of 1957 daily CPM, in contrast to children in the 90th percentile of PA, with an approximate mean of 3165 daily CPM. By age three, this increased to 2356 ± 307 CPM. For daytime PA, the mean hourly values were higher: 2510 ± 471 CPM at age one and 3784 ± 552 CPM at age three. Associations between PA at ages one and three and body composition at age three, expressed as total BF% and FFM measured by DXA, are presented in Figs. 2 and 3.

Higher daytime PA at one year of age was associated with greater FFM at age three (β = 0.90, 95% CI [0.187, 1.613], $p=0.015$), indicating that a 100-CPM higher level of daytime PA was associated with 90 g higher FFM at age three. There was a trend toward an association between 24-hour PA at age one and FFM at age three (β = 1.30, 95% CI [-0.040, 2.557], $p=0.057$). Neither daytime PA nor 24-hour PA at age one was associated with BF% at age three (Fig. 2).

At age three, higher 24-hour PA was associated with both lower BF% (β = -0.003, 95% CI [-0.006; -0.000], $p=0.041$) and higher FFM (β = 1.72, 95% CI [0.461, 2.982], $p=0.009$), indicating that a 100-CPM higher level of 24-hour PA was associated with approximately a 0.3% lower body fat percentage and a 172 g higher fat-free mass at age three. Daytime PA was likewise associated with FFM (β = 1.0, 95% CI [0.306, 1.694], $p=0.006$), but not with BF% (Fig. 3).

Based on the average activity level at age three of 2356 ± 307 CPM, a 10% increase in 24-hour PA (≈ + 236 CPM) would correspond to approximately 400 g (CI [119, 693]) higher FFM and 0.7% (95% CI [-1.4, -0.1]) lower BF%. For daytime PA, a similar 10% increase would be associated with approximately 378 g (95% CI [124, 632]) higher FFM. Looking at the long-term effect of PA, being a child in the 90th percentile of PA at age one was associated with 0.84 kg higher FFM (95% CI [0.02, 1.67]) at age three compared to being a child in the 10th percentile.

Objectively measured maternal PA during pregnancy and child body composition at age three was not associated (Table 3).

Discussion

We found that children's PA at ages one and three was associated with their body composition at age three, suggesting potential short- and longer-term relationships between early PA and body composition. To our knowledge, this is the first study to incorporate detailed, objective measures of maternal PA during pregnancy together with repeated child PA assessments in infancy and early childhood, in relation to body composition at age three.

Prenatal vs. postnatal influence

In the present study, we did not find any associations between maternal PA in the prenatal period and body composition in the three-year-old children. However, our sample size is small, and the results should therefore be

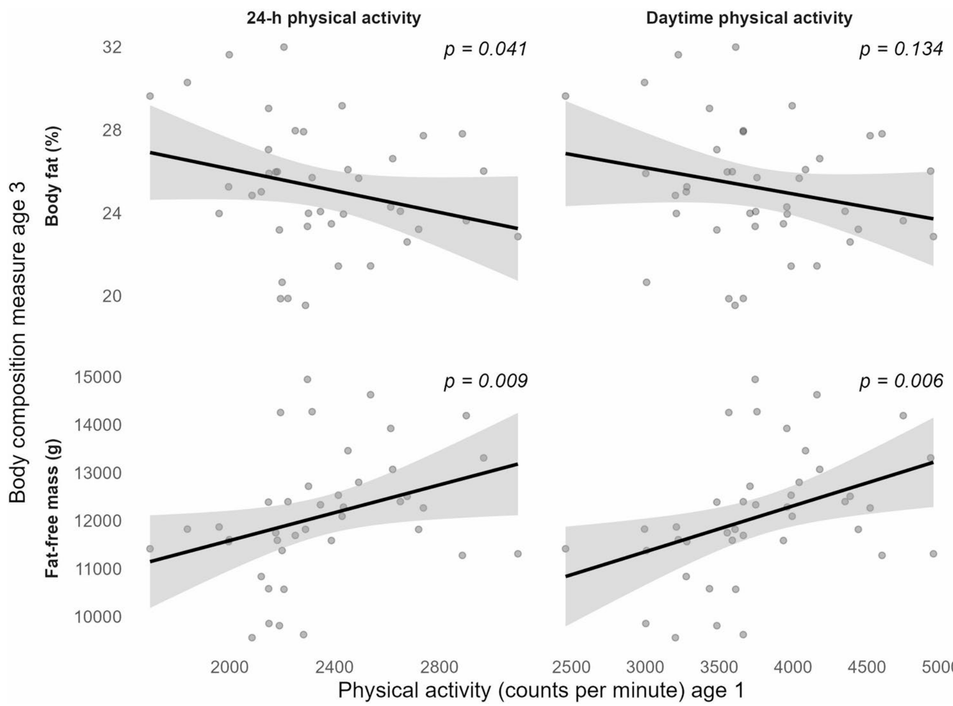

Fig. 2 Linear associations between child physical activity at one year of age and child body composition assessed with DXA at three years of age Number of participants in the analyses = 47. Daytime: the hours from 6 a.m. to 8 p.m. All analyses are adjusted for maternal education (holding a bachelor's degree or not), child sex, and walking status at age one (yes). Black lines show the estimated linear association between physical activity and body composition outcomes, with light grey shaded areas indicating 95% confidence intervals

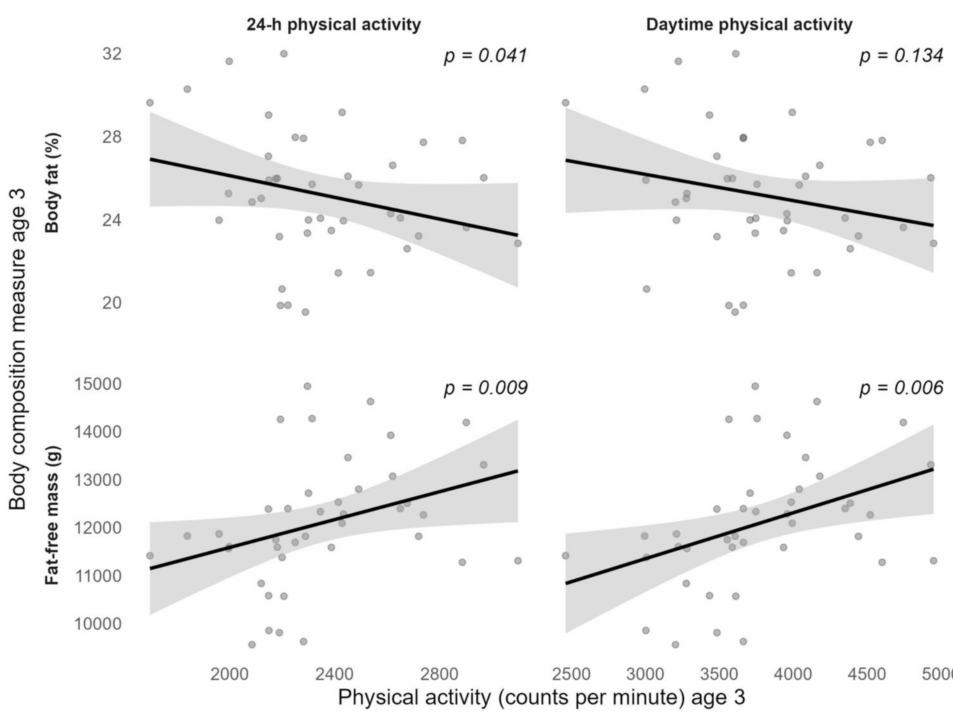

Fig. 3 Linear associations between child physical activity at three years of age and child body composition assessed with DXA at three years of age Number of participants in the analyses = 41. Daytime: the hours from 6 a.m. to 8 p.m. All analyses are adjusted for maternal education (holding a bachelor's degree or not), child sex, and child age. Black lines show the estimated linear association between physical activity and body composition outcomes, with light grey shaded areas indicating 95% confidence intervals

Table 3 Associations between maternal moderate-to-vigorous intensity physical activity during pregnancy and the children's body composition at three years of age

Maternal MVPA (min/day)	Child body fat (%) β [CI 95%]	*P*-value	Child fat-free mass (g) β [CI 95%]	*P*-value
Crude analyses				
Inclusion to birth	0.008 [-0.05;0.07]	0.792	0.953 [-21.14;23.05]	0.931
Second trimester	-0.015 [-0.09;0.06]	0.668	0.663 [-26.39;27.71]	0.961
Third trimester	0.015 [-0.03;0.06]	0.536	0.718 [-17.08;18.52]	0.936
Adjusted analyses				
Inclusion to birth	0.016 [-0.05;0.08]	0.637	-7.116 [-30.48;16.25]	0.542
Second trimester	-0.009 [-0.09;0.07]	0.821	-7.691 [-36.17;20.78]	0.589
Third trimester	0.021 [-0.03;0.07]	0.424	-5.811 [-24.58;12.96]	0.536

Linear regression models exploring the association between maternal moderate-to-vigorous intensity physical activity during pregnancy and the children's body composition at age three

All adjusted analyses are adjusted for maternal age at baseline, maternal pre-pregnancy BMI, gestational weight gain, parity (nullipara, yes/no), and maternal educational level (bachelor's degree or not) at baseline

MVPA moderate-to-vigorous intensity physical activity, *g* gram, *CI* confidence intervals

interpreted with caution, as associations may reflect limited statistical power. If the lack of association between maternal PA and child body composition is genuine, a possible explanation could be that most women in this study were enrolled late in their first trimester or early in their second trimester, a period during which many of the processes believed to contribute to intrauterine programming may already have occurred [43]. Consequently, the intervention may simply have been initiated too late to capture the full impact. In contrast to our findings, other studies have reported potential associations between maternal PA during pregnancy and offspring body composition [21, 22]. However, an important limitation of these studies is their reliance on self-reported PA during pregnancy, a method known to systematically overestimate actual activity levels because of both recall and social desirability bias [44, 45].

The association between PA at age one and FFM at age three may be clinically relevant, with children in the 90th percentile of PA at age one exhibiting 0.84 kg higher FFM at age three than those in the 10th percentile, suggesting a persistent association between early PA and body composition. Consistent with our results, other studies have reported positive associations between objectively measured PA and body composition in preschool-aged children [46, 47]. A study including 3-5-year-old children explored both the cross-sectional and longitudinal associations between PA and body composition and found a cross-sectional association between increased MVPA and a lower BF% [46]. Prospectively, over the course of a year, higher levels of MVPA were associated with an increase in FFM but not BF% [46], results that are consistent with the findings of the present study.

It is well established that PA can influence body composition by modulating energy balance and tissue development [48]. Also, the finding that activity patterns at one year of age are associated with body composition two years later highlights the potential importance of early-life PA behaviors. Specifically, the positive association with FFM, but not BF%, suggests PA may be more strongly associated with lean tissue development than FM in early childhood.

24-hour physical activity and daytime physical activity in children

PA was expressed as both 24-hour PA and daytime PA in this study to explore the potential differences in PA during the day. While examining associations between both 24-hour and daytime PA and body composition is scientifically relevant, 24-hour PA may be of limited practical value. Because daytime (6 a.m. – 8 p.m.) in our study was defined using an empirical, data-driven approach, incorporating 24-hour PA measures helps mitigate potential statistical limitations related to this definition. Assessing activity across the full 24-hour cycle provides a more comprehensive representation of children's total daily movement, including play-based or spontaneous activities that may occur outside the predefined daytime window. The modest association between 24-hour PA and BF% may reflect that this measure captures total movement across the entire day, including low-intensity nighttime activity that contributes to overall energy expenditure. However, daytime PA, characterized to a greater extent by active play and purposeful movement, may exert a stronger influence, particularly on FFM, than the sporadic, low-intensity movements that occur during nighttime. Regardless of the association between 24-hour PA and lower BF%, it is important to emphasize that interventions targeting nighttime activity are neither feasible nor advisable. Sleep, particularly in young children, is essential for healthy development, as longer and higher-quality sleep has been associated with decreased BMI and fat mass index in young children [49–51]. We did not collect data on sleep duration or quality of sleep, but future studies should focus on both daytime PA as well as sleep parameters as potential targets for early prevention of obesity.

Strengths and limitations

This study is a follow-up study that allows individual tracking of changes over time and establishes temporal relationships. A notable strength of the present study is the use of continuous objective maternal PA measurements, since shorter periods of tracking in adults might alter their behavior. Moreover, objective measures overcome the limitations of self-reported PA. Objective measures of child PA ensure high validity and reduce the risk of parental recall bias. A large knowledge of background characteristics allows for the adjustment of potential confounders. However, the lack of data on maternal BMI at the three-year follow-up and on the family's dietary habits is a limitation. We did not collect sleep diaries, and nighttime hours were defined using a statistical test, which is less precise than parent-reported data. For children's PA, shorter epochs (< 60 s) may have been better suited to capture the brief, sporadic bursts of PA typical in young children (52) only other studies in this age group reporting CPM have also used 60-second epochs, which informed our choice to ensure comparability across studies. The study is subject to attrition as only a subset of the original FitMum cohort participated in the FitKids examination, and an even smaller number of children contributed valid DXA and PA data. Although no significant baseline differences were identified between participants and non-participants, the reduced sample size limited our ability to detect such differences and introduced a risk of selection bias. The relatively high educational level and limited diversity of the remaining sample may further constrain generalizability.

Conclusion

We found that children's PA at ages one and three was associated with body composition at age three. These findings may indicate that PA in early childhood exerts both immediate and long-term effects on body composition. Our results suggest that infancy may represent an important period for establishing healthy activity patterns and suggest that promoting age-appropriate PA from the first year of life might be an effective strategy in healthy weight development. Future research on preventing childhood obesity should focus on both the perinatal period and early childhood.

Abbreviations

PA	Physical activity
BF%	Body fat percentage
FFM	Fat-free mass
MVPA	Moderate-to-vigorous intensity physical activity
DXA	Dual-energy X-ray Absorptiometry
GA	Gestational age
CPM	Counts per minute
VM	Vector magnitude
BMI	Body mass index
CI	Confidence interval
BMI Z-score	Body mass index standard deviation score

Acknowledgements

The authors would like to acknowledge and thank all the participants for signing up for the project and delivering important data. We thank MD, PhD, Tine Dalsgaard Clausen, Department of Gynecology and Obstetrics, Sjaellands University Hospital, Roskilde, Denmark, for her involvement in the clinical part of the FitMum intervention and her valuable input throughout the process.

Authors' contributions

SVG: Funding acquisition, Conceptualization, Project administration, Investigation, Methodology, Formal analysis, Visualization, Writing - Original Draft, Writing - Review & Editing. ADJ: Funding acquisition, Conceptualization, Project administration, Investigation, Methodology, Writing - Review & Editing. IKBJ: Investigation, Writing - Review & Editing. JMB: Funding acquisition, Writing - Review & Editing. SM: Funding acquisition, Writing - Review & Editing. EL: Funding acquisition, Conceptualization, Writing - Review & Editing. BS: Funding acquisition, Conceptualization, Writing - Review & Editing. KAP: Funding acquisition, Conceptualization, Methodology, Writing - Review & Editing, Supervision. LSB: Methodology, Writing - Review & Editing. GT: Funding acquisition, Conceptualization, Writing - Review & Editing.

Funding

Open access funding provided by Copenhagen University. The FitMum and FitBaby studies were supported by The Independent Research Fund Denmark [8020-00353B] and [0218-00014B], TrygFonden [128509], Copenhagen Center for Health Technology [061017], Beckett-Fonden [17–2-0883], Aase and Ejnar Danielsens Fond [10–002052], and Familien Hede Nielsens Fond [2017–1142]. Financial support was also provided by the University of Copenhagen and Copenhagen University Hospital – North Zealand, Hilleroed. The FitKids study was funded by the Novo Nordisk Foundation [NNF21OC0068834].

Data availability

The datasets generated and analyzed in the current study are not publicly available due to confidentiality, but are available from the corresponding author upon reasonable request. Individual participant data will be transferred according to the Data Protection Act, when approval from the Danish Data Protection Agency is obtained, and a Standard Contractual Clause is completed, to ensure the legal basis of the transfer.

Declarations

Ethics approval and consent to participate

Detailed oral and written information about the studies was provided, and written informed consent was obtained from all participants and for the children from their parents or guardians, respectively. The FitMum study, which included the FitBaby study, was approved by the Regional Committee on Health Research Ethics, The Capital Region of Denmark (August 30, 2018, #H-18011067) and the Danish Data Protection Agency (September 12, 2018, #P-2019-512). The study is registered at ClinicalTrials.gov; NCT03679130; 20/09/2018. The FitKids study was approved by the Regional Committee on Health Research Ethics, The Capital Region of Denmark (September 19, 2022, #H-22018855) and the Danish Data Protection Agency (August 18, 2022, #P-2022-566). The study is registered at ClinicalTrials.gov; NCT05570396; 26/09/2022. The study adheres to the principles of the Helsinki Declaration.

Consent for publication

Not Applicable.

Competing interests

The authors declare no competing interests.

Received: 6 January 2026 / Accepted: 20 April 2026
Published online: 01 May 2026

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