Preventive Medicine 112 (2018) 104–110

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Physical activity and dual disease burden among South African primary schoolchildren from disadvantaged neighbourhoods

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ARTICLE INFO

Keywords:
Blood pressure
Body fat
Body mass index
Obesity
Overweight
Soil-transmitted helminths

ABSTRACT

People from low- and middle-income countries still face challenges stemming from parasitic infections. Additionally, non-communicable diseases (NCDs) and their risk factors are rapidly increasing, which puts South African children at an elevated risk of a dual disease burden, with negative consequences for child development and wellbeing. Contrastingly, regular physical activity (PA) is associated with decreased cardiovascular disease (CVD) risk. Therefore, the objective of this study was to examine whether PA is associated with the double infection-CVD phenotype burden in South African schoolchildren. 801 children (402 boys, 399 girls; mean age 9.5 years) from eight schools from disadvantaged neighbourhoods were included. Data assessment took place between February and March 2015 in Port Elizabeth, South Africa. Children who achieved PA recommendations (physically active on 6–7 days/week for at least 60 min), who were active, but below recommended standards (2–5 physically active days/week), or who were insufficiently active on almost all days (0–1 physically active days/week) were compared with regard to systolic and diastolic blood pressure, body mass index (BMI), percent body fat, and infection with soil-transmitted helminths. Moderate and high self-reported PA levels were associated with lower BMI, lower body fat, and lower risk of being hypertensive. Conversely, children with high self-reported PA were more likely to be infected with soil-transmitted helminths than peers with low PA levels. Promoting PA in disadvantaged areas is worthwhile to prevent NCD later in life, but should be combined with regular anthelminthic treatment to comprehensively improve children's health and wellbeing.

1. Introduction

People living in low- and middle-income countries (LMICs) are still facing challenges stemming from parasitic infections (Colley et al., 2014). Indeed, > 1 billion people are infected with soil-transmitted helminths (Pullan et al., 2014). Symptoms associated with soil-transmitted helminth infections include abdominal pain, diarrhoea, anaemia, and cognitive impairment (Utzinger et al., 2012). Important risk factors for soil-transmitted helminth infection are lack of clean water, sanitation, and hygiene, as transmission mostly occurs through faecal contamination of soil, food, and drinking water (Grimes et al., 2014). These conditions are typically found in socioeconomically deprived populations, including marginalised neighbourhoods in South Africa (Pillay et al., 2014; Müller et al., 2016).

Additionally, the prevalence of non-communicable diseases (NCDs) and their risk factors are rapidly increasing and impose a growing burden on the health of populations in LMICs (Marshall, 2004). This phenomenon has only recently been recognised by the global health community and must be addressed in the new era of the Sustainable Development Goals. New research has revealed that the South African population has moved towards a disease profile similar to Western countries, with increasing proportions of deaths attributed to chronic lifestyle-related diseases. For example, overweight is replacing undernutrition as a risk factor (Lim et al., 2012).

Consequently, South African children are at an elevated risk of compromised health due to a combination of infectious diseases and NCD risks, with negative consequences for their short- and long-term cognitive and physical development and wellbeing (Marshall, 2004).

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https://doi.org/10.1016/j.ypmed.2018.04.001
Received 27 October 2017; Received in revised form 2 March 2018; Accepted 2 April 2018
Available online 04 April 2018
0091-7435/

Dealing with this dual burden also constitutes a major and increasing challenge for the health system. While young children are mainly affected by infectious diseases, they may increasingly experience risk-factors predisposing them to NCDs in adolescence and early adulthood. Overweight and hypertension, in particular, have been identified as two of the leading causes of cardiovascular diseases in LMICs (Agyemang et al., 2005). For instance, children with elevated blood pressure have an increased risk of developing (subclinical) target organ damage, including increased carotid intima-media thickness or ventricular hypertrophy (Neuhauser et al., 2011).

According to the American Heart Association, cardiovascular health is characterised by three biomarkers of cardiometabolic health (low cholesterol, low blood pressure, and low fasting glucose), and four specific health behaviours (non-smoking, body mass index (BMI) < 25, healthy eating, and regular physical activity [PA]) (Lloyd-Jones et al., 2010). In line with this notion, physical inactivity has been identified as one of the most important risk factors for NCDs (Monyeki and Kemper, 2008). In South Africa, using data from the World Health Survey 2003, researchers have estimated that in adolescents and adults aged 15 years or older, 30% of ischaemic heart disease, 27% of colon cancer, 22% of ischaemic stroke, 20% of type 2 diabetes, and 17% of breast cancer could be attributed to physical inactivity. Moreover, the burden due to physical inactivity was estimated at 1.1% disability-adjusted life years (Joubert et al., 2007). Contrastingly, epidemiological studies carried out in European children show small, but consistent significant relationships between regular PA and decreased diastolic and systolic blood pressure, lower skinfold thickness, lower blood glucose levels, and lower risk of dyslipidemia (Ekelund et al., 2007). Based on these findings, international organisations generally recommend that children aged 5–17 years should pursue at least 60 min of moderate PA per day (www.cdc.gov/physicalactivity/basics/children/index.htm). However, based on global surveillance questionnaires, South Africa was found to have the fourth highest prevalence of physical inactivity in Africa (Lambert, 2012). Surveys found that about one third of young South African children (grade 7 learners, approximately 13 years old) are physically inactive and that up to 80% accumulate PA below the recommended standards (De Vos et al., 2016).

We are currently unaware of any study testing how PA in children is associated with the co-occurrence of infections and NCD phenotypes in LMICs. This study therefore aimed to investigate whether self-reported levels of PA are associated with both risk factors for NCDs and parasitic infections in 8- to 12-year-old schoolchildren from disadvantaged neighbourhoods in South Africa.

2. Materials and methods

2.1. Ethics statement

The ethics review board of North-Western and Central Switzerland (EKNZ 2014–179), the Nelson Mandela University Human Ethics Committee (H14-HEA-HMS-002), and the Eastern Cape Departments of Education and Health approved the study. All procedures performed were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments. All parameters were assessed by trained researchers with training in anthropometry equivalent to a Level 2 ISAK (International Society for the Advancement of Kinanthropometry) certification, using the same instruments across all locations. Detailed information regarding recruitment of participants, inclusion, and exclusion criteria has been published previously (Yap et al., 2015). Oral assent was sought from each child, in addition to written informed consent from parents/guardians. Participation was voluntary (neither children nor parents were reimbursed), and hence, children could withdraw at any time without further obligations. Each child was assigned a unique identification number to ensure confidentiality.

Children infected with parasitic infections were treated according to national guidelines, while children showing severe symptoms (e.g. bloody stool, diarrhoea, abdominal pain) were referred to the nearest local clinic.

2.2. Study population

Eight urban quintile three schools were included in the study (quintile one of five being the poorest) conducted in disadvantaged neighbourhoods of Port Elizabeth, South Africa. Children with any notable clinical signs and symptoms (e.g. severe fever, severe headache, and severe diarrhoea) or known serious health problems such as Crohn's disease, liver or kidney diseases as well as those enrolled in any other studies were excluded. In total, 1009 grade four schoolchildren agreed to participate in the survey in February/March 2015. Hereof, 201 children were excluded because of missing data with regard to sex ($n = 6$), age ($n = 31$), height and/or weight ($n = 54$), socioeconomic status (SES; $n = 8$), self-reported PA ($n = 12$), body composition ($n = 1$), blood pressure ($n = 13$), and parasitological examinations ($n = 74$). Nine children were excluded because they were < 8 or > 12 years, resulting in a study cohort of 801 children (402 boys, 399 girls) with complete data sets.

2.3. Assessment of self-reported PA

A single-item question from the Health-Behaviour of School-Aged Children study was used to assess children's self-reported PA behaviour: “Over the past 7 days (1 week), on how many days were you physically active for a total of at least 60 min (1 hour) a day?” Response options ranged from zero days to seven days. Children were classified into groups with low PA (0 to 1 active days per week), moderate PA (2 to 5 active days per week), and high PA (6 to 7 active days per week), hereby ensuring that children in the highest category were active on almost every day for at least 60 min, and thus accomplish international PA recommendations. Children with moderate PA levels showed PA levels below recommended standards, but were active on some days a week. Children classified into the category with low PA levels were far from meeting recommended PA levels since they were unable to accumulate ≥60 min of PA on almost any day of the week.

2.4. Assessment of blood pressure

For the detection of hypertension, the blood pressure of each child was measured once after the child had been seated for approximately 5 min using a validated oscillometric digital blood pressure monitor (Omron® M6 AC; Hoofddorp, Netherlands). The bottom of the cuff was placed about 4 cm above the elbow of the left arm with the palm facing upwards, while the blood pressure was taken in the sitting position. A cuff-size of 17–22 cm appropriate for the range of arm-circumferences of children was chosen (Omron® CS2 Small cuff; Hoofddorp, Netherlands). Reference values for normal and hypertensive blood pressure are available for children living in Europe (Neuhauser et al., 2011) and the United States of America (National High Blood Pressure Education Program Working Group, 2004), while such reference values do not yet exist for sub-Saharan African children (Agyemang et al., 2005). In the present study, we used reference tables from a nationally representative sample of 12,199 non-overweight German children (aged 3–17 years), in which standardised blood pressure assessments were carried out with an automated oscillometric device (Neuhauser et al., 2011). In our study, the children were divided in a normotensive, prehypertensive, or hypertensive group, based on percentiles taking into account children's age, sex, and height (normotensive: < 90th percentile; prehypertensive: ≥90th to < 95th percentile; hypertensive: ≥95th percentile). In the standardisation study with German children, blood pressure readings were taken twice, with the first reading generally resulting in higher values (1.5–1.9 mm Hg and 1.8–2.2 mm Hg for systolic and diastolic blood pressure, respectively) than the second one