Physical Activity in School-Age Children Born Preterm

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Objectives To compare objectively measured physical activity in 11- and 15-year-old children who were born preterm with term-born controls and related physical activity measures to lung function measures.

Study design We used data from the Avon Longitudinal Study of Parents and Children. We compared total physical activity, moderate-to-vigorous physical activity, and sedentary behavior between children born at 25-32, 33-34, 35-36, and 37-43 weeks' gestation at ages 11 and 15 years. At age 11 years, physical activity measures were correlated with lung spirometry recorded at age 7-9 years.

Results Valid physical activity data at age 11 years were available for 5025, 197, 57, and 48 children born at 37-43, 35-36, 33-34, and 25-32 weeks' gestation, respectively. At age 15 years, valid physical activity data were available for 1829, 62, 32, and 24 children born at 37-43, 35-36, 33-34, and 25-32 weeks' gestation. Boys were more physically active than girls at both ages. There were no differences in total physical activity, moderate-to-vigorous physical activity, or sedentary behavior in children between the different gestation groups. Physical activity at age 11 years did not correlate with spirometry measures at age 7-9 years.

Conclusions Physical activity was similar for the different gestational groups and did not correlate with lung spirometry. Physical activity does not appear to be limited in preterm-born children despite lung function deficits noted in childhood. *(J Pediatr 2015;166:877-83)*.

We previously reported decreased lung function in children born preterm, including those born late preterm, by using data from a large longitudinal cohort study[1] and in a systematic review.[2] Increasing evidence suggests such decrements may lead to premature and/or accelerated decreases in pulmonary function later in life.[3-5] Increased respiratory symptoms (for example, "wheeze-ever") in preterm-born children have been reported, but it is unclear whether the decreased lung function is associated with decreased levels of physical activity. One possible reason for reduced levels of physical activity in preterm-born compared with term-born subjects could be airway obstruction and associated impaired gas exchange on exertion.

There have been few epidemiologic studies in which authors investigated the levels of objectively measured physical activity in children who were born preterm and have lung function measurements. A number of systematic reviews and meta-analyses have synthesized the literature, but most studies rely on questionnaire data to quantify activity and relate mainly to exercise capacity[6,7] or focus on those born with extremely low birth weight and who had chronic lung disease of prematurity (CLD)/bronchopulmonary dysplasia.[8] Our aim was to investigate whether children born preterm have lower levels of objectively measured physical activity compared with those born at term and whether measures of physical activity were correlated with lung function.

Methods

We used data from the Avon Longitudinal Study of Parents and Children (ALSPAC).[9] A total of 14 541 pregnant women with an expected delivery date of April 1, 1991, to December 31, 1992, were enrolled. There were 14 062 live born infants (13 988 alive at 1 year) who were subsequently followed up with questionnaires and clinical assessments. Ethical approval for the study was from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees. The study Web site contains details of all the data that is available through a fully searchable data dictionary.[10]

Children attending the ALSPAC clinics at age 11 and 15 years were invited to wear an accelerometer (MTI Actigraph; Manufacturing Technology Inc, Fort Walton Beach, Florida) for a 7-day period during waking hours. The Actigraph has been validated against criterion standards and for use in free-living

ALSPAC	Avon Longitudinal Study of Parents and Children
CLD	Chronic lung disease of prematurity
cpm	Counts per minute
FEV_1	Forced expiratory volume in 1 second
MVPA	Moderate-to-vigorous physical activity

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conditions[11]; the methods for data recording and processing are described elsewhere.[12,13] Three outcomes were used for analysis: average counts per minute (cpm) during the period of the valid recording, time (in minutes per day) spent at ≥3600 cpm (moderate-to-vigorous physical activity [MVPA]), and time (in minutes per day) spent at <200 cpm (sedentary behavior). MVPA was used to provide a measure of intensity because guidelines for levels of physical activity in children present recommendations in terms of MVPA.[14] Sedentary time was used because it is possible for an individual to spend increased amounts of time sedentary even if they meet guidelines for MVPA,[15] and because it has been independently associated with risk factors for chronic disease.[16] Because we included only participants with valid accelerometer data, we were unlikely to include children with severe cognitive or physical impairments.

All children with valid physical activity data were divided into 4 groups on the basis of gestational age: 25-32 weeks, 33-34 weeks, 35-36 weeks, and 37-43 weeks (term control). Gestational age was based on maternal reporting of the last menstrual period and pediatric assessment at birth for the majority of the cohort, with antenatal ultrasounds scans only being available in a minority of cases.[17]

Spirometry was performed at the clinic visit according to established international guidelines when the children were approximately 7-9 years of age.[18] Measurements of forced expiratory volume in 1 second (FEV_1), forced vital capacity, and forced expiratory flow at 25%-75% of forced vital capacity were converted in to z-scores adjusted for age, sex, and height.[1] "Doctor–diagnosed" asthma was reported by parental questionnaire.

Before birth the mother completed an antenatal questionnaire that asked her to record information regarding smoking habits and her greatest level of education, which was categorized into none, Certificate of Secondary Education (national school examinations at age 16) or vocational, O level (national school examinations at 16, greater level than CSE), A level (national school examinations at age 18), or university degree. Social status was based on the father's occupation. Perinatal data on respiratory management were from hospital records.

Statistical Analyses

To assess the representativeness of the data, demographic information was compared between participants who attended clinic and provided valid actigraphy data and those who did not attend via the use of χ^2 tests. This analysis was repeated with participants who attended clinic and provided valid data and those who attended but did not provide valid data. Characteristics of the gestation groups were compared using independent sample *t* tests for normally distributed data and Mann-Whitney *U* tests were used for non-normal data. Normality of physical activity data distribution was investigated using P-P plots. At age 11 and 15, both the total physical activity and MVPA had positively skewed distributions and were transformed prior to use in the analysis (natural $\log_e$ and square root, respectively). Sedentary behavior was normally distributed. Z-scores also were created to correlate the physical activity variables with lung function and to present the results graphically using scatter plots split by gestation group.

One-way ANOVA (with post-hoc multiple comparisons using Bonferroni correction) was used to investigate differences in physical activity between gestation groups. All analyses were split by sex because previous studies using this cohort have shown significant differences in physical activity between boys and girls.[19]

Results

Valid physical activity data at age 11 were available for 5327 children. A total of 5025 were term-born (≥37 weeks); 48 were born at 25-32 weeks, 57 were born at 33-34 weeks, and 197 were born at 35-36 weeks' gestation. At age 15, valid physical activity data were available for 1947 children, of which 1829 were term; 24 were born at 25-32 weeks, 32 were born at 33-34 weeks, and 62 were born at 35-36 weeks gestational age (**Table I**). The maximum duration of ventilation during the perinatal period for children with valid accelerometer data was 624 hours (approximately 26 days); of those children admitted to the neonatal unit, few received supplemental oxygen for 5 days or more. There were no differences between groups in those reporting doctor diagnosed asthma at age 7.

Children who provided valid accelerometry data were more likely to be girls, white, have nonsmoking mothers with a greater level of education, and be of greater socioeconomic status when compared with children who did not attend the clinic (**Table II**). A similar pattern was seen in comparison with children who took part in activity monitoring but failed to provide valid data (no differences in sex and ethnicity, data not shown). These results are consistent with previous findings in this cohort[19] and were similar at age 15.

In all gestation groups, females were more sedentary and were significantly less active than males. The median levels of MVPA were substantially lower than the recommended levels of 60 minutes per day (preterm females 16.2, males 26.6 $min \cdot d^{-1}$; term females 15.6, males 25.5 $min \cdot d^{-1}$). There was no strong evidence of differences in total physical activity, MVPA, or sedentary behavior between children born preterm and those born at term at age 11 years (**Figure** and **Table III**). When lung function measures were plotted against values of physical activity, there were no significant correlations; the best model fit was between total physical activity and FEV_1 in the 25-32 gestation group ($R^2 = 0.1$), but numbers in the subgroup were small (38 individuals with both measurements). At 15 years of age, levels of MVPA were similar to those at age 11 (preterm females 15.4, males 25.2 $min \cdot d^{-1}$; term females 14.7, males 26.0 $min \cdot d^{-1}$), although total physical activity was significantly reduced and sedentary