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Original research

30-year changes in Australian children's standing broad jump: 1985–2015

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ABSTRACT

Objectives: Muscular strength is an important component of fitness that enables the execution of a range of daily activities across the lifespan including sport participation. The purpose of this study was to examine changes in children's standing broad jump, an indicator of muscular strength, between 1985 and 2015.
Design: Two representative cross-sectional population surveys of Australian children age 9–15 years (n = 7051).
Methods: In 1985 and 2015 children's standing broad jump (SBJ; cm) and anthropometry were measured by trained field teams. General linear regression examined the temporal change in SBJ by sex and age adjusting for height, weight, socioeconomic status, and linguistic background.
Results: Over a 30-year period, the height, weight, and BMI of children significantly increased and muscular strength decreased. Among boys, the adjusted SBJ distance declined −4.5 cms (95%CI −8.8, −0.10) in 9–11 year olds and 7.6 cms (95%CI −12.5, −2.7) in 12–15 year olds. Among girls, the adjusted SBJ distance declined 8.5 cms (95%CI −12.9, −4.2) in 9–11 year olds and 9.3 cms (95%CI −14.1, −4.6) in 12–15 year olds. Larger declines in the distance jumped were observed among children and adolescents from non-English speaking backgrounds, than English speaking peers and children from low socioeconomic neighbourhoods than the declines among children from high SES neighbourhoods.
Conclusions: Overall, the distance children and adolescents jumped in 2015 was lower than the distance their peers jumped in 1985. The declines differed by sex and sociodemographic characteristics, which suggests targeted sub-population interventions to improve children's muscular strength should be considered.

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1. Introduction

Muscular strength is an important component of physical fitness that enables the execution of a range of daily activities, including sport participation across the lifespan.[1] Muscular strength refers to the amount of force a muscle can produce with a single maximal effort and may be measured using three dimensions; isometric (static), explosive, and dynamic (functional) strength.

Several reviews have examined health outcomes associated with muscular strength and indicate that low muscular strength in children and adolescents is associated with poorer cardiovascular disease, metabolic profiles, skeletal health,[2,3] adiposity, and self-esteem.[3] Other research has shown high levels of muscular strength in adolescents is associated with healthier lipid-metabolic profiles independent of cardiorespiratory fitness,[4,5] suggesting that muscle strength may be an independent protective factor in the development of cardiovascular disease risk in childhood.[6]

Collectively, the evidence indicates muscular strength is an important marker of health. In children, muscular strength is associated with mass and maturation but is also modulated by genetic factors and will vary overtime according to changes in individual's habitual physical activity.[1] Physical activity and weight training are two important factors associated with muscular strength and these behaviours may be influenced by lifestyle and environmental factors.[7] The importance of muscular strength is recognised in the global physical activity guidelines for children which recommends children age 5–17 years include muscle and bone strengthening physical activities at least three times a week, in addition to

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accumulating at least 60-min of moderate-to-vigorous physical activity.[8]

Lower body muscular strength can be evaluated by several tests including vertical jump, squat jump, standing broad jump and countermovement jump. Of the available muscular strength tests, the standing broad jump (SBJ) is strongly associated with other tests of upper and lower muscular strength and is considered a reliable, practical, time-efficient, low cost and low participant burden measure that provides a general index of muscular strength in youth.[9,10]

Temporal changes in the SBJ among children have been explored, but not extensively and the findings are mixed and dated. Two studies have shown significant declines in the SBJ: (1) New Zealand boys age 10–14 years jumped 6.2 cm less and girls 2.6 cm less in 2003 than their 1991 counterparts, although the decline was only significant for boys; and (2) decreases in the SBJ among Spanish adolescents age 12–18 years was reported between 2000/1 and 2006/7.[11] A study of Finnish 13–16 year olds reported there was no change in performance in the standing broad jump over time in boys and only a slight positive trend in girls.[12] Similarly, there was little change in the distance jumped among Lithuanian adolescents' age 12–16 years between 1992 and 2002,[13] but between 2002 and 2012 significant declines were observed among boys, with no change among girls.[14] A British study of 10 year old children showed there was a significant 6% mean increase in SBJ distance between 1998 and 2008.[15] A meta-analysis of SBJ and vertical jump (Sargent's jump) between 1958–2003 showed there were improvements in muscular strength until the 1980s followed by declines, and the declines differed across global geographical regions.[7] The purpose of this study is to build on the limited evidence by using population health data from Australia to examine changes in youth's muscular strength measured by the SBJ and anthropometry between 1985 and 2015.

2. Methods

Two cross-sectional population health surveys of children and adolescents living in New South Wales (NSW; 2015 pop 7.6mil) Australia conducted in 1985 and 2015 were analyzed to examine change in SBJ distance. Briefly, the surveys are designed to be representative of school age children in terms of type of school, residence and socioeconomic status. The 1985 data originated from the Australian Health and Fitness Survey[16]; a national survey of children age 8–15 years (n = 8484), in 104 elementary and high schools randomly selected from each education sector, stratified by state, and students were selected at random within schools. The survey was conducted between May–October. NSW data were extracted and comprised 2955 students from 37 elementary and high schools The 2015 data are from the NSW Schools Physical Activity and Nutrition Survey, a representative population survey of NSW children age 4–18 years (n = 7557), in elementary and high schools (n = 84), conducted between February and March.[17]

The sample size for 1985 was based on detecting a 5% group difference with 90% power and alpha at 0.05. For 2015, the sample size was based on a 10% group difference with 80% power and alpha level of 0.05. Both surveys were school-based and used comparable sampling frames that were based on a two-stage probability sample (school and student). The sampling frame comprised all NSW schools with the exception of special education schools (e.g., blind, sport) and schools with few enrolments (i.e., <180 students). Schools were sampled from each education sector (government, independent, Catholic) proportional to enrolment in that sector, and then all students from randomly selected classes in each target grade were invited to participate. Data were collected by trained field teams. Written consent from each child's parent/carer was a requirement for participation. Ethics approvals were granted by the University of Sydney Human Research Ethics Committee (HREC 2014/587), the NSW Department of Education and Communities (SERAP 2014188), and each participating Catholic Diocese.

The data collection protocols were identical in 1985 and 2015.[16,17] For the SBJ children were assessed individually on a hard surface with a marked starting line. Children were asked to stand with toes behind the line with feet slightly apart and instructed to jump as far as they could using two feet to take-off and land. Children were allowed two trials with the longest distance (cm) measured from the line to the back of the closest heel recorded. Sociodemographic information included sex, date of birth, language spoken most often at home, and postcode of residence. Postcode of residence was used as proxy measure of socioeconomic status (SES) using the Australian Bureau of Statistics' Socioeconomic Index for Areas (SEIFA) Index of Relative Socioeconomic Disadvantage.[18] SEIFA scores from the 1986 and 2011 census data were used to rank students in 1985 and 2015, respectively, into low, middle, and high SES neighbourhood areas. Language spoken most often at home was used to categorise student's linguistic background as English speaking or non-English speaking.[19] Height (cm) and weight (kg) were considered potential confounders and were measured during the school visit by trained staff using standard procedures to the nearest 0.1 cm and 0.1 kg, respectively.[20] Body mass index was calculated as kg/m^2.

Data were analysed in February 2018 using Complex Samples SPSS (version 24 for Windows; IBM, Chicago, IL, USA) to account for the cluster design of the surveys (school sector and school). Differences in the socio-demographic distribution between the two surveys were examined using linear regression for continuous variables or chi-square tests for proportions, as appropriate. The mean (±SE) difference and associated 95% confidence intervals of anthropometric measures and SBJ were first tabulated and stratified by sex and age to account for difference in children's growth and development. Sex-specific general linear regression models were then used to examine absolute changes in SBJ distance jumped (cm) between 1985 and 2015 after accounting for the changes in weight, height, age, SES tertile and linguistic background. Finally, we stratified the sample into children (9–11 years old) and adolescents (12–15 year olds) and examined the change in SBJ distance jumped by SES tertile and linguistic background using general linear models controlling for height, weight, age, and mutually adjusting for the other sociodemographic variable.

Table 1
Characteristics of the sample by survey year (%, SE).

Characteristic	1985	2015	P-value
Survey response rate (%)	68	63	
N	2257	4794	
Girls (%)	49.2 (2.8)	50.4 (2.4)	0.17
Age (%)			
9 years	14.1 (2.3)	22.7 (2.6)	
10 years	16.4 (2.7)	6.5 (1.0)	
11 years	15.6 (2.5)	21.7 (2.5)	
12 years	14.8 (1.1)	5.9 (0.8)	0.211
13 years	13.3 (2.2)	20.5 (2.6)	
14 years	13.3 (2.3)	5.6 (0.9)	
15 years	12.6 (2.3)	17.2 (2.2)	
Socioeconomic status (%)			
Low	30.6 (6.6)	26.2 (3.9)	
Middle	36.7 (7.0)	35.0 (4.4)	**<0.001**
High	32.7 (7.0)	38.9 (5.0)	
Language background (%)			
English speaking	91.5 (1.8)	87.9 (1.8)	**<0.001**

Bold values are significant.

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