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A favorable built environment is associated with better physical fitness in European adolescents

Jérémy Vanhelst [a,b,*], Laurent Béghin [a,b], Julia Salleron [c], Jonatan R. Ruiz [d,e], Francisco B. Ortega [d,f], Ilse De Bourdeaudhuij [g], Dénes Molnar [h], Yannis Manios [i], Kurt Widhalm [j], Germán Vicente-Rodriguez [k], Beatrice Mauro [l], Luis A. Moreno [k], Michael Sjöström [d], Manuel J. Castillo [f], Frédéric Gottrand [a], on behalf of the HELENA study group

[a] INSERM U995, University Lille Nord de France, Lille, France
[b] CIC-PT-9301-INSERM-CH&U, University Hospital, Lille, France
[c] Department of Biostatistic, University Lille Nord de France, Lille, France
[d] Unit for Preventive Nutrition, Department of Biosciences and Nutrition, Karolinska Institutet, Huddinge, Sweden
[e] Department of Physical Education and Sport, School of Sport Sciences, Granada University, Granada, Spain
[f] Department of Medical Physiology, School of Medicine, Granada University, Granada, Spain
[g] Department of Movement and Sport Sciences, Ghent University, Ghent, Belgium
[h] Department of Pediatrics, Pécs University, Pécs, Hungary
[i] Department of Nutrition and Dietetics, Harokopio University, Athens, Greece
[j] Department of Pediatrics, School of Medicine, Vienna University, Vienna, Austria
[k] GENUD (Growth, Exercise, Nutrition and Development) Research Group, Facultad de Ciencias de la Salud, Zaragoza University, Zaragoza, Spain
[l] National Research Institute for Food and Nutrition, Rome, Italy

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ABSTRACT

Objective. To assess the association between the built environment and physical fitness and physical activity in adolescents.

Methods. The study included 3528 adolescents, aged 12.5–17.5 years, who participated in the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study. The health-related physical fitness components were assessed using the physical fitness tests. Participants wore a uniaxial accelerometer (ActiGraph®) for 7 days to measure physical activity. A specific questionnaire addressing the built environment was used. Potential confounding factors including age, gender, body mass index, body composition, pubertal status, smoking, educational level of parents, and socioeconomic status were analyzed using backward stepwise linear regression analysis.

Results. Heavy traffic in the neighborhood was the strongest factor negatively associated with both physical fitness and physical activity (both $P < 0.05$). Conversely, a secure bicycling or walking route from home to school was positively associated with various components of physical fitness and physical activity ($P < 0.01$). Outdoor fields and gymnasiums near home were also associated with better physical fitness ($P < 0.01$), but not with physical activity.

Conclusions. A favorable built environment may contribute to health-related physical fitness and physical activity of adolescents and should be considered in future interventions and health promotion strategies.

Introduction

Physical fitness and physical activity are important determinants of health in children and adolescents. These determinants are influenced by individual, interpersonal, social, and environmental factors. Parental influence is positively associated with adolescent physical fitness (Cleland et al., 2005; Martín-Matillas et al., 2012). Low levels of moderate and vigorous physical activity are associated with overweight and obesity in adolescence (Ruiz et al., 2011; Valery et al., 2012). Social context and parental education level also influence physical activity level and aerobic fitness in youth (Beets et al., 2006; Duncan et al., 2005; Machado-Rodriges et al., 2011; Riddoch et al., 2007; Salvy et al., 2008).

Several studies have found positive associations between active modes of traveling from home to school and aerobic fitness (Andersen et al., 2011; Cooper et al., 2006, 2008; Voss and Sandercock, 2010). However, only one study investigated the relationship between built environment and physical fitness in adolescents aged 14–16 years (Cheah

* Corresponding author at: Antenne pédiatrique du CIC, Hôpital Jeanne de Flandre, CHRU de Lille, Avenue Eugène Avinée, 59000 Lille Cedex, France. Fax: +33 3 20 44 66 87.
E-mail address: jeremy.vanhelst@chru-lille.fr (J. Vanhelst).

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et al., 2012). In this study the relationship between perceived built environment attributes and aerobic fitness in adolescents aged 14–16 years was assessed (Cheah et al., 2012). Authors used a modified questionnaire adapted from the Neighborhood Environment Walkability Scale—Youth (NEWS-Y) including 9 sections on the neighborhood (safety route and crime, access to services …); the authors found no significant influence of neighborhood factors on aerobic fitness, except for infrastructure (Cheah et al., 2012). The main limitation of this study was that only one component of physical fitness was assessed. To the best of our knowledge, there is no study examining the relationship between built environment and different aspects of health-related physical fitness including muscular strength, flexibility, and speed/agility.

In contrast, several studies assessed the relationship between built environment factors and physical activity in youth (Cohen et al., 2006; De Meester et al., 2012; Dowda et al., 2007; Grow et al., 2008; Hume et al., 2009; Larsen et al., 2009; Rodríguez et al., 2012; Scott et al., 2007). Having public parks or physical activity facilities near home was associated positively to time spent in moderate to vigorous physical activity (Cohen et al., 2006; Dowda et al., 2007; Grow et al., 2008; Rodríguez et al., 2012; Scott et al., 2007). The street design (pedestrian safe route), high diversity of land uses and a short distance from home to school were also associated positively with more walking and biking to school (Hume et al., 2009; Larsen et al., 2009). Interestingly the majority of research has been performed in North America, while very few data are available in European countries. Only one study was performed in a European country (Belgium) showing that neighborhood walkability was related to higher accelerometer-based physical activity in adolescents living in a neighborhood with a low socioeconomic status (De Meester et al., 2012).

The aim of this study was to assess the effects of the built environment on different components of health-related physical fitness and on objectively measured physical activity in European adolescents.

Methods

Study design

The current report is based on data from the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study. The aim of the HELENA study was to obtain a broad range of standardized, reliable, and comparable nutrition- and health-related data from a random sample of European adolescents aged 12.5–17.5 years. Data were collected in 2006 and 2007 in 10 European cities: Vienna (Austria), Ghent (Belgium), Lille (France), Athens (Greece), Heraklion (Greece), Pecs (Hungary), Rome (Italy), Dortmund (Germany), Zaragoza (Spain), and Stockholm (Sweden). In total, 3528 adolescents (1844 girls and 1684 boys) meeting the inclusion criteria completed all examinations. A detailed description of the HELENA study methodology and sampling has been published elsewhere (Béghin et al., 2012; Moreno et al., 2008a, 2008b).

The aims and objectives were explained carefully to each adolescent and to parents. Written, informed consent was obtained from the adolescent and the parents. The HELENA study was approved by the local ethics committee for each country, and all procedures were performed in accordance with the ethical standards of the Helsinki Declaration of 1975 as revised in 2008 and the European Good Clinical Practices (Béghin et al., 2008).

Measurements

Participants' characteristics

As detailed elsewhere, age, height, and weight were measured, and body mass index (BMI) was calculated (De Cocker et al., 2011). The nutritional status was assessed by the International Obesity Task Force scale (Cole et al., 2000). Body composition (fat mass and fat-free mass) was assessed using the bioelectrical impedance method (BodyGram V. 1.31, Akern, Bioresearch, Florence, Italy) as described previously (Vicente-Rodríguez et al., 2012). Pubertal status was assessed by a physician through direct observation according to Tanner and Whitehouse (1976). Parental educational level (PEL) was classified into one of four categories using a specific questionnaire adapted from the International Standard Classification of Education (ISCED) (http://www.uis.unesco.org/Library/Documents/isced97-en.pdf). PEL was scored as 1, primary education (levels 0 and 1 in the ISCED classification); 2, lower secondary (level 2 in the ISCED classification); 3, higher secondary (levels 3 and 4 in the ISCED classification); and 4, tertiary (levels 5 and 6 in the ISCED classification).

Socioeconomic status was assessed according to the International Standard Classification of Occupation (ISCO: http://unstats.un.org/unsd/class/family/family2.asp?Cl=224). The ISCO categories of 1 (highest level) to 9 (lowest level) were scored as high (ISCO categories 1 and 2), medium (ISCO categories 3–5), and low (ISCO categories 6–9).

Smoking habit was assessed by a self-reported questionnaire filled up by the adolescent who was informed that the information will be used anonymously, and was categorized in four groups: every day (1); at least once a week, but not every day (2); less than once a week (3); and do not smoke (4).

Physical fitness

The health-related physical fitness components were assessed by the physical fitness tests modified from the Eurofit and FitnessGram battery. This battery of tests assesses cardiorespiratory fitness, muscular strength (upper and lower limbs), flexibility, and speed/agility. All tests were performed twice, and the best score was recorded except for the cardiorespiratory fitness and the bent arm hang tests, which were performed only once each. Good reliability in young people has been reported for all tests used in the study (Ortega et al., 2008).

Cardiorespiratory fitness. 20-m shuttle run test assesses the cardiorespiratory fitness. The adolescents performed the test as described earlier (Leger et al., 1988). Participants are required to run between two lines 20 m apart, while keeping pace with audio signals emitted from a pre-recorded CD. The initial speed is 8.5 $km \cdot h^{-1}$, which is increased by 0.5 $km \cdot h^{-1} \cdot min^{-1}$ (1 min equals one stage). Participants are instructed to run in a straight line, to pivot on completing a shuttle, and to pace themselves in accordance with the audio signals. The test is finished when the participant fails to reach the end lines concurrent with the audio signals on two consecutive occasions. Otherwise, the test ends when the participant stops because of fatigue. All measurements were carried out under standardized conditions on an indoor rubber-floored gymnasium. The participants were encouraged to keep running as long as possible throughout the course of the test. The last completed stage or half-stage at which the participant drops out was scored.

Muscular strength. Muscular strength for lower limbs was assessed by the standing broad jump test. From a starting position immediately behind a line, standing with feet approximately shoulder's width apart, the adolescent jumps as far as possible with feet together. The result was recorded in centimeters. A non-slip hard surface, chalk and a tape measure were used to perform the test.

Muscular strength for upper limbs was assessed by the bent arm hang test. The adolescent hangs from a bar for as long as possible, with the arms bent at 90°. The palms face forward and the chin must be over the bar's plane. The time spent in this position, to the nearest tenth of a second, is recorded.

Flexibility. The flexibility was assessed by the Back-saver sit and reach test. A standard box with a small bar, which has to be pushed by the participant, was used to perform the test. The adolescent bends his/her trunk and reaches forward as far as possible from a seated position, with one leg straight and the other bent at the knee. The test is performed once again with the opposite leg. The farthest position of the bar reached by each leg was scored in centimeters and the average of the distances reached by both legs was used in the analysis.

Speed/agility. Speed/agility was assessed by the 4 × 10 m shuttle run test. Two parallel lines are drawn on the floor 10 m apart. The adolescent runs as fast as possible from the starting line to the other line and returns to the starting line, crossing each line with both feet every time. This is performed twice, covering a distance of 40 m (4 × 10 m). Every time the adolescent crosses any of the lines, he/she should pick up (the first time) or exchange (second and third times) a sponge that has earlier been placed behind the lines. The stopwatch is stopped when the adolescent crosses the end line with one foot. The time taken to complete the test is recorded to the nearest tenth of a second.

Physical activity

The ActiGraph® monitor (ActiGraph® GT1M®, Pensacola, FL) was used to assess the physical activity in free-living conditions (Ruiz et al., 2011). The dimensions of this uniaxial accelerometer are 51 × 41 × 15 mm, and it weighs 43 g. Accelerometry assesses physical activity level by measuring mechanical movement. The uniaxial ActiGraph accelerometer is based on the piezoelectric

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