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**High self-reported physical activity is a strong indicator
for high health-related quality of life among
schoolchildren in poor neighbourhoods of Port Elizabeth,
South Africa**

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Self-reported physical activity is associated with higher health-related quality of life among schoolchildren from disadvantaged neighbourhoods of Port Elizabeth, South Africa

Short title: Physical activity and quality of life in South African schoolchildren

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Abstract

Purpose: Little research is available on the relationship between health-related quality of life (HRQoL), physical activity (PA) and cardiorespiratory fitness (CRF) from disadvantaged communities in middle- and low-income countries. In South Africa, children living in socioeconomically deprived environments are at an increased risk of sedentary lifestyles and poor HRQoL. Therefore, the purpose of this study is to examine whether higher self-reported PA and higher CRF levels are associated with better HRQoL in South African schoolchildren from disadvantaged neighbourhoods.

Methods: Overall 832 children and adolescents aged 8 to 12 years (415 girls, 417 boys, $M_{age} = 9.5$ years) participated in this cross-sectional study. HRQoL was assessed through five dimensions of the KIDSCREEN-27. Self-reported PA was measured using a single item and CRF with the 20-meter shuttle run test. Data analysis was based on analyses of (co)variance using age, gender, socioeconomic status, and school class as covariates.

Results: Self-reported PA was significantly related to HRQoL. Significant group differences existed across all dimensions of HRQoL between low and high self-reported PA. However, no associations with HRQoL were observed for CRF.

Conclusions: Schoolchildren meeting recommended levels of PA (60 minutes on at least six days a week) show higher HRQoL than their peers with lower PA levels. Further research is needed to determine how the PA levels of South African children can be improved for example, through school-based PA interventions.

Keywords: quality of life, physical activity, cardiorespiratory fitness, South Africa, schoolchildren

Introduction

Physical activity (PA) and cardiorespiratory fitness (CRF) are powerful markers of health [1]. One central aspect of health is health-related quality of life (HRQoL), which can be seen as a subjective representation of and well-being and the optimal overall functioning of the body [2]. HRQoL has become a fundamental element in medical and caring sciences [3]. The assessment of HRQoL is increasingly important as means of monitoring population health status over time, detecting subgroups within the general population with poor HRQoL, and assessing the impact of public health interventions within a given population [4]. HRQoL of children has proved to be an important predictor of health care costs and future illness [5] and is also characterized by remarkable stability over time [6]. Therefore, Bisegger et al. [7] have argued that quality of life in adolescence is the basis for quality of life in adulthood. This especially applies to South African children living in disadvantaged neighbourhoods, where a strong and persistent relationship has been observed between low socioeconomic status and impaired HRQoL [8].

By contrast, PA has been associated with multiple health benefits in both adults [9] and children [10]. Research suggests that participating in regular PA and being in good physical shape reduces the risk of cardiovascular diseases, type II diabetes, helps to control body weight, has a positive impact on muscles and bones and contributes to an improved psychological well-being. Furthermore, regular PA is associated with an improved capacity to deal with stress, better quality of sleep, and decreases the risk of developing symptoms of depression and anxiety [11]. Research with children also shows that regular PA is related to improved HRQoL [12]. For instance, Wafa et al. [13] demonstrated with 156 Malaysian children aged 9 to 11 years that children with higher levels of moderate-to-vigorous PA reported

better HRQoL. Furthermore, Shoup et al. [14] revealed in a study of 177 overweight and obese boys and girls (8-12 years old) that children who met PA recommendations reported higher HRQoL, irrespective of their weight status. Gopinath et al. [15] showed in a longitudinal study with 2553 children (median age 12.7 years) that those with high PA levels reported significantly higher HRQoL five years later. Gu et al. [16] further observed in a sample of 201 children from the United States (mean age 9.8 years) that PA was positively related to several dimensions of HRQoL, a relationship which was mediated by children's CRF. Finally, Kantor et al. [17] revealed in a study of 448 Hispanic 3rd through 5th graders that greater participation in sport teams was associated with better physical and social functioning and a higher total HRQoL. The authors concluded that these findings have important implications for the development of interventions to promote health and well-being among children and adolescents.

In summary, while previous studies indicated that regular PA is associated with increased HRQoL among children, most of the evidence is based on children from upper-to-middle or higher income countries [18]. Nevertheless, some studies suggest that increased PA might be especially beneficial for disadvantaged children. For instance, Crew et al. [19] found that an aerobic exercise training had a positive impact on psychological well-being among Hispanic children from low-income families. In South Africa, however, only one study has examined the relationship between children's PA and their quality of life [20], showing that schoolchildren from a disadvantaged community had higher scores across all domains of quality of life if they participated in sports at least twice per week.

Despite these promising results, physical education is increasingly cut to a minimum in many low-to-middle income countries, while more time is invested in

other academic subjects [21]. As a result, many children do not engage in the recommended daily 60 minutes of moderate-to-vigorous PA [22]. According to Walter [23], this might be one reason for the increasing sedentariness among South African schoolchildren. Given this background, the purpose of the present study was to find out whether higher self-reported PA and higher CRF levels are associated with higher HRQoL in South African schoolchildren from disadvantaged neighbourhoods, both before and after controlling for major covariates.

Methods

Procedures and ethical approval

The “Disease, Activity and Schoolchildren’s Health” (DASH) cohort study was approved by the ethical review board of North-western and Central Switzerland, the Nelson Mandela Metropolitan University Human Ethics Committee, the Eastern Cape Department of Education, and the Eastern Cape Department of Health in Port Elizabeth, South Africa.

Details regarding the information of potential study participants, inclusion and exclusion criteria have been published previously [24]. In brief, oral assent from each participating child was sought and individual written informed consent was obtained from parents/guardians. Participation was voluntary and children could withdraw from the study at any time without further obligations. To ensure confidentiality, each study participant was given a unique identification number. All tests were available in English, Xhosa, and Afrikaans. To ensure optimal translation of the tests, a collaboration with independent professional translators was realized. All items were pilot-tested with a small sample of Xhosa and Afrikaans speaking schoolchildren of the same age as the study cohort. No children were found with

exceptional negative and serious psychosocial health conditions and therefore no referral to local clinics were made.

Study population

Baseline data was collected from a total of 1009 grade four schoolchildren, aged 8 to 12 years, in February/March 2015. South African public schools are classified into five different groups depending on their financial resources, ranging from quintile one (poorest) to quintile five (least poor) [25]. The present study was conducted in eight quintile three schools, located in disadvantaged neighbourhoods in Port Elizabeth, South Africa.

Measures

Physical activity

PA behaviour was assessed with a single-item question from the Health-Behaviour of School-Aged Children (HBSC) study [26]: “Over the past 7 days (1 week), on how many days were you physically active for a total of at least 60 minutes (1 hour) a day?” The options to answer the question ranged from zero days to seven days. This question is based on the recommendation for PA among young people stating that children and youth aged 6 to 17 should perform at least 60 minutes of moderate- to vigorous-intensity PA per day [27,28]. Using this single item, researchers were able to establish significant relationships between PA and children’s psychosomatic symptoms in prior studies [29]. Previous research also showed that such simple questions were equally correlated with objectively assessed PA as more detailed questionnaires [30]. Students were compared with 0 to 1 active days per week (low PA), 2 to 5 active days per week (moderate PA) and 6 to 7 active days per week (high PA).

Cardiorespiratory fitness

To measure children's CRF, the 20-meter shuttle run test was carried out [31]. A premeasured running course was laid out on a flat terrain and marked with colour-coded cones. Children who felt sick or were not comfortable enough did not participate in the shuttle run. The test procedures were explained and a researcher demonstrated two trial runs. Once children were familiar with the test procedures, they started with a running speed of 8.5 km/h, following a researcher who set the pace according to the sound signal. The frequency of the sound-signal gradually increased every minute by 0.5 km/h. If a child was unable to cross the marked 2-meter line before each end of the course at the moment of the sound signal for two successive intervals, the individual maximum was reached. Children were then asked to stop and the fully completed laps were noted. The level at which the child stopped running during the 20-meter shuttle run test was used to calculate an estimate of maximal oxygen uptake (VO_{2max}) and was adjusted for age [31]. The 20-meter shuttle run test proved to be a valid measure of children's CRF in prior research [31] and could be associated with both physical and psychological health outcomes [32,33]. Based on their VO_{2max} scores, students were categorized into three groups with (a) low CRF (children in the lowest quartile), (b) moderate CRF (second and third quartiles), and (c) high CRF (fourth quartile).

Socioeconomic status

Nine questions were used to estimate children's socioeconomic status (SES) covering household-level living standards, such as infrastructure and housing characteristics (e.g. house type, number of bedrooms) and questions related to ownership of three durable assets (e.g. presence of a working refrigerator). The

dichotomized items (0=poor quality, not available; 1=higher quality, available) were summed up to build an overall SES index, with higher scores reflecting higher SES. The validity of similar measures has been established in previous research [34].

Body weight and height

To assess body weight and height, all children were asked to take off their shoes and sweater before standing on the digital weighing scale (Micro T7E electronic platform scale, Optima Electronics; George, South Africa). Body weight was measured once and recorded to the nearest 0.1 kg. With the shoes removed, each child stood against a Seca stadiometer (Surgical SA; Johannesburg, South Africa) with their back erect and shoulders relaxed. Body height was measured once and recorded to the nearest 0.1 cm. Body weight and height values were used to calculate Body Mass Index (BMI), defined as weight (in kg)/height² (in m²). The BMI was calculated using the WHO growth reference [35].

Health-related quality of life

HRQoL was assessed with the 27-item version of the KIDSCREEN questionnaire [36], which was developed to assess HRQoL among children and adolescents aged 8 to 18 years. Evidence for the validity and reliability of the KIDSCREEN has been shown previously in international studies [37,38], including South Africa [39]. The KIDSCREEN-27 consists of five subscales, namely physical well-being (5 items: e.g., “Have you physically felt fit and well?”), psychological well-being (7 items: e.g., “Has your life been enjoyable?”), autonomy and parent relation (7 items: e.g., “Have you been able to talk to your parent(s)/guardian(s) when you wanted to?”), social support and peers (4 items: e.g., “Have you spent time with your friends?”), and school environment (4 items: e.g., “Have you been happy at school?”). All items

were anchored on a 5-point Likert-type scale ranging from 1 (never or not at all) to 5 (always or extremely). Negatively poled items were reverted before calculating the subscale scores, to ensure that higher values reflect higher HRQoL across all subscales. Following the recommended procedures [36], Rasch scores were computed for each dimension and were transformed into T-values with a mean of 50 and a standard deviation of 10. The internal consistency of all subscales was acceptable in this sample, with Cronbach's alpha values varying between $\alpha = .67$ and $.72$ [40].

Statistical analysis

Data was double-entered, validated using EpiData version 3.1 (EpiData Association; Odense, Denmark) and merged into a single datafile. Statistical analyses were performed with SPSS® 23 (IBM Corporation, Armonk, USA) for Windows® and STATA® 13.0 (STATA.; College Station, TX, USA). Statistical significance was set at $p < 0.05$ across all analyses. Descriptive statistics are displayed as means (*M*) and standard deviations (*SD*). Univariate analyses of variance (ANOVAs) were calculated to examine gender differences in the main study variables. Chi²-tests were calculated to examine whether boys and girls were equally represented in the groups with low, moderate or high PA and CRF levels. Finally, multi- and univariate analyses of variance ([M]ANOVA) and covariance ([M]ANCOVA) were calculated to test whether children classified in the groups with low, moderate or high PA and whether CRF differed with regard to HRQoL, before and after controlling for gender, age, SES, BMI, school class and CRF (if PA was used as dependent variable) or PA (if CRF was used as dependent variable).

Results

Study population

As shown in the participant flow chart (Figure 1), after receiving written informed consent from a parent or legal guardian, a total of 1009 students agreed to take part in the study. Complete data records were available for 832 (82.5%) children. All analyses refer to this final cohort, including 417 girls (50.1%) and 415 boys (49.9%).

Anthropometric indicators, SES, physical activity and cardiorespiratory fitness

Table 1 provides an overview of the descriptive statistics and gender differences for all study variables. Girls were significantly younger than boys and had a higher BMI. No gender differences were identified for height, weight or SES. Boys achieved significantly higher mean VO_2 max estimates than girls. However, no significant gender difference was found for self-reported PA ($p=.057$). With regard to HRQoL, girls had significantly higher scores than boys in two KIDSCREEN dimensions (autonomy and parent relations, social support and peers). Table 2 shows the number and percentage of students classified into the three groups with low, moderate or high PA/CRF and reveals that boys and girls were equally distributed among the groups with low, moderate and high PA levels, $Chi^2(2,832)=2.82, p=.244$, whereas girls were overrepresented in the group with low CRF scores, and underrepresented among students with high CRF levels, $Chi^2(2,832)=122.40, p<.001$.

HRQoL as a function of self-reported physical activity

MANOVA yielded an overall significant effect of self-reported PA on HRQoL, Wilk's lambda: $F(10,1650)=6.70$, $p<.001$, $\eta^2=.039$. Results of the follow-up ANOVAs (Model 1: uncontrolled) showed that significant group differences existed across all dimensions of HRQoL (Table 3). Bonferroni post-hoc tests revealed that children with low and moderate PA had lower scores on physical well-being, psychological well-being, autonomy and parent relations, social support and peers, and school environment than peers with high PA levels. Children with low PA also scored significantly lower on physical and psychological well-being compared to their peers with moderate PA levels.

After controlling for age, gender, SES, school class and CRF (Model 2), the MANCOVA still showed a significant main effect for PA, Wilk's lambda: $F(10,1638)=4.64$, $p<.001$, $\eta^2=.028$. In the univariate follow-up ANCOVAs, the group differences persisted after controlling for covariates, although the effect sizes slightly decreased (Table 3).

HRQoL as a function of cardiorespiratory fitness

Table 4 shows the findings of the (M)ANOVAs and (M)ANCOVAs with CRF as independent variable. In Model 1 (uncontrolled), the MANOVA did not yield significant group differences, Wilk's lambda: $F(10,1650)=0.61$, $p=.809$, $\eta^2=.004$. Accordingly, all univariate ANOVAs were insignificant. The same pattern of results was observed in Model 2 (after controlling for covariates), with both the MANCOVA, Wilk's lambda: $F(10,1638)=0.78$, $p=.648$, $\eta^2=.005$, and all follow-up ANCOVAs showing insignificant relationships.

Discussion

The main purpose of this study was to examine how self-reported PA and CRF are associated with HRQoL in children living in disadvantaged neighbourhoods in Port Elizabeth, South Africa. The key finding is that schoolchildren who are physically active for more than 60 minutes on at least six days per week reported significantly higher HRQoL than their peers with lower PA levels, even after controlling for possible confounders.

Children with high self-reported PA reached higher scores across all five KIDSCREEN dimensions compared to peers with low PA levels. This supports the recommendation of the United Kingdom Expert Consensus Group [28] and the Centers for Disease Control and Prevention [27] suggesting daily activity of at least one hour among children aged 6 to 17 years. Furthermore, our data revealed that children with low PA levels had the lowest scores across all KIDSCREEN dimensions, with children in this group differing significantly from peers with moderate PA levels in both physical and psychological well-being. This suggests that even a medium amount of self-reported PA is positively associated with HRQoL among children living in disadvantaged areas in a low-to-middle income country such as South Africa.

Our findings are in line with previous investigations showing that physically active children generally experience better HRQoL [15-17,13]. The reasons why physically active children report higher quality of life are multi-fold: First, Breslin [41] argued that there might be a connection between PA and higher overall well-being because participation in sports, games and playground activities may result from and contribute to being socially accepted, popular, and spending time actively with friends. Second, Anokye et al. [42] suggested that higher HRQoL might be

attributable to the fact that PA is associated with improved self-esteem, a relationship which is mediated through positive perceptions of competences and a positive physical self-concept [43]. Third, researchers have claimed that PA is associated with increased mental toughness [44], a mindset which may help physically active children to better cope with stress [45,46]. In line with this notion, a study with 8-year-old children showed that children who engaged in regular PA exhibited a lower adrenocortical reactivity when exposed to a psychosocial laboratory stressor [47]. Fourth, increased PA might be associated with better quality of sleep [48], which in turn can have a positive impact on physical health indicators, as well as behavioural/emotional health outcomes [49]. Fifth, a significant relationship has been described between regular PA and reduced depressive symptoms [50]. For instance, Tomson et al. [51] showed that among 8- to 12-year-old children, being classified as inactive, not playing sport outside or not meeting health-related CRF goals, was associated with a 1.3 to 4.0 times higher risk of reporting high depressive symptoms. This relationship was corroborated in a study using objective PA assessments and semi-structured clinical interviews to diagnose depression [52]. Despite these insights, studies directly testing the mediating role of the above mentioned factors are still missing. More longitudinal research is needed to obtain a deeper understanding of the underlying mechanisms that may explain the beneficial impact of PA on HRQoL. Moreover, although the present study suggests that already moderate PA levels can have a beneficial effect, little is known about the exact dose-response-relationships. Therefore, additional research is warranted in which PA is assessed with more precise methods (e.g. accelerometry), to find out how much PA is needed to increase children's HRQoL.

The fact that no significant differences were found between children with low, moderate and high CRF levels was unexpected. For instance, previous research with children showed that PA and CRF are independently associated with reduced risk for cardiometabolic diseases [53]. In the present study, however, Bonferroni post-hoc tests indicated that even children in the highest and lowest quartile did not differ with regard to their self-reported HRQoL. Several reasons are possible: First, researchers found that only small correlations existed between self-reported PA and children's performance in the 20-meter shuttle run test [46]. This was supported in the present sample with a correlation of $r=-.015$ ($p=.66$). Second, although CRF can generally be regarded as a proxy measure of PA, CRF also depends on genetic factors, whereas PA is a behavioural variable [54]. Third, because PA and HRQoL are based on self-reports, these constructs may share common method variance [55]. For instance, previous research has shown that how people think about their PA is related to their mental well-being [56]. Fourth, in a study with Swedish adults, Lindwall et al. [57] observed that self-reported PA is more closely associated with mental health outcomes than objectively assessed CRF. Lindwall et al. argued that PA does not primarily affect mental health via improved CRF and cardiovascular change, but that psychological processes (e.g., perceptions of mastery, perceived control over one's health and body) might play a more important role. Nevertheless, we acknowledge that other researchers have found positive associations between CRF and HRQoL [16], which they attributed to enhanced body image or an effect on neurochemicals in the brain (e.g. serotonin), known to be involved in the regulation of mood [1]. Moreover, researchers reported positive relationships between higher CRF levels and other psychological variables such as selective attention or academic performance [58,59]. Therefore, increased CRF should still

be considered as a key target for public health promotion, despite the lacking associations with HRQoL in the present study. This applies particularly to South African schoolchildren living in deprived neighbourhoods, where good academic performances represent a major factor to escape the vicious circle of poverty and poor health.

The strengths of this study are that PA and CRF were assessed simultaneously in a relatively large sample of primary schoolchildren. Moreover, an internationally accepted instrument was used to measure children's HRQoL [38]. Using this instrument allowed a comparison of HRQoL between South African children living in disadvantaged neighbourhoods and European KIDSCREEN norm data for 8- to 11-year-old children [36]. While only minor differences were observed for physical well-being, autonomy and parent relations, and social support and peers, the children in the present study reported markedly lower scores with regard to psychological well-being than European peers. On the other hand, compared to European peers, South African children reported higher scores with regard to school environment. Although speculative, we assume that low scores for psychological well-being and positive perceptions of the school environment in the present sample are due to the fact that many children growing up in disadvantaged areas in South Africa are faced with difficult family situations and poor living conditions. Therefore, children might consider school as a "sanctuary", which provides relief from the troubles associated with everyday life. In line with this, the 2016 South African Early Childhood Review showed that 63% of all South African children live in poverty and 28% live in households where nobody is employed [60].

While the present study provided novel insights with regard to the association between PA and HRQoL in South African schoolchildren, the current results must

be considered in light of certain limitations. First, the sample is limited to fourth grade students attending quintile 3 schools in urban areas. Therefore, caution is needed when generalizing the findings to children from other school grades, educational levels or schools located in more rural regions. Second, the cross-sectional nature of the data precludes conclusions about possible causal relationship between PA and HRQoL. While it is plausible that PA leads to increased HRQoL, it is just as likely that children with low HRQoL are less motivated to engage in regular PA [61]. With regard to the reciprocity between PA and mental health outcomes, one of the few studies with children showed that PA predicted later depressive symptoms, but that prior depression also had an impact on later PA [62]. Third, information about HRQoL is exclusively based on self-reports. As shown previously, children's self-reports may differ considerably from other informants such as teachers or parents [63]. To ensure that children understood all questions correctly, they were allowed to fill in the questionnaires in their home language, and native speakers were present to support the children if necessary. Fourth, PA was assessed with a relative simple 1-item measure. However, this item proved to be similarly associated with accelerometer data as more detailed questionnaires [30,64]. Because such short measures take less time to complete, are simpler and therefore do not require higher level cognitions [30], researchers have concluded that single-item instruments are valid screening tools useful for population surveys [65]. Moreover, when creating categories of low, moderate or vigorous PA, we referred to internationally accepted PA standards [27,28] to ensure that children in the highest category were active on almost every day for at least 60 minutes, and thus met PA recommendations. By contrast, children with moderate PA levels were active on some days a week, and therefore did not meet PA recommendations. Finally, children with low PA levels

failed to accumulate 60 minutes of PA on almost all days of the week, and were therefore far from meeting recommended PA levels.

Conclusions

In South Africa, poverty and stress jeopardize children's health [66]. By contrast, participation in sufficient amounts of daily PA is positively associated with HRQoL. This finding is important because HRQoL does not only have an immediate impact on children's well-being, but also tracks into adulthood, with negative long-term consequences for both the individual and the society [67]. Further research is needed to determine how PA levels of South African children can be increased, for example, through school-based PA interventions, and to find out how such an increase impacts on children's HRQoL.

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Manteltext

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1. Introduction

Physical activity and cardiorespiratory fitness are powerful markers of health [1]. Another central aspect of health is health-related quality of life, which can be viewed as a subjective representation of function and well-being [2]. Health-related quality of life of children has proved to be an important predictor of health care costs and future illness [3] and is also characterized by remarkable stability over time [4]. Therefore, Bisegger et al. [5] have argued that quality of life during childhood and adolescence is the basis for quality of life in adulthood. Furthermore research has demonstrated that participating in regular physical activity and being physically active has multiple health benefits [6] and is also associated with improved health-related quality of life [7]. However, most of the evidence is based on children from upper-to-middle or higher income countries [8]. Whereas, some studies suggest that increased physical activity might be especially beneficial for disadvantaged children.

Despite these promising fields of research, physical education is increasingly cut to a minimum in many low-to-middle income countries, while more time is being invested in other academic purposes [9,10]. As a result, many children do not engage in the recommended daily 60 minutes of moderate-to-vigorous physical activity [11]. This is particularly alarming in low-to-middle income countries such as South Africa, which are facing multiple challenges on an already overburdened health care system [12]. In accordance with international developments, studies show that urban South African children are growing increasingly unfit, sedentary and overweight [13,14]. Given this background, the purpose of the present study was to find out whether higher self-reported physical activity and higher cardiorespiratory fitness levels are associated with higher health-related quality of life in South African schoolchildren in disadvantaged neighbourhoods, both before and after controlling for major covariates.

The following research questions were the basis for the present article:

- I. Does higher self-reported physical activity correlate with higher health-related quality of life?
- II. Does higher cardiorespiratory fitness correlate with higher health-related quality of life?

The aim of this Manteltext was on the one hand, to summaries methods and results of the subsequent paper. One exception being the KIDSCREEN tool which is described in more detail in the *Method* section. On the other hand, the theoretical background (current state of research) will be dealt with in depth.

2. Background and definitions

2.1. Physical activity and fitness

Physical fitness has been referred to as an integrated measure of most body functions including skeletomuscular, cardiorespiratory, hematocirculatory, psychoneurological and endocrine-metabolic functions involved in the performance of daily physical activity or physical exercise [15]. Being physically fit has been reported to reduce the risk of cardiovascular disease and type II diabetes, help control body weight and improve mental variables such as stress, depression and anxiety among children and adolescents [15]. Furthermore, associations between cognitive performance and physical fitness have been observed indicating that physical fitness can benefit both, health and academic performance [16].

Physical activity is defined as any body movement through muscle action which increases energy levels. Regular physical activity has multiple benefits for physical, mental, and psychosocial health [17]. Physical activity also assists in social development by providing opportunities for self-expression and social interaction [18]. Beneficial effects on several mental health outcomes, including improved mood states and health-related quality of life are reported to be associated with physical activity in a study by Penedo and Dahl [7]. A study by Ortega reports that low muscular strength is associated with an increased risk of mortality due to suicide, supporting the notion that physically weaker people might also be mentally more vulnerable. Low muscular strength should be considered as an emerging risk factor for major causes of death in young adulthood [15]. Adolescents which participate in physical activity regularly are more likely to continue being active throughout adulthood compared to their less active peers [19]. However, most children fail to engage in 60 minutes of vigorous- or moderate-intensity physical activity each day as recommended by the WHO [20], with as many as one-third reporting no physical activity in the preceding 5 days [21]. This indicates the necessity of early and ongoing opportunities for physical activity to reach a maximum health benefit [17].

2.2. Health-related quality of life

Over the past decades, progress in public health and medicine have increased the average life expectancy. Alongside this development, there has been a significant rise in percentage of adults living with chronic health conditions such as heart disease, cancer, diabetes, arthritis and mental illness. Consequently, within the field of public health and medicine, it was considered important to not only focus on issues of quantity of life but also on quality [22]. The concept of quality of life is multidimensional and abstract [22]. Quality of life is a broad concept or reference point that has relevance to virtually every area of human function [23]. Therefore, it is not surprising that it has been researched, reviewed and discussed extensively in

social science, psychology, economic and medical literature [22]. A central aspect of quality of life is *health*. It can also be seen as a subjective representation of function and well-being, which shifted from a merely biological model to a bio-psycho-social model. Furthermore, self-assessed health status is also a more powerful predictor of mortality and morbidity than many objective measures of health [24]. Health-related quality of life has become a fundamental element in medical and caring sciences [25] and today, the importance of measuring health-related quality of life in groups or individuals is well accepted [22]. The measurement of health-related quality of life is increasingly important as a means of monitoring population health status over time, of detecting sub-groups within the general population with poor health-related quality of life and of assessing the impact of public health interventions within a given population [26].

2.3. Socioeconomic status

According to Baker [27] socioeconomic status (SES) is defined as a measure of one's combined economic and social status and tends to be positively associated with better health. Research has shown that SES is linked to child well-being and the most influencing factors being access to material and social resources or reaction to stress-inducing conditions by both children themselves and their parents. Effects of SES on children are moderated by their own characteristics, family characteristics and their external support systems [28].

In the present article the following definition of socioeconomic status was used:

“Socioeconomic status is commonly conceptualised as the social standing or class of an individual group. It is often measured as a combination of education, income and occupation. Examination of socioeconomic status often reveal inequities in access to resources, plus issues related to privilege, power and control.” [29].

It is important to mention that when referring to high or higher SES it has to be seen in perspective of our study sample which stems from a disadvantaged community in South Africa. Thus, a higher socioeconomic status would presumably still be referred to as a lower socioeconomic status in a Western sample.

3. Parameters and their relations in the current field of research

3.1. Physical activity and fitness

The following chapter will provide an overview of the current state of research on physical activity and fitness in children and adolescents with relation to other variables of the article. In the subsequent study, fitness is referred to as cardiorespiratory fitness, however other researchers might ascribe fitness to a broader term.

3.1.1. Physical activity, fitness and low socioeconomic status

Studies have shown that socioeconomic factors help understand the differences in physical activity behaviour of children and adolescents [30]. In general it has been reported that higher socioeconomic status is associated with higher physical activity [31,32]. Furthermore, children growing up in low socioeconomic status families are at an increased risk of unhealthy overall health behaviours and chronic illnesses compared to children from higher socioeconomic status [33,34].

A study by Finger et al [35] showed that parental physical activity levels correlate strongly with their children's physical activity level. Finger et al. suggests that parents with higher education tend to be working in a more sedentary surrounding and are therefore compensating their exercises during their leisure time. Children might be able to observe this habit which could consequently lead to a more active lifestyle of the children as well [35]. On the other hand, parents who work in a physically demanding environment may recover from physical work by staying home, using media for entertainment and are therefore less active in their leisure time [35]. In a more recent article Finger et. al [36] report that 'parental education' was more strongly associated with physical activity and aerobic outcomes among adolescents in comparison with 'parental occupation' and 'household income'. Further, among the broad survey of health behaviour in school-aged children (HBSC), 153'028 children from 32 countries were questioned about their physical activity and their socioeconomic status was assessed using the Family Affluence Scale (FAS). Results revealed that girls with parents from a high socioeconomic position had higher levels of leisure time physical activity but that this association was less clear among boys. Other reviews have also reported that the relationship between parental socioeconomic position and physical activity and fitness is inconsistent [37]. Gustafson and Rhodes [37] report that children living with only one active parent were less active compared to their peers living with two active parents. On the other hand, families with one active parent seemed to be a more positive influence compared to families with two inactive role models. Furthermore, they state that relevant societal differences between generations might explain the

discrepancy in the physical activity variables between parent and child. Their review suggests that the increases in both social individualisation (leading to rejection of traditional norms) and health awareness (leading to an increase in opportunities for physical activity) have supported the decrease in intergenerational correlation with respect to physical activity [37].

3.1.1. Physical activity and fitness in South Africa

Only few studies have examined physical activity levels in South African school children. Information on trends of physical inactivity and related negative consequences are important for implementing strategies, since low and middle income countries are already faced with multiple challenges and an overburdened health care system. A country such as South Africa is confronted with a double burden, where on the one hand people suffer from communicable disease such as tuberculosis, helminth infections and HIV epidemics and on the other hand lifestyle related health behaviours arise paired with low physical activity levels [38].

South African schoolchildren have shown an increasing sedentary lifestyle with insufficient levels of physical activity [39]. Particularly alarming is the fact that the prevalence of overweight and obesity among South African boys has doubled while physical inactivity has increased measurably over a 6-year period, from 2002-2008, as shown in a study done by Walter [40]. South Africa's 2014 Report Card on Physical Activity for Children and Youth [41] outlined that sports participation appeared to be higher in urban settings with one report indicating that 66% of urban children and adolescents participated in sport and recreation in their spare time. On the other hand, regional surveys reveal that less than 50% of rural children and adolescents participated in sports [42]. Furthermore, a recent study in rural South Africa among young adolescents showed that less than two-thirds of boys and girls participated in weekly physical education classes and the medium time spent in physical education was about 30 – 40 minutes per week [43]. McVeigh's study further points out that among South African children lower socioeconomic status was associated with more television time [44]. In addition to insufficient activity levels, children living in high-risk environments such as townships are exposed to environmental stressors, which increases their risk of physical and psychological health problems [45]. South Africa's 2014 Report Card on Physical Activity for Children and Youth [41] thus concluded that South Africa has moved from a grade C- in 2010 to a grade D (C= 60-69%, D= 50-59%) in terms of involvement of children in physical activity and the promotion of healthy eating habits.

3.2. Health-related quality of life in children and adolescents

The following chapter will provide an overview of the current state of research on health-related quality of life of children and adolescents. Health-related quality of life

will be discussed in relation to 'low socioeconomic status' as well as in the setting of South Africa. In the subsequent article, the KIDSCREEN questionnaire has been used in order to measure health related quality of life in children and adolescents.

Children's perception of health-related quality of life is influenced by various factors such as gender, age, personal and family characteristics, as well as their socioeconomic status [46]. The KIDSCREEN group, who developed the KIDSCREEN questionnaire, conducted a study in 13 European countries testing 22'827 children [47]. The results of the study show that the higher the Family Affluence Scale (FAS) category the higher the scores on the KIDSCREEN-27 dimensions. Children aged 8-11 years achieved higher scores than adolescents aged 12-18 in all KIDSCREEN-27 dimensions but especially in the dimension *Physical Well-Being* and *Psychological Well-Being*. Overall results of Ravens-Sieberers study showed that boys reported higher health-related quality of life in the dimensions *Physical Well-Being*, *Psychological Well-Being* and *Parents Relation & Autonomy*. Further, she points out that girls aged 12-18 scored slightly higher in the *Social Support and Peers* dimension and girls aged 8-11 had higher values on the *School Environment* dimension. Haraldstad et al.'s [25] results are in line with previous findings reporting that in addition to age, being bullied and the experience of pain were significant risk factors for lower health-related quality of life in children and adolescents, adding that a positive body image was a significant predictor of higher health-related quality of life. A study by Gaspar et al. [48] which used the KIDSCREEN-52 questionnaire among 3195 children from 5th and 7th grades in Portuguese public schools also verified that boys, younger children and participants with higher SES had a better perception of their health-related quality of life. They report that the impact of the psychosocial variables and health-related quality of life is higher in children (10 to 11 years) and smaller in male students. Also, physical activity has a bigger influence on the health-related quality of life of boys, whereas on the other hand social variables have a stronger impact on girls.

So far only six longitudinal studies, ranging from six months to five years, have used the KIDSCREEN questionnaire [49-54]. These studies report that changes in health-related quality of life were more noticeable among females, indicating a decrease over time. Meade [55] further points out that those differences may be discrete but nonetheless indicative of the potential vulnerability during this stage of development.

3.2.1. Health related quality of life and low socioeconomic status in children and adolescents

The socioeconomic status is often associated with the low academic background on the parents' behalf and is reported to have a deep impact on health-related quality of life [56]. Previous research has shown a relationship between low socioeconomic status and health outcomes in adulthood, reporting that people with lower

socioeconomic status experience higher rates of morbidity and mortality than people with higher SES [57]. With regard to the impact of familial socioeconomic status on children's or adolescents' health-related quality of life, studies have found that social class gradients are related to self-reported health status and health-related quality of life [58]. An association between familial socioeconomic status and satisfaction with health, comfort, resilience and risk avoidance for both children and adolescents has been pointed out by Starfield [58]. Further, Torsheim et al. [59] found that more deprived students seem to have poorer self-rated health than less deprived students. Higher neighbourhood SES was found to be associated with better quality of life and health outcome for children [60]. Gaspar's study [48] is in line with these findings, adding that children with medium/high socioeconomic status have significantly higher mean values of health-related quality of life than children with low socioeconomic status, except regarding *Autonomy*, where children with a lower socioeconomic status show a slightly more positive (non-significant) perception.

3.2.2. Health-related quality of life in South Africa

Little research is available on the general health-related quality of life of children and adolescents in South Africa. A number of studies have documented the relationship between specific disease or infection and health-related quality of life in specific African regions [61-64]. Whereas health-related quality of life would actually be relevant for monitoring the impact of a disease on both well-being and treatment outcomes. However, appropriate screening tools to assess health-related quality of life in low-resource settings are scarce [63]. Masquillier et al. conducted a study aiming to fill this research gap and assessing the reliability of an Eastern African English version of a European health-related quality of life scale for adolescents determining which version of the KIDSCREEN (52-, 27- and 10-item version) is most suitable for low-resource settings [63]. The KIDSCREEN-27 was decided to be the most suitable. Furthermore, this version requires less time to administer than the long version (KIDSCREEN 52), but captures nonetheless all the important aspects of health-related quality of life. Nevertheless they point out that further adjustments of the KIDSCREEN-27 were required [63].

A South African study aimed to investigate the reliability and construct validity of the KIDSCREEN-52 [65]. It also assessed the internal consistency reliability of each of the scales, using Cronbach's alpha which demonstrated to be acceptable to good, with Cronbach's alpha values ranging from 0.76 to 0.81 for the 10 scales [65].

To my knowledge none of these pilot studies have yet reported further results of applying the KIDSCREEN tool in an African context. More generally speaking Ataguba et al. [66] and Myer et al. [67] point out that in South Africa, there is a strong and persistent negative relationship between socioeconomic standard and psychological distress. Therefore our article *High self-reported physical activity is a*

strong indicator for high health-related quality of life among schoolchildren in poor neighbourhoods of Port Elizabeth, South Africa is an important contribution in this field.

3.3. Associations between physical activity, fitness and health-related quality of life in children and adolescents

Over the past decades, research has demonstrated the beneficial effects of physical activity on skeletal health, obesity prevention and psychological health in children [68-70]. Numerous studies have reported a positive relationship between excess weight and decrease in health-related quality of life in children [71,72]. Obesity in general is associated with low self-image, low self-confidence and even depression influencing the quality of life [73]. Wafa et al.'s study [74] revealed that children who spent more time in sedentary behaviour had significantly lower quality of life in the *Psychosocial Health* dimension and in the *Total Score*. Breslin's study results [75], which also used the KIDSCREEN questionnaire, are also in line with previous findings. Active children scored higher on the KIDSCREEN dimension of *Satisfaction, Comfort, Resilience* and *Achievement* and reported higher *Global Self-Esteem, Social Acceptance, more Social Support* as well as better *Peer Relations* [75].

In a cross-sectional as well as longitudinal study by Gopinath et al. using a different questionnaire (Pediatric Quality of Life Inventory) [76], positive association between regular physical activity and better health-related quality of life was congruent with previous research. The longitudinal results (5-year period), showed that physically active participants (particularly engaging in outdoor activity) had higher health-related quality of life scores compared to their less active peers [76]. Furthermore, they found that adolescents who engaged in excessive screen viewing activities over the 5 year period had significantly lower scores in multiple domains of paediatric quality of life inventory [76]. From a public health perspective, a healthier lifestyle, such as increasing physical activity, can influence the health-related quality of life among children and adolescents. This knowledge is important in order to define policies intended to incentivise physical activity in the population [77].

Nevertheless, trying to summarise current research about the relationship between physical activity and fitness with health-related quality of life, leaves some questions still open. Lindwall et al. [78] raise awareness that fitness measures and self-reported physical activity are not per definition the same thing and might relate differently to health, particularly when examining both physiological and mental health parameters at the same time. For instance, researchers found that only small correlations existed between self-reported physical activity and children's performance in the 20-meter shuttle run test [79]. Although physical fitness can generally be regarded as a proxy measure of physical activity, physical fitness

depends on sex, age and genetic factors, whereas physical activity is purely behavioural [80]. This could be due to the fact that both, self-reported physical activity and health-related quality of life, are subjectively measured variables and may share common method variance [81]. For example, in a study with Swedish adults, Lindwall et al. [82] observed that self-reported physical activity is more closely associated with mental health outcomes than objectively assessed cardiorespiratory fitness. They therefore argued, that physical activity does not primarily affect mental health through improved fitness and cardiovascular change, but that psychological processes (e.g., perceptions of mastery, perceived control over one's health and body) might be more important factors. A further aspect that needs to be taken into account is that self-reported physical activity might sometimes be over-reported. Meaning that 90 minutes of at least moderate intensive physical activity reported through a subjective measure might actually be shorter in time or less intense when captured objectively [68]. Hamer et al. undermine these previously discussed results. Their study analysed the associations of objectively assessed physical activity and fitness with subjective measures of wellbeing. Strong associations were found between objectively assessed moderate-to-vigorous physical activity and self-rated health, although no association was detected for fitness and self-rated health. No relationship was observed between fitness and objectively assessed physical activity and psychological wellbeing [83].

There is still little evidence on the association between physical activity and fitness and health-related quality of life in low- and middle-income countries. In South Africa only one study has examined the relationship between children's physical activity and their quality of life, showing that schoolchildren from a disadvantaged community have higher scores across all domains of quality of life if they participated in sports at least twice a week [84].

4. Method

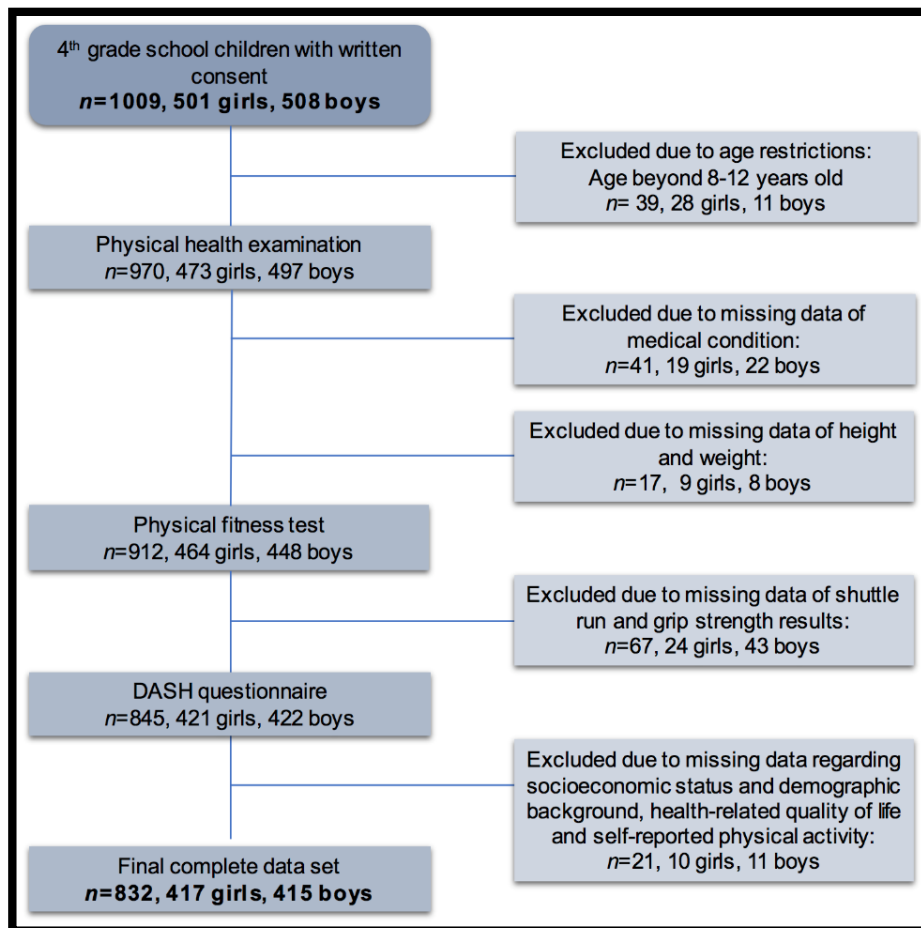
4.1. General information

Details regarding the information of potential study participants, inclusion and exclusion criteria have been published previously [85]. Baseline data was collected from a total of 1009 grade four schoolchildren, aged between 8 and 12 years, in February/March 2015. South African public schools are classified into five different groups depending on their financial resources, ranging from quintile one (poorest) to quintile five (least poor) [86]. The DASH study was conducted in eight quintile three schools, located in deprived neighbourhoods in Port Elizabeth, South Africa.

4.2. Study population and participant flow chart

As shown in the participant flow chart (Figure 1), after receiving written consent from a parent or legal guardian, a total of 1009 students agreed to take part in the study. Complete data records were available for 832 children. All analyses presented in this article refer to this final cohort, including 417 girls (50.1%) and 415 boys (49.9%).

Figure 1. Participant flow chart



4.3. Physical activity and cardiorespiratory fitness

In our study physical activity behaviour was assessed with a single-item question from the Health-Behaviour of School-Aged Children (HBSC) study: “Over the past 7 days (1 week), on how many days were you physically active for a total of at least 60 minutes (1hours) a day?” [87]. The options to answer the question ranged from zero days to seven days.

To measure children’s cardiorespiratory fitness, the 20-meter shuttle run test was carried out [88]. Based on their VO₂max scores, students were categorized into

three groups with (a) low CRF (children in the lowest quartile), (b) moderate CRF (second and third quartiles), and (c) high CRF (fourth quartile).

4.4. Socioeconomic status

In order to estimate children's socioeconomic status, they were asked to answer nine items, covering household-level living standards, such as infrastructure and housing characteristics (e.g. washing machine for clothes) and questions related to ownership of durable assets (e.g. "Do your parents have a cell phone?"). The dichotomized items (0=poor quality, not available; 1=higher quality, available) were summed up to build an overall SES index, with higher scores reflecting higher SES. The validity of similar measures has been established in previous research [89].

4.5. BMI

Body height was measured once and recorded to the nearest 0.1 cm. Body weight and height values were used to calculate Body Mass Index (BMI), defined as weight (in kg)/height² (in m²). The BMI was calculated using the WHO growth reference [90]. The BMI and Height-for-Age Z-Scores (HAZ) were calculated using the WHO growth reference [90].

4.6. DASH questionnaire

A setting-specific questionnaire was developed and divided into six different segments; The d2-test of attention, a socioeconomic and demographic profile, a brief self-control scale, a school burnout inventory, including the KIDSCREEN-27 questionnaire. To ensure transparency and comprehensibility, the questionnaire was translated into English, Afrikaans and Xhosa. In the classroom, a translator, two to three community members, a researcher and the teacher helped with the comprehension of the questionnaire. It was worked on in sections with multiple breaks in between and needed two days for completion [85].

4.7. KIDSCREEN questionnaire

The KIDSCREEN generic health-related quality of life measures for children and adolescents were developed within the project "Screening and Promotion for Health-related Quality of Life in Children and Adolescents - A European Public Health Perspective." The project was funded by the European Commission and took place over three years from 2001 until 2004 [22]. Its purpose was to assess generic health-related quality of life in healthy and chronically ill children and adolescents, to identify children at risk with regard to their subjective health, and to suggest appropriate early interventions by including the instrument in health services research and health reporting [22]. The KIDSCREEN instruments were designed to address generic health-related quality of life. They are based on a

comprehensive process of development across different countries. The instruments are designed to assess health-related quality of life in a standardized format as reported by children/ adolescents or parents. The KIDSCREEN measures are applicable to healthy and chronically ill children and adolescents from 8 to 18 years [22]. The original long version is the KIDSCREEN-52 allowing detailed profile information for ten Rasch-scaled dimensions. The KIDSCREEN-27 was developed as a shorter version of the KIDSCREEN-52 including five Rasch scaled dimensions with a minimum of information loss and with good psychometric properties [22].

For the DASH study the KIDSCREEN-27 instrument was chosen in order to measure the health-related quality of life. The KIDSCREEN-27 is not designed as a clinical diagnostic tool for screening psychiatric disorders, but rather to measure overall well-being [55]. The questionnaire consists of 27 items which can be divided into 5 dimensions. The questions were answered on a 5-point Likert scale ranging from never/not at all (0) to always (5). In the present study, the internal consistency values (Cronbach's Alpha) of the self-reported KIDSCREEN-27 are shown to be acceptable across all five dimensions, with Cronbach's alpha values varying between $\alpha = .67$ and $.72$.

The children were asked to think about their last week and report on their feelings. They were reminded that this is not a test and that there will be no marks and no wrong answers. Instructors also told the children that no one else will get to see the results. The questions 1, 9 and 10 had to be converted as the answers on the Likert scale meant the opposite compared to the answers of the other questions.

A key controversial issue is the impact of language on final scores. Measures were adapted from one language and culture to derive a valid measurement to another cultural context [91]. However, language difficulties or the literacy level of test-takers and low familiarity with item content can influence test scores. Administering a test in a language other than the mother tongue of the test-takers can also have an impact on test scores [65]. In order to prevent critical discussion about the validity of the KIDSCREEN-27 tool in the setting of disadvantaged communities in South Africa, the tool would have to be tested on its validity in a pilot study.

4.7.1. Physical Well-Being

This dimension explores the level of physical activity, energy and fitness of the child/adolescent and to which extent they feel unwell or complain of poor health. It contains the following questions [22]:

- In general, how would you say your health is? (excellent, very good, good, fair, poor)
- Have you physically felt fit and well? (never, seldom, sometimes, often, always)
- Have you been physically active? (never, seldom, sometimes, often, always)

- Have you been able to run well? (never, seldom, sometimes, often, always)
- Have you felt full of energy? (never, seldom, sometimes, often, always)

4.7.2. Psychological Well-Being

Psychological Well-Being examines elements such as positive emotions and satisfaction with life and the absence of loneliness and sadness [22].

- Has your life been enjoyable? (never, seldom, sometimes, often, always)
- Have you been in a good mood? (never, seldom, sometimes, often, always)
- Have you had fun? (never, seldom, sometimes, often, always)
- Have you felt so bad that you didn't want to do anything? (never, seldom, sometimes, often, always)
- Have you felt lonely? (never, seldom, sometimes, often, always)
- Have you been happy with the way you are? (never, seldom, sometimes, often, always)

4.7.3. Autonomy and parents

The dimension *Autonomy and Parents Relations* examines the quality of child/adolescent and parent/care-giver interactions and the extent to which the child/adolescents feels loved and supported by the family. Furthermore, it explores the level of autonomy that the child/adolescent perceives to possess and the quality of financial resources perceived by the child/adolescent [22].

- Have you had enough time for yourself? (never, seldom, sometimes, often, always)
- Have you been able to do the things that you want to do in your free time? (never, seldom, sometimes, often, always)
- Have your parent(s)/guardian(s) paid enough attention to you? (never, seldom, sometimes, often, always)
- Have your parent(s)/guardian(s) treated you fairly? (never, seldom, sometimes, often, always)
- Have you been able to talk to your parent(s)/guardian(s) when you wanted to? (never, seldom, sometimes, often, always)
- Have you had enough money for your needs? (never, seldom, sometimes, often, always)

Improved caregiver-child interactions promote the health and development of vulnerable children. They also increase the resilience of young children to the damaging effect of poverty and deprivation [92]. Reciprocal relations between negative parenting and children's prosocial behaviour have been pointed out by empirical studies. On the other hand, being prosocial in late childhood contributes to some degree to the enhancement of nurturing and involved mother-child relationships [93].

4.7.4. Peers and Social Support

This dimension explores the quality of the child's/adolescent's social relations and interactions with friends and peers, and the extent of their perceived support [22].

- Have you spent time with your friends? (never, seldom, sometimes, often, always)
- Have you had fun with our friends? (never, seldom, sometimes, often, always)
- Have you and your friends helped each other? (never, seldom, sometimes, often, always)
- Have you been able to rely on your friends? (never, seldom, sometimes, often, always)

4.7.5. School Environment

With regard to the school environment the perceptions that a child/adolescent holds regarding their cognitive capacity, learning and concentration have been explored. This dimension also examines how the child/adolescent views the relationship between themselves and their teachers [22].

- Have you been happy at school? (never, seldom, sometimes, often, always)
- Have you got on well at school? (never, seldom, sometimes, often, always)
- Have you been able to pay attention? (never, seldom, sometimes, often, always)
- Have you got along well with your teachers? (never, seldom, sometimes, often, always)

5. Results and further results

5.1. Statistical analysis

Univariate analyses of variance (ANOVAs) were calculated to examine gender differences in the main study variables. Moreover, Chi²-tests were calculated to examine whether boys and girls are equally represented in the groups with low, moderate or high physical activity and fitness levels. Finally, multi- and univariate analyses of variance ([M]ANOVA) and covariance ([M]ANCOVA) were calculated to test whether children classified in the groups with low, moderate or high physical activity and cardiorespiratory fitness differ with regard to health-related quality of life, before and after controlling for gender, age, SES, BMI, school class and cardiorespiratory fitness (if physical activity was used as dependent variable) or physical activity (if cardiorespiratory fitness was used as dependent variable).

5.2. Results

Table 1 provides an overview of the descriptive statistics and gender differences for all study variables. Significant differences between boys and girls were found for age, BMI and VO₂max. However, no significant gender difference was found for self-reported physical activity ($p = .057$) With regard to health-related quality of life, girls had significantly higher scores than boys in two out of the five KIDSCREEN dimensions (autonomy and parent relations; social support and peers).

A Pearson correlation analysis was conducted, where strong correlations among KIDSCREEN dimensions were found ($r = .25$ to $.59$, $p < .001$).

ANOVA showed an overall significant relationship between the KIDSCREEN dimensions and self-reported physical activity (all $p < .001$). Whereas on the other hand no significant relations could be found in the MANOVA as well as the follow up MANCOVA between the KIDSCREEN dimensions and cardiorespiratory fitness.

Self-reported physical activity but not cardiorespiratory fitness is significantly related to self-reported health-related quality of life. Schoolchildren who reach the recommended WHO guidelines for physical activity show significantly higher results in health-related quality of life among all five KIDSCREEN dimensions in comparison to children with low physical activity.

Self-reported physical activity seems to be a more informative tool than cardiorespiratory fitness in order to monitor health-related quality of life among schoolchildren. Supervising self-reported behaviour of regular physical activity has a great potential for preventive action to support children's mental health.

Table 1. Characteristics of the study population, descriptive statistics, and differences between Boys and Girls

Parameter	total	boys	girls	<i>F</i>	<i>p</i>	η^2
	<i>n</i> =832 <i>M</i> (<i>SD</i>)	<i>n</i> =417 <i>M</i> (<i>SD</i>)	<i>n</i> =415 <i>M</i> (<i>SD</i>)			
Age and anthropometry						
Age (years)	9.5 (0.9)	9.7 (0.9)	9.4 (0.9)	26.10	<.001	.030
Height (cm)	133.1 (7.1)	133.2 (6.7)	133.0 (7.5)	0.19	.663	.000
Weight (kg)	30.5 (7.5)	30.0 (6.5)	31.0 (8.3)	3.27	.071	.004
BMI (kg/m ²)	17.0 (3.0)	16.8 (2.6)	17.3 (3.3)	6.25	.013	.007
Sociocultural characteristics						
Socioeconomic status ^a	7.3 (1.9)	7.3 (1.9)	7.4 (1.9)	0.38	.539	.000
Cardiorespiratory fitness						
Shuttle run (VO ₂ max) ^b	49.0 (4.3)	50.8 (4.3)	47.2 (3.5)	174.46	<.001	.174
Self-reported physical activity						
60 minutes active per day/week ^c	3.5 (2.5)	3.7 (2.4)	3.3 (2.5)	3.63	.057	.004
Health-related quality of life						
Physical well-being ^d	50.5 (13.2)	50.3 (13.4)	50.7 (13.0)	0.28	.598	.000
Psychological well-being ^d	38.3 (8.6)	38.3 (9.8)	38.3 (7.2)	0.00	.996	.000
Autonomy and parent relations ^d	49.5 (12.4)	48.4 (12.6)	50.6 (12.2)	6.21	.013	.007
Social support and peers ^d	48.6 (11.8)	48.0 (12.0)	49.3 (11.4)	2.74	.099	.003
School environment ^d	55.4 (12.4)	53.6 (12.9)	57.1 (11.7)	16.84	<.001	.020

^aSocioeconomic status measured by ownership and housing questions on a scale from 0-9 points (0 = low score), ^ball mean VO₂ estimates are expressed in ml kg⁻¹ min⁻¹ and are adjusted for age, ^cphysical activity measured by question on how many days achieved activity of at least 60 minutes on a scale from 0-7 days (0=never, 7=each day of the week), ^dKIDSCREEN questionnaire answered on a 5-point Likert scale (0=never/not at all, 5=always)

Table 2. Levels of Self-Reported Physical Activity and Cardiorespiratory Fitness, in Boys and Girls

	Total n=832		Boys n=417		Girls n=415	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Self-reported physical activity						
Low (0-1 days/week)	229	27.5	104	24.9	125	30.1
Moderate (2-5 days/week)	376	45.2	196	47.0	180	43.4
High (6-7 days/week)	227	27.3	117	28.1	110	26.5
Cardiorespiratory Fitness						
Low (1st quartile) ^a	236	28.4	61	14.6	175	42.2
Moderate (2nd and 3rd quartile) ^b	382	45.9	189	45.3	193	46.5
High (4th quartile) ^c	214	25.7	167	40.0	47	11.3

Note. ^aScores of students in the first quartile are ranging from 37.78 to 45.68. ^bScores of students in the second and third quartiles are ranging from 45.69 to 51.96. ^cScores of students in the fourth quartile are ranging from 51.97 to 61.86.

Table 3. Health-Related Quality of Life as a Function of Self-Reported Physical Activity

	Low physical activity (0-1 days/week) (n = 229)		Moderate physical activity (2-5 days/week) (n = 376)		High physical activity (6-7 days/week) (n = 227)		Model 1		Model 2		
	M (SD)		M (SD)		M (SD)		F	p	F	p	
Physical well-being	46.4 (12.4) ^{a,b}		50.3 (13.1) ^{a,c}		54.1 (13.3) ^{b,c}		20.52	<.001	16.00	<.001	.037
Psychological well-being	36.3 (8.3) ^{a,b}		38.2 (9.1) ^{a,c}		40.3 (7.4) ^{b,c}		12.70	<.001	6.84	<.001	.016
Autonomy and parent relations	46.7 (10.7) ^a		49.0 (12.4) ^b		53.0 (13.3) ^{a,b}		15.90	<.001	12.14	<.001	.029
Social support and peers	47.0 (11.3) ^a		47.7 (11.3) ^b		51.9 (12.2) ^{a,b}		12.74	<.001	6.58	<.001	.016
School environment	52.6 (12.3) ^a		54.7 (12.1) ^b		59.4 (12.4) ^{a,b}		17.69	<.001	9.07	<.001	.022

Note. Degrees of freedom = 2,832 across all analyses. Model 1 = uncontrolled. Model 2 = controlled for age, gender, BMI, socioeconomic status, cardiorespiratory fitness, and school class.

Table 4. Health-Related Quality of Life as a Function of Cardiorespiratory Fitness

	Low fitness (1st quartile) (<i>n</i> = 236)		Moderate fitness (2nd+3rd quartiles) (<i>n</i> = 382)		High fitness (4th quartile) (<i>n</i> = 214)		Model 1		Model 2	
	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>F</i>	<i>p</i>	η^2	<i>F</i>	<i>p</i>	η^2
Physical well-being	49.7 (13.3)	51.3 (13.2)	50.5 (13.3)	1.17	.311	.003	0.60	.548	.001	
Psychological well-being	38.0 (8.1)	38.5 (8.8)	38.1 (8.7)	0.26	.768	.001	0.20	.820	.000	
Autonomy and parent relations	48.7 (12.7)	50.5 (12.8)	48.5 (11.3)	2.41	.090	.006	1.97	.140	.005	
Social support and peers	48.3 (12.6)	48.9 (11.8)	48.5 (10.7)	0.20	.818	.000	0.12	.887	.000	
School environment	55.0 (12.6)	55.9 (12.5)	54.8 (12.3)	0.65	.521	.002	1.27	.281	.003	

Note. Degrees of freedom = 2,832 across all analyses. Bonferroni post-hoc tests: Mean values with equal letters are significantly different. Model 1 = uncontrolled. Model 2 = controlled for age, gender, BMI, socioeconomic status, cardiorespiratory fitness, and school class.

6. Further discussion and research questions

This section will provide a summary of the discussion from the article. Furthermore, some aspects will be discussed in more detail due to limitations of scope and focus within the present manuscript.

6.1. Summary

The main aim of this study was to examine how self-reported physical activity and cardiorespiratory fitness are associated with health-related quality of life in children living in disadvantaged neighbourhoods in Port Elizabeth, South Africa. The key finding is that schoolchildren who are physically active for more than 60 minutes on at least six days a week reported significantly higher health related quality of life than their peers with lower physical activity levels, even after controlling for possible confounders. Furthermore, our results suggest that even a medium amount of self-reported physical activity is positively associated with health-related quality of life among children living in disadvantaged areas in a low-to-middle income country such as South Africa. Our findings are in line with previous investigations showing that physically active children generally perceive better health-related quality of life [94-97].

The fact that no significant differences were found between children with low, moderate and high cardiorespiratory fitness levels was unexpected. Although cardiorespiratory fitness can generally be regarded as a proxy measure of physical activity, cardiorespiratory fitness depends on sex, age, and genetic factors, whereas physical activity is purely behavioural [98]. Because physical activity and health-related quality of life are based on self-reports, these constructs may share common method variance. Nevertheless, as researchers have reported multiple benefits between higher cardiorespiratory fitness levels and other psychological variables, increased cardiorespiratory fitness should still be considered as key target for public health promotion [99].

6.2. Comparison of KIDSCREEN dimensions between DASH study population and European KIDSCREEN norm data

This section is a more in-depth discussion about the comparison of the KIDSCREEN norm data and our study population.

The KIDSCREEN Group Europe provides European norm data for children and adolescents, referring to a total of 3977 participants. There were 1460 children between the age of 8 and 11 years and the distribution by age and gender were reported to be fairly good and comparable across countries. Most noticeable difference is recognisable in the dimension *Psychological Well-Being* with the South African study population indicating a clearly lower result. However, in an Australian longitudinal study

by Meade [55] similar findings were reported. In their sample, Australian students reported similar levels of health-related quality of life to European adolescents with the exception of strikingly lower levels in the *Psychological Well-Being* dimension [55].

Table 5. Comparison of DASH study population and European Norm data (KIDSCREEN-27)

Parameter	DASH study population aged 8-12 years			European KIDSCREEN-27 population aged 8-11 years		
	total	boys	girls	total	boys	girls
Health-related quality of life						
Physical well-being ^a	50.5	50.3	50.7	52.7	53.2	52.1
Psychological well-being ^a	38.3	38.3	38.3	51.7	51.5	51.9
Autonomy and parent relations ^a	49.5	48.4	50.6	50.8	50.45	50.3
Social support and peers ^a	48.6	48.0	49.3	50.4	50.2	50.6
School environment ^a	55.4	53.6	57.1	53.0	51.5	54.3

^aKIDSCREEN questionnaire answered on a 5-point Likert scale (0=never/not at all, 5=always)

As shown in Table 5 the South African study population achieved higher results in the *School Environment* dimension compared to the European sample. We think this could be explained due to the fact that the apartheid government and the forced removal of black communities into so called townships had major effects on the black population and are still visible today. Many housing facilities in townships are still very basic, consist of one room houses and are mostly crowded. Therefore, children might consider school as a “sanctuary”, which provides relief from the troubles associated with everyday life. Furthermore, teachers might be cherished as supporters in difficult living condition and viewed as link to escape the vicious circle of poverty. In line with this, the 2016 South African Early Childhood Review showed that 63% of all South African children live in poverty, that 28% live in households where nobody is employed, and that 30% of all pregnant women are tested HIV+ [100]. Whereas, in higher income countries school environments might be associated with the pressure to perform, achieve high marks and adapt to social norms.

6.3. BMI and health-related quality of life

The association between BMI and health-related quality of life was not discussed in more detail within the article. No significant results were found comparing these two variables after controlling for covariates. Contrary to what we expected, there were no significant associations between BMI and any of KIDSCREEN dimensions for health-related quality of life.

Tsiros et al. [72] account that twenty-two cross-sectional and population-based studies have reported that obesity reduced the overall health-related quality of life compared to their normal weight counterparts. Nevertheless, there still seem to be some inconsistencies among findings about childhood obesity and its effect on health-related quality of life. Tsiros et al. also mention three smaller cross-sectional studies which did not observe a significant inverse relationship between BMI and overall health-related quality of life [101-103]. In a study which also used the KIDSCREEN-27 tool among children living in Irish urban disadvantaged communities, BMI was weakly inversely associated with 'total health-related quality of life' ($r = -.15, p < .05$), *Physical Well-Being* and *Autonomy and Parent Relations*. Significant differences were found between normal weight and obese children on the dimension *Psychological Well-Being, Social Support and Peers* and *School Environment* [54]. A possible explanation might be that BMI is an objective measure whereas on the other hand the subjective experience of well-being and body image is a subjective measure based on self-report. Even if children's and adolescents' BMI are normal, their perception of their own body size may be negative. Thus, the concept of body image might be a relevant predictor of health-related quality of life because of the subjective nature of the concept [25]. However, considering the concept of body image, the cultural background has to be taken into account. The relationship between the objectively measured BMI and the subjectively assessed body image might vary according to the prevailing perception of the ideal of beauty. Pulvers et al. suggest that instruments measuring body image need to be culturally relevant tools [104].

6.4. Strengths and Limitations

While our study provides novel insights with regard to the association between physical activity, cardiorespiratory fitness and health-related quality of life in South African schoolchildren, the current results must be considered in light of certain limitations. First, the sample is limited to fourth grade students attending quintile 3 schools in urban areas. Thus, caution is needed when generalizing the findings. The same applies to the cross-sectional nature of the study precluding causal inferences. Second, information about self-reported physical activity is exclusively based on subjective self-report, which may differ from other informants or objective measurements. Also, physical activity was assessed with a simple 1-item measure. Third, three categories (low, moderate or vigorous physical activity) were created in order to compare groups according to their self-reported physical activity. These subcategories refer to internationally accepted physical activity standards [105]. Last, no concept has yet been established on how to treat children and parent with especially low health-related quality of life. Similar actions were considered in relation with bad conditions of physical health (e.g. parasite infections) and treatments were provided. However, no such steps have yet been taken for the psychological part.

The present study expands previous research in several important ways. First, it contributes to the sparse prevailing research on the association between physical activity and health-related quality of life among disadvantaged children and adolescents. Second, the results spur the discussion on the relationship between objectively measured fitness and subjectively measured physical activity and on the association, that these two measuring methods have with health-related quality of life. Third, it underlines the importance of daily physical activity and supports the prevailing physical activity recommendation for children and adolescents.

7. Conclusion

In South Africa, poverty and stress jeopardize children's health [106]. By contrast, participation in sufficient amounts of daily physical activity is positively associated with health-related quality of life. This finding is important because health-related quality of life does not only have an immediate impact on children's well-being, but also tracks into adulthood, with negative long-term consequences for both the individual and the society [107]. Further research is needed to determine how physical activity levels of South African children can be increased, for example, through school-based physical activity interventions, and to find out how such an increase impacts on children's health-related quality of life.

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11. Appendix

11.1. Declaration of Authenticity

I Marina Salvini declare that all material presented in this paper is my own work or fully and specifically acknowledged wherever adapted from other sources. I confirm that the presented thesis, or parts of it, have not been presented or submitted in a different university, institution of higher education, seminar or project. I understand that if at any time, it is shown that I have significantly misrepresented material presented here, any degree or credits awarded to me on the basis of that material may be revoked. I declare that all statements and information contained herein are true, correct and accurate to the best of my knowledge and belief.

Ich versichere hiermit, dass ich die vorgelegte Arbeit selbstständig angefertigt und keine anderen als die in der Arbeit angegebenen Hilfsmittel benutzt habe. Alle Stellen, die wörtlich oder sinngemäss aus Quellen entnommen wurden, habe ich als solche gekennzeichnet. Darüber hinaus bestätige ich, dass die vorgelegte Arbeit nicht an einer anderen Hochschule als Abschluss-, Seminar- oder Projektarbeit oder als Teil solcher Arbeiten eingereicht wurde. Ich bin mir bewusst, dass Plagiate gemäss § 28 der Ordnung für das Masterstudium «Sports Sciences» (Sportwissenschaften) an der Medizinischen Fakultät der Universität Basel vom 30. Januar 2006 als unlauteres Prüfungsverhalten gewertet werden und kenne die Konsequenzen eines solchen Handelns.

Wettingen, 27.04.17

(Datum)



(Unterschrift)

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Wettingen, 27.04.17

(Datum)



(Unterschrift)

20 meter shuttle run

Purpose

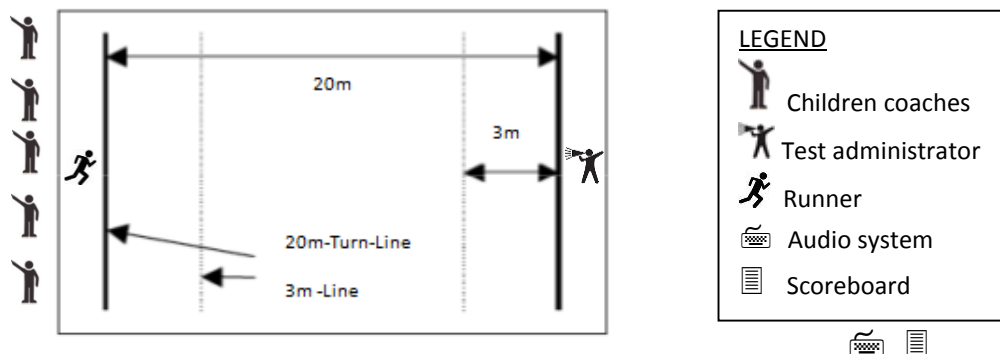
Measurement of cardiovascular endurance

Equipment

- Numbered sports bibs (1 – 50)
- Portable audio system
- USB stick with audio
- Scoreboard (numbered 1-100)
- 50 colour co-ordinated beacons
- 80m rope
- Four tent pegs
- Minimum number of people required to run test: 8
 - 1 runner
 - 1 manager of audio system and scoreboard
 - 1 test administrator ensuring children fulfil test requirements
 - 5 children coaches (4 children per coach, maximum of 20 children per shuttle run)

Site construction

An 80m rope is used to mark the 20m x 20m demarcated area. The 80m rope is premeasured at each 20m point which allows the researcher to mark the area using the four tent pegs. One beacon is placed 3m from each corner of the turn-line which is used as a control measure (Adaptation from original test description which states 2m). Forty coloured cones are placed along each 20m turn-line (20 cones per line which must be colour coordinated). Each child is assigned to a coloured cone to ensure the children run in a straight line. Before the test starts children should know the colour of their cone that they were assigned to.



Procedure

The shuttle run test is administered between two lines 20m apart, the child runs between the two lines in time to the recorded audio signals. The running speed is controlled by intervals of recorded sound signals, also known as “beeps”. The test starts with the child standing behind one of the turn-lines facing the direction of the other turn-line and should begin running when instructed by the audio. At the beginning of the test, the running speed is 8.5 km/h. The child will run continuously between the two turn-lines and turn only when they reach the 20m turning line. The child must touch the line with their foot and turn as quickly as possible. Every minute, the audio will signal an increase in speed by 0.5 km/h in which the beep signals will be closer together. The children run at a uniform pace, this means that they do not run faster or slower than the speed specified by the sound signals.

Instruction to participant

The test administrator explains the procedure in the children's home language afterwards the runner will demonstrate the test prior to the test being conducted.

"The test starts slowly and gets faster and faster. At each 'beep' you have to touch the marked line (which represents the 20m mark) with your foot. You must reach the turn-line on time and you must wait until the signal is heard, only then are you allowed to run. If you are not at the turning line on time, you have to catch up, by running faster to reach the turn-line in time. A 'runner' will run with you, please do not overtake him. Stop only when you are tired or if the test administrator says that the test is completed."

Data collection and error sources

- A volunteer will keep record of the number of the completed lengths with a scoreboard which is displayed during the test.
- Scoring: Record the last completed lap (and not necessarily the lap stopped at)
- The test result is the number of full laps completed.
- If a child has not reached the 20m turning line, they need to catch up and run faster to touch the line with their foot before they can continue.
- If the child runs before the time, the test administrator must ask the child to return to the line.
- If the children stop running, they should leave the field as quickly as possible without disturbing the other children.
- Termination of test:
 - If children stop by themselves due to exhaustion.
 - If children do not reach the 3m-line twice in a row after a warning.
 - The test administrator determines whether the child has reached the 3m- line or not.

DASH Standardization

- The test administrator must ensure that the testing environment has limited noise and distraction. Volunteers will be placed on each side of the 20m line to inform the children to run to their designated cone/ not to run to fast or not to run not to run ahead of the runner.
- Giving instructions before the test is advisable (tying shoelaces, run in a straight line, run faster or slower, wait at the line etc.)
- Encouraging the children is allowed!

Source

- Test-protocol from Léger *et al.* 1984

Table 1: Test Protocol Summary

Levels	Shuttles	Cumulative Shuttles	Speed (km/h)	Shuttle Time (s)	Total level time (s)	Distance (m)	Cumulative Distance (m)	Cumulative Time (mm:ss)
1	7	7	8.5	9.00	63.00	140	140	01:03
2	8	15	9.0	8.00	64.00	160	300	02:07
3	8	23	9.5	7.58	60.63	160	460	03:08
4	9	32	10.0	7.20	64.80	180	640	04:12
5	9	41	10.5	6.86	61.71	180	820	05:14
6	10	51	11.0	6.55	65.50	200	1020	06:20
7	10	61	11.5	6.26	62.61	200	1220	07:22
8	11	72	12.0	6.00	66.00	220	1440	08:28
9	11	83	12.5	5.76	63.36	220	1660	09:31
10	11	94	13.0	5.54	60.92	220	1880	10:32
11	12	106	13.5	5.33	64.00	240	2120	11:36
12	12	118	14.0	5.14	61.71	240	2360	12:38
13	13	131	14.5	4.97	64.55	260	2620	13:43
14	13	144	15.0	4.80	62.40	260	2880	14:45
15	13	157	15.5	4.65	60.39	260	3140	15:46

The 20 m shuttle run test: Prediction of VO₂max according to speed and age

The age of the participating child and the speed at which the child stopped running will be converted into the maximum volume of oxygen that can be utilized within 1 min during exhaustive exercise (VO₂ max). The equation below will be used to calculate the VO₂ max value, the equation is as follows:

$$Y = 31.025 + 3.238 * X - 3.248 * A + 0.1536 * A * X$$

Y = VO₂max Value

X = reached speed (km/h)

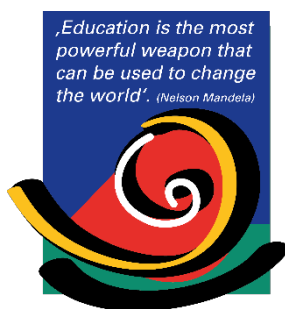
A = rounded lower age

Survey on the impact of disease burden on schoolchildren's physical fitness and psychosocial health in Port Elizabeth, South Africa

Questionnaire

SSAJRP-project

Version 7, 27 January 2015



Hello,

How are you? How do you feel? This is what we would like **you** to tell us and is the reason why we are doing this questionnaire with you. We are not looking for right or wrong answers. We simply want you to write the response that tells us your feelings.

Please read every question carefully. Whatever answer comes to your mind that best reflects your feelings, choose the box that fits that answer best and tick (✓) it. The entire test takes about 2 hours. After 1 hour, you have earned a 15 minute break.

Remember:

- This is not a test.
- There is no mark, and there are no wrong answers.
- Please answer all the questions, as honestly and accurately as you can.
- It is important that you answer all the questions.
- Make sure we can see your marks clearly.
- You do not have to show your answers to anybody.
- All answers remain secret.
- Neither your teacher nor the school principal gets to see the answers.
- Please only tick one box (☐) when answering the questions.
- If you have ticked something wrong, then cross out the field and mark the right place.
- If something is unclear, you can ask one of the investigators of course.

When you are done, please give the questionnaire directly to the investigator. Thank you!

Port Elizabeth and Basel, January 2015; the SSAJRP-team

PART B
SOCIO-ECONOMIC AND DEMOGRAPHIC PROFILE

1. ID-Number (filled out by the researcher):

2. First name:

3. Surname:

4. Age: (in completed years)

5. Grade:

6. Surname of the teacher:

7. Ethnic group/race: 1. Black 2. Indian 3. Coloured 4. White

5. Mixed: _____ & _____

8. Home language: 1. Xhosa 2. Afrikaans 3. English 4. Other: _____

9. Asset ownership: Do you have at home...

- | | | |
|---|---|-----------------------------|
| a. ... a washing machine for clothes? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| b. ... a fridge? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| c. ... a freezer for food? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| d. ... radios? | <input type="checkbox"/> Yes, how many: _____ | <input type="checkbox"/> No |
| e. ... a land line phone / house phone? | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| f. ... a television? | <input type="checkbox"/> Yes, how many: _____ | <input type="checkbox"/> No |
| g. Do your parents have a cell phone? | <input type="checkbox"/> Yes, how many: _____ | <input type="checkbox"/> No |
| h. Does your family have a car? | <input type="checkbox"/> Yes, how many: _____ | <input type="checkbox"/> No |
| i. Does your family have a computer? | <input type="checkbox"/> Yes, how many: _____ | <input type="checkbox"/> No |

Housing questions:

10. Do you live in a ...

- a. Shack in informal settlement
- b. Backyard shack/room
- c. Privately built house
- d. RDP house
- e. Council house
- f. Other, specify:

11. How is your house made?

- a. Zinc
- b. Bricks
- c. Wood
- d. Other, specify:

12. How many bedrooms does your house have?

13. Do you have a bathroom inside your house? Yes No

14. Do you have a toilet inside your house? Yes No

15. What type of toilet does your house have?

- a. Flush toilet
- b. Pit toilet
- c. Bucket
- d. Communal toilet

16. How does your family get water?

- a. Taps inside house
- b. Tap in the yard
- c. Water tank
- d. Communal tap/tap shared with other families

17. Does your house have electricity? Yes No

18. How does your family cook food? With ...

- a. Electricity
- b. Gas
- c. Paraffin stove
- d. Fire

Family questions:

19. How many other people live in your house with you?

20. Who looks after you for the most of the time?

- a. Mother and father
- b. Mother only
- c. Father only
- d. Grandparents
- e. Brothers or sisters
- f. Other adults / guardians

21. Who in your house has a job?

- a. Both parents / guardians
- b. One parent or guardian
- c. None is employed

22. Does any person in your house get a government grant? Yes No Don't know

PART C
BRIEF SELF-CONTROL SCALE (SCS)

Please choose the answer that best describes how you typically are.

	Never	Seldom	Sometimes	Often	Always
23. I am lazy.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24. I say things that are strange and out of place.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25. I do certain things that are bad for me, if they are fun.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26. I refuse things that are bad for me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27. I am lacking self-discipline.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
28. I can't stop myself from doing something, even if I know it is wrong.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

PART D
SCHOOL BURNOUT INVENTORY (SBI)

Please choose the answer that best describes your situation at school. Think about the last week...

	Never	Seldom	Sometimes	Often	Always
29. I feel overstressed by my schoolwork.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30. I feel a lack of motivation in my schoolwork.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31. I think of giving up in my schoolwork.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
32. I feel that my schoolwork is weak.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
33. I sleep badly because of a matter related to my schoolwork.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
34. I feel that I am losing interest in my schoolwork.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
35. I am wondering whether my schoolwork has any meaning.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
36. I brood over matters related to my schoolwork a lot during my free time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
37. I am not able to achieve so well in my school work.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
38. I learn things quickly in most school subjects.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

PART E

KIDSCREEN-27: Health Questionnaire for Children and Young People

Think about the last week...

39. In general, how would you say your health is?

- a. Excellent
- b. Very good
- c. Good
- d. Fair
- e. Poor

	Never	Seldom	Sometimes	Often	Always
40. Have you physically felt fit and well?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
41. Have you been physically active (e. g. running, playing)?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
42. Have you been able to run well?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
43. Have you felt full of energy?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
44. Has your life been enjoyable?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
45. Have you been in a good mood?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
46. Have you had fun?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
47. Have you felt sad?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
48. Have you felt so bad that you didn't want to do anything?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
49. Have you felt lonely?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
50. Have you been happy with the way you are?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
51. Have you had enough time for yourself?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
52. Have you been able to do the things that you want to do in your free time?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	Never	Seldom	Sometimes	Often	Always
53. Have your parent(s)/guardian(s) paid enough attention to you?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
54. Have your parent(s)/guardian(s) treated you fairly?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
55. Have you been able to talk to your parent(s)/guardian(s) when you wanted to?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
56. Have you had enough money to do the same things as your friends?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
57. Have you had enough money for your needs?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
58. Have you spent time with your friends?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
59. Have you had fun with your friends?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
60. Have you and your friends helped each other?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
61. Have you been able to rely on your friends?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
62. Have you been happy at school?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
63. Have you got on well at school?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
64. Have you been able to pay attention?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
65. Have you got along well with your teachers?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

PART F
Health Behaviours in School Age Children Survey

Physical activity can be done in sports, school activities, playing with friends or walking to school.

66. Over the past 7 days (1 week), on how many days were you physically active for a total of at least 60 minutes (1 hour) per day?

- | | | | |
|--------|--------------------------|--------|--------------------------|
| 0 days | <input type="checkbox"/> | 4 days | <input type="checkbox"/> |
| 1 day | <input type="checkbox"/> | 5 days | <input type="checkbox"/> |
| 2 days | <input type="checkbox"/> | 6 days | <input type="checkbox"/> |
| 3 days | <input type="checkbox"/> | 7 days | <input type="checkbox"/> |

67. OUTSIDE SCHOOL HOURS: How OFTEN do you usually exercise in your free time so much that you get out of breath or sweat?

- | | |
|---------------------------|--------------------------|
| a. Every day | <input type="checkbox"/> |
| b. 4 to 6 times a week | <input type="checkbox"/> |
| c. 2 to 3 times a week | <input type="checkbox"/> |
| d. Once a week | <input type="checkbox"/> |
| e. Once a month | <input type="checkbox"/> |
| f. Less than once a month | <input type="checkbox"/> |
| g. Never | <input type="checkbox"/> |

68. How long does it usually take you to travel to school from your home?

- | | |
|-------------------------|--------------------------|
| a. Less than 5 minutes | <input type="checkbox"/> |
| b. 5-15 minutes | <input type="checkbox"/> |
| c. 15-30 minutes | <input type="checkbox"/> |
| d. 30 minutes to 1 hour | <input type="checkbox"/> |
| e. More than 1 hour | <input type="checkbox"/> |

69. On a typical day is the MAIN part of your trip TO school made by...? (Please circle one only)

- | | |
|---------------------------|--------------------------|
| a. Walking | <input type="checkbox"/> |
| b. Bicycle | <input type="checkbox"/> |
| c. Bus or train | <input type="checkbox"/> |
| d. Car, taxi or motorbike | <input type="checkbox"/> |
| e. Other means | <input type="checkbox"/> |

70. On a typical day is the MAIN part of your trip FROM school made by...? (Please circle one only)

- | | |
|---------------------------|--------------------------|
| a. Walking | <input type="checkbox"/> |
| b. Bicycle | <input type="checkbox"/> |
| c. Bus or train | <input type="checkbox"/> |
| d. Car, taxi or motorbike | <input type="checkbox"/> |
| e. Other means | <input type="checkbox"/> |



71. First and last name of the investigator: _____

72. Date of evaluation:

				2	0		
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Table 1. Characteristics of the study population, descriptive statistics, and differences between boys and girls

Parameter	total	boys	girls	<i>F</i>	<i>p</i>	η^2
	<i>n</i> =832 <i>M</i> (<i>SD</i>)	<i>n</i> =417 <i>M</i> (<i>SD</i>)	<i>n</i> =415 <i>M</i> (<i>SD</i>)			
Age and anthropometry						
Age (years)	9.5 (0.9)	9.7 (0.9)	9.4 (0.9)	26.10	<.001	.030
Height (cm)	133.1 (7.1)	133.2 (6.7)	133.0 (7.5)	0.19	.663	.000
Weight (kg)	30.5 (7.5)	30.0 (6.5)	31.0 (8.3)	3.27	.071	.004
BMI (kg/m ²)	17.0 (3.0)	16.8 (2.6)	17.3 (3.3)	6.25	.013	.007
Sociocultural characteristics						
Socioeconomic status ^a	7.3 (1.9)	7.3 (1.9)	7.4 (1.9)	0.38	.539	.000
Cardiorespiratory fitness						
Shuttle run (VO ₂ max) ^b	49.0 (4.3)	50.8 (4.3)	47.2 (3.5)	174.46	<.001	.174
Self-reported physical activity						
60 minutes active per day/week ^c	3.5 (2.5)	3.7 (2.4)	3.3 (2.5)	3.63	.057	.004
Health-related quality of life						
Physical well-being ^d	50.5 (13.2)	50.3 (13.4)	50.7 (13.0)	0.28	.598	.000
Psychological well-being ^d	38.3 (8.6)	38.3 (9.8)	38.3 (7.2)	0.00	.996	.000
Autonomy and parent relations ^d	49.5 (12.4)	48.4 (12.6)	50.6 (12.2)	6.21	.013	.007
Social support and peers ^d	48.6 (11.8)	48.0 (12.0)	49.3 (11.4)	2.74	.099	.003
School environment ^d	55.4 (12.4)	53.6 (12.9)	57.1 (11.7)	16.84	<.001	.020

^aSocioeconomic status measured by ownership and housing questions on a scale from 0-9 points (0 = low score), ^ball mean VO₂max estimates are expressed in ml kg⁻¹ min⁻¹ and are adjusted for age, ^cphysical activity measured by question on how many days achieved activity of at least 60 minutes on a scale from 0-7 days (0=never, 7=each day of the week), ^dKIDSCREEN questionnaire answered on a 5-point Likert scale (0=never/not at all, 5=always)

Table 2. Levels of self-reported physical activity and cardiorespiratory fitness, in boys and girls

Self-reported physical activity	Total n=832		Boys n=417		Girls n=415	
	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Low (0-1 days/week)	229	27.5	104	24.9	125	30.1
Moderate (2-5 days/week)	376	45.2	196	47.0	180	43.4
High (6-7 days/week)	227	27.3	117	28.1	110	26.5
Cardiorespiratory fitness	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Low (1st quartile) ^a	236	28.4	61	14.6	175	42.2
Moderate (2nd and 3rd quartile) ^b	382	45.9	189	45.3	193	46.5
High (4th quartile) ^c	214	25.7	167	40.0	47	11.3

Note. ^aScores of students in the first quartile are ranging from 37.78 to 45.68. ^bScores of students in the second and third quartiles are ranging from 45.69 to 51.96. ^cScores of students in the fourth quartile are ranging from 51.97 to 61.86.

Table 3. Health-related quality of life as a function of self-reported physical activity

	Low		Moderate		High		Model 1		Model 2	
	physical activity (0-1 days/week) (n = 229)		physical activity (2-5 days/week) (n = 376)		physical activity (6-7 days/week) (n = 227)		F	p	F	p
	M (SD)	M (SD)	M (SD)	M (SD)	η^2	η^2				
Physical well-being	46.4 (12.4) ^{a,b}	50.3 (13.1) ^{a,c}	54.1 (13.3) ^{b,c}	20.52	<.001	.047	16.00	<.001	.037	
Psychological well-being	36.3 (8.3) ^{a,b}	38.2 (9.1) ^{a,c}	40.3 (7.4) ^{b,c}	12.70	<.001	.030	6.84	<.001	.016	
Autonomy and parent relations	46.7 (10.7) ^a	49.0 (12.4) ^b	53.0 (13.3) ^{a,b}	15.90	<.001	.037	12.14	<.001	.029	
Social support and peers	47.0 (11.3) ^a	47.7 (11.3) ^b	51.9 (12.2) ^{a,b}	12.74	<.001	.030	6.58	<.001	.016	
School environment	52.6 (12.3) ^a	54.7 (12.1) ^b	59.4 (12.4) ^{a,b}	17.69	<.001	.041	9.07	<.001	.022	

Note. Degrees of freedom = 2,832 across all analyses. Bonferroni post-hoc tests: Mean values with equal letters are significantly different ($p < .05$). Model 1 = uncontrolled. Model 2 = controlled for age, gender, BMI, socioeconomic status, cardiorespiratory fitness, and school class.

Table 4. Health-related quality of life as a function of cardiorespiratory fitness

	Low fitness (1st quartile) (<i>n</i> = 236)		Moderate fitness (2nd+3rd quartiles) (<i>n</i> = 382)		High fitness (4th quartile) (<i>n</i> = 214)		Model 1		Model 2			
	<i>M</i> (<i>SD</i>)		<i>M</i> (<i>SD</i>)		<i>M</i> (<i>SD</i>)		<i>F</i>	<i>p</i>	η^2	<i>F</i>	<i>p</i>	η^2
Physical well-being	49.7 (13.3)		51.3 (13.2)		50.5 (13.3)		1.17	.311	.003	0.60	.548	.001
Psychological well-being	38.0 (8.1)		38.5 (8.8)		38.1 (8.7)		0.26	.768	.001	0.20	.820	.000
Autonomy and parent relations	48.7 (12.7)		50.5 (12.8)		48.5 (11.3)		2.41	.090	.006	1.97	.140	.005
Social support and peers	48.3 (12.6)		48.9 (11.8)		48.5 (10.7)		0.20	.818	.000	0.12	.887	.000
School environment	55.0 (12.6)		55.9 (12.5)		54.8 (12.3)		0.65	.521	.002	1.27	.281	.003

Note. Degrees of freedom = 2,832 across all analyses. Model 1 = uncontrolled. Model 2 = controlled for age, gender, BMI, socioeconomic status, cardiorespiratory fitness, and school class.