Research in Developmental Disabilities 53-54 (2016) 107–114

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Developmental and physical-fitness associations with gross motor coordination problems in Peruvian children

Raquel Nichele de Chaves [a,*], Alcibíades Bustamante Valdívia [b], Alan Nevill [c], Duarte Freitas [d], Go Tani [e], Peter T. Katzmarzyk [f], José António Ribeiro Maia [g]

[a] Department of Physical Education, Federal University of Technology – Parana, Av. Sete de Setembro, 3165, 80230901 Curitiba, PR, Brazil
[b] National University of Education Enrique Guzmán y Valle, Enrique Guzmán y Valle S/N, La Cantuta, Chosica, Lima, Peru
[c] Faculty of Education, Health and Wellbeing, University of Wolverhampton, WS1 3BD, United Kingdom
[d] Department of Physical Education and Sports, University of Madeira, Praça do Município, 9000-082 Funchal, Portugal
[e] School of Physical Education and Sport, University of São Paulo, Av. Professor Melo Morais, 65, Cidade Universitária, 05508-030 São Paulo, Brazil
[f] Pennington Biomedical Research Center, Louisiana State University, 6400 Perkins Rd, Baton Rouge, LA 70808, USA
[g] CIFI²D, Faculty of Sport, University of Porto, Rua Dr. Plácido Costa, 91, 4200-450 Porto, Portugal

ARTICLE INFO

Article history:
Received 11 April 2015
Received in revised form 5 January 2016
Accepted 6 January 2016
Available online 10 February 2016

Keywords:
Gross motor coordination
Poor motor proficiency
Physical fitness
Children

ABSTRACT

The aims of this cross-sectional study were to examine the developmental characteristics (biological maturation and body size) associated with gross motor coordination problems in 5193 Peruvian children (2787 girls) aged 6–14 years from different geographical locations, and to investigate how the probability that children suffer with gross motor coordination problems varies with physical fitness. Children with gross motor coordination problems were more likely to have lower flexibility and explosive strength levels, having adjusted for age, sex, maturation and study site. Older children were more likely to suffer from gross motor coordination problems, as were those with greater body mass index. However, more mature children were less likely to have gross motor coordination problems, although children who live at sea level or at high altitude were more likely to suffer from gross motor coordination problems than children living in the jungle. Our results provide evidence that children and adolescents with lower physical fitness are more likely to have gross motor coordination difficulties. The identification of youths with gross motor coordination problems and providing them with effective intervention programs is an important priority in order to overcome such developmental problems, and help to improve their general health status.

1. Introduction

There is a renewed research interest concerning the motor coordination of school-aged children (Largo, Fischer, & Rousson, 2003; Rivilis et al., 2011) given its potential influence on a variety of outcomes. For example, children with poor motor coordination have been shown to have significant impairments in their daily tasks, from self-care and school-based

* Corresponding author.
E-mail addresses: raquelchaves@utfpr.edu.br (R.N. Chaves), huanta2609@yahoo.es (A. Bustamante Valdívia), a.m.nevill@wlv.ac.uk (A. Nevill), dfreitas@uma.pt (D. Freitas), gotani@usp.br (G. Tani), Peter.Katzmarzyk@pbrc.edu (P.T. Katzmarzyk), jmaia@fade.up.pt (J.A.R. Maia).

http://dx.doi.org/10.1016/j.ridd.2016.01.003
0891-4222/

activities to emotional and social interactions within typically developing groups (Emck, Bosscher, Beek, & Doreleijers, 2009; Vandorpe et al., 2011). Furthermore, these children seem to be at increased risk of developing obesity and associated co-morbidities due to their lower physical fitness (PF) levels, decreased participation in physical activities, and higher body fatness than their peers (Lubans, Morgan, Cliff, Barnett, & Okely, 2010; Rivilis et al., 2011).

Gross motor coordination (GMC) is a complex trait that integrates internal neurological and neuro-motor processes (Keogh & Sugden, 1985), and its manifold expression is generally explained in terms of additive genetic effects as well as their interaction with environmental factors (Bouchard, Malina, & Pérusse, 1997; Chaves, Tani, Souza, Santos, & Maia, 2012; Malina, Bouchard, & Bar-Or, 2004). Additionally, the developmental process of GMC is dependent upon neuromuscular maturation, prior and current motor opportunities, as well as physical growth and biological maturation, which influence and mediate a variety of movement experiences (Bouchard et al., 1997; Malina et al., 2004).

With increasing age, a gradual and steady increase in motor coordination is expected, particularly among elementary school children (Antunes et al., 2015; Chaves, Tani, Souza, Baxter-Jones, & Maia, 2013; Valdívia et al., 2008; Vandorpe et al., 2011). Yet, it is important to consider the effects of possible correlates/confounding variables associated with such increases in order to better understand their influence, confounders that previous studies might have ignored. For example, in a recent cross-sectional study, Chaves et al. (2015) showed that age effects in GMC are confounded by children's physical fitness levels as well as by their levels of body fat. Moreover, biological maturation may also play an important role in GMC development because differences in the timing and tempo in the pubertal growth spurt may induce additional difficulties in children who already have poor motor performance (Visser, Geuze, & Kalverboer, 1998). It is also important to recognize that the available GMC research mostly used raw performance data, i.e., apparently no reports consider age differences in children with coordination problems as they grow. As children mature, they face increasing challenges in the complexity of motor tasks/tests (Fliers et al., 2008), and those children with motor coordination difficulties may develop further motor performance deficiencies with increasing age. Additionally, changes in body dimensions during puberty (Visser et al., 1998) as well as low physical fitness levels and inactivity may increase the likelihood of GMC problems (Cattuzzo et al., 2014), and it is thus possible that more mature youths may be more prone to having GMC problems.

Differences in motor proficiency between boys and girls have been reported not only in cross-sectional but also in longitudinal studies (Graf et al., 2004; Willimczik, 1980), suggesting that boys are more coordinated. These sex trends in motor proficiency are expected, and are usually explained in terms of differences in body growth and biological maturation (Malina et al., 2004). Additionally, GMC differences within and between sexes might also be explained by the differential expression of their PF characteristics (Vandorpe et al., 2011) because it has been suggested that cardiorespiratory fitness, power, muscle strength and endurance are positively associated with motor proficiency (Cattuzzo et al., 2014; Rivilis et al., 2011). Yet, the interpretation of the relationship between GMC, biological maturation and PF components is not a simple task, requiring the testing of sequential/alternative hypotheses using age, sex, physical growth and biological maturation as suitable predictors (Bouchard et al., 1997).

The effects of altitude on morphological and physiological traits affecting motor performance in Andean populations have been considered in previous studies (Greksa, 2006; Mueller, Schull, Schull, Soto, & Rothhammer, 1978; Valdivia, Maia, & Nevill, 2014). The results suggest that differences in geography play an important role in GMC. In Peru, three natural areas are identified: (i) the coast or coastal desert that occupies 11.7% of the total area, located between the western mountain and the Pacific Ocean, with a subtropical desert climate; (ii) the Saw or Andean region comprising 28% of the total Peruvian area, located in the central part of the Andes mountains, with high mountain and mountain climate; (iii) and the jungle or Amazon region being the largest of the Peruvian territory, i.e., approximately 60.3%, with warm and rainy tropical climate. Differences in physical activity levels marked by daily chores and subsistence activities are evident, as well as in cardiorespiratory fitness and muscular strength in children and adolescents residing at high altitude, sea level and rainforest (Valdivia et al., 2014). This may also affect GMC levels and may shed light in the interpretation of GMC differences. Thus, the purpose of the current study was to identify the developmental characteristics associated with GMC in Peruvian children, namely biological maturation and body size. A further aim was to investigate how the probability or odds that children suffer from GMC difficulties is related to PF components having controlled for the developmental characteristics (body size and biological maturation) already identified in children. This paper will address the following hypotheses: (1) boys and older children are less likely to have GMC problems than girls; (2) more mature children and those with higher BMI are more likely to have GMC problems, as well as children who live in the sea level region; (3) those more physically fit are more likely to have higher GMC.

2. Methods

2.1. Participants

The present cross-sectional sample (see Table 1) comes from the Healthy and Optimistic Growth Study conducted in Peru which investigates growth, development and health of children, adolescents and their families. A sample of 5193 adolescents (2787 girls) aged 6–14 years was obtained from 18 random public schools belonging to 4 cities located in the three natural regions of central Peru: in the coast, Barranco (58 m), which forms part of the province of Lima; in the Saw, Junín district (4107 m), in the province of the same name, and in the jungle, the districts of La Merced and San Ramon (751 m) that have a geographical continuity and integrate the Chanchamayo province. Within each school all children were invited to