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Review

Physical activity outcomes following preterm birth

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EDUCATIONAL AIMS

The reader will be able to:

- Discuss that few studies in preterm-born children are specifically focused on physical activity (PA); questionnaire-based data contribute more to the evidence base than do objective measures such as accelerometry.
- Appreciate that determinates of PA in preterm born children are multifactorial; most evidence of reduced PA in those born preterm starts to emerge during adolescence whereas the ability to perform tests of strength, endurance and coordination appears to be reduced from early childhood.
- Discuss that detraining of the cardiorespiratory system as a result of reduced PA during the transition to adulthood may explain the decrements in exercise capacity in preterm-born young adults.

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SUMMARY

Physical activity (PA) is an important mediator of health and disease. Many correlates may play an important role in explaining differences in PA between populations; however, the role of birth outcomes such as prematurity on levels of PA is relatively poorly represented in the literature. Children born preterm may be at risk for reduced levels of PA as they have increased respiratory symptoms as well as decrements in lung function and exercise capacity. Emerging evidence suggests that the effects are prevalent across the whole range of gestational age. This review summarises the current literature in regards to levels of PA in preterm-born children and also explores PA in cohorts of young adults in order to contextualise the possible impact on long term risks to respiratory health.

INTRODUCTION

Preterm birth

Preterm birth, defined by the World Health Organisation as birth occurring at less than 37 weeks of completed gestation, has a major impact on health service usage worldwide; in the UK, this represents approximately 7-8% of all live births. Survival of those born ≤32 weeks' gestation ('very preterm') has improved significantly over the last 20 years but the overall rates of preterm birth are rising worldwide [1] especially in the 'late preterm' group (34-36 weeks' gestation) [2]. The extent of the impact of preterm birth in childhood has been mostly described in the very preterm and 'extremely preterm' groups (<28 weeks' gestation) [3] as they are most likely to require significant neonatal care following birth, perhaps for weeks or months as a result of interruption to the normal development of the respiratory and other systems. However, it is increasingly recognised that birth occurring at 33-36 weeks' gestation [4], and indeed 37-38 weeks' gestation [5] also carries increased risk of respiratory morbidity in childhood in an inversely dose-dependent manor as postnatal lung development may still be relatively immature [6].

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Physical activity

Caspersen describes physical activity (PA) as "any bodily movement produced by skeletal muscle that results in energy expenditure" [7]. Participation in PA is a lifestyle choice which has been shown to be protective against development of major chronic diseases [8]. Thus, promotion of adequate levels of PA therefore forms an increasingly important part of the international public health agenda [9]. Few children, however, achieve the recommended levels of 60 minutes each day of moderate-to-vigorous physical activity (MVPA) [10] and are spending increasing amounts of time in sedentary behaviour (SED) [11] Levels of PA are highest in early school age and decline over time, especially during adolescence [12–14], the decline being especially pronounced in females. Low levels of activity in children have frequently been associated with future health risks, including obesity and cardiovascular disease [15,16].

Primary studies directly measuring PA in preterm-born children are relatively few, rather these data are often discussed as add-on elements to investigations of lung function, exercise capacity, neuromotor development, or a combination of these elements. Furthermore, most studies rely on subjective questionnaire data to quantify activity, whereas some secondary analyses of epidemiological data from longitudinal cohort studies have utilised objectively measured habitual PA from accelerometer recordings. One complication in comparing results is that some studies report associations based on birthweight rather than gestational age. Since such studies often include large numbers of preterm-born participants, all are included here for completeness.

Physical activity in childhood following preterm birth (≤18 years)

In the youngest cohort of unimpaired preterm-born 5-7 year olds with and without Chronic Lung Disease of Prematurity (CLD, also called bronchopulmonary dysplasia, BPD), habitual PA, expressed in hours per week, has been reported using a questionnaire comparing results to matched term controls [17]. Lung function and exercise capacity were assessed as the primary endpoints of the study. The authors did not find statistically significant differences in PA between the three groups under study despite preterm-born children having reduced lung function (worse still in the CLD group) and higher degrees of reported exercise-induced bronchoconstriction when compared to the term controls. Although there was no difference in maximal uptake of oxygen or exercise capacity, the oxygen cost of maximal power output was higher in the preterm-born children with CLD. These children also had increased respiratory rate, lower tidal volumes but similar minute ventilation compared to those without history of CLD and controls. Together these findings indicated that there may be a higher metabolic cost of exercise which may limit participation in prolonged activities. A further study using the same cohort examined anaerobic performance in children born with low birthweight, all of whom were born preterm (<32 weeks' gestation) [18]. Habitual PA was quantified using a self-administered questionnaire, although the focus of the study was on impaired anaerobic muscle performance which was noted to be reduced in extremely low birthweight (ELBW, <1000 g) when compared to very low birthweight (VLBW, 1000-1500 g) and normal birthweight (>2500 g). The authors suggested that reduced levels of PA could be a contributing factor in the reduction of muscle performance, perhaps due to impaired exercise capacity and thus increased amount of time spent sedentary. However, they did not observe differences in levels of PA between the different birthweight groups and presented very limited data on the results - only indicating the proportion of children undertaking recreational activities in addition to normal physical education classes.

In a further study, focusing on neurological outcomes, Wolcadlo investigated levels of PA in preterm-born 8 year old children both with and without Developmental Coordination Disorder (DCD) [19]. The primary aim of the study was to assess motor impairment and learning ability since other studies show deficits in ELBW and VLBW children. Measurement of PA was taken from verbal reports by the child and their parent of participation in after school sporting activities. Children with DCD scores of below the 15th centile were more likely to be motor impaired, have lower intellectual performance and participated in less sporting activity. The authors suggest that withdrawing from participation due to movement difficulties, or through exclusion by peers may explain the difference in activity levels.

Svien et al investigated the 'health-related fitness' of a group of moderately preterm-born children (excluding those with history of CLD or other complications of preterm birth) and well-matched controls at approximately 9 years of age [20]. PA data were captured using a questionnaire completed by the child and by their parents. The preterm group demonstrated deficits in muscle strength, endurance and coordination. However, no evidence of differences in cardiorespiratory endurance or in measures of PA (frequency of exercise or frequency of sports team participation in the past 7 days) were reported between those born preterm and those born at term. Of interest, a difference was noted in percentage body fat despite the groups being of similar weight, suggesting that the term controls had higher muscle mass contributing to higher cardiovascular endurance. There is a lack of detailed research relating to body composition in preterm-born children and results of available studies are conflicting. The study by Bott et al reported that 4-8 year old children with CLD were smaller and leaner than healthy controls [21]. Vardar-Yagli et al. compared a slightly older group of preterm-born children with CLD with term controls and reported fat-free mass was significantly lower in CLD children which correlated with reduced distance covered on a six-minute walk test [22]. In contrast, other studies have reported that fat mass adjusted for height is lower in preterm-born children at 8-12 years of age when compared to term-born children but fat-free mass adjusted for height does not show the same association [23].

Focusing on exercise capacity, Joshi et al recently noted that preterm-born children with a history of CLD reported less time spent on PA when compared to preterm-born children without CLD and those born at term. The study team demonstrated exercise-induced bronchoconstriction, manifested as reduced forced expiratory volume in one second (FEV_1), in preterm-born children with and without CLD after formal exercise [24]. This was reversible following administration of salbutamol in the CLD group. The study also showed that at peak exercise, preterm born children have different breathing patterns, using increased ventilatory reserve to maintain similar oxygen uptake at maximal or peak exercise ($V?O_2$) as term-born children. Investigators from the EPICure study focussed on extremely preterm birth (<25 completed weeks' of gestation) and associations with exercise capacity and PA using data from a national cohort of children at age 11 years [25]. In contrast to studies relying on questionnaire responses, a strength of this study was the use of accelerometers to collect objective measurements of PA. Exercise capacity, assessed using cycle ergometer, and spirometry were also performed. Extremely preterm-born children were noted to have reduced peak V?O2, tidal volume, minute ventilation and used more of their ventilatory reserve. Despite these differences, there was only a weak correlation between peak V?O2 and accelerometer counts (total activity or MVPA). Interestingly, those born extremely preterm did perceive themselves as having inferior exercise capability and reported increased difficulty in breathing during exercise when compared to term-born peers.