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Effects of a school-based health intervention programme, the *KaziBantu* project, in marginalized neighbourhoods of Port Elizabeth, South Africa: a study protocol

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Abstract

Background: Countries with populations predominantly in the low- and middle-income brackets often face the continuing challenges of poverty-related infectious diseases. An attempt to increase health literacy in South African children at primary school was undertaken in the 'Disease, Activity and Schoolchildren's Health' (DASH) project. The goal of this project is to assess the efficacy of a school-based intervention programmes on risk factors for non-communicable diseases, wellbeing and psychosocial health in school-aged children from disadvantaged neighbourhoods in Port Elizabeth, South Africa. Additionally, we aim to develop and pilot-test a workplace health intervention for primary school teachers.

Methods/Design:

To be included at the very end.

Discussion:

To be included at the very end.

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Keywords: Anthropometry, Cardiovascular risk markers, Cognitive performance, Diabetes, Health interventions, Physical fitness, Physical activity, Psychosocial health, South Africa.

Background

Countries with populations predominantly in the low- and middle-income brackets often face the continuing challenges of poverty-related infectious diseases (1-3). Therefore, ensuring a healthy life and promoting the well-being of children is a challenging task. Indeed, children's health depends on cultural, environmental, and socioeconomic factors as well as current living conditions and social and community networks (4). In low- and middle-income countries (LMICs), infectious diseases remain a key public health problem, which negatively impacts on children's physical and cognitive development (5). For example, more than 1 billion people are infected with parasitic worms (helminths) (6, 7). Helminth infections can cause abdominal pain, diarrhoea, and anaemia, and might impair cognitive and physical development (8), resulting in reduced fitness and work productivity (9). Moreover, helminth infections can have a negative impact on children's nutritional status (10). While neglected tropical diseases (NTDs) do not feature prominently in the burden of disease statistics of South Africa, some NTDs are common in disadvantaged populations, especially in children growing up in poor neighborhoods. Chronic helminth infections (worms) not only cause morbidity, but also negatively affect the cognitive and physical development and school performance of children. The general wellbeing of primary schoolchildren from poor neighbourhoods may also be affected by lack of nutritional value, since schoolchildren usually eat food served by tuck shops and vendors during school hours.

In summary, a deprived socio-economic environment can put children at risk of malnutrition and growth retardation. Malnutrition has been found to be associated with stunting and poor cognitive development resulting in low IQ, cognitive delays and a negative impact on motor development. This, in turn, can negatively affect children's ability to concentrate, process information and focus on academic work. Children from low socio-economic status (SES) families are also less likely to have access to health care or health insurance and subsequently lead to a greater risk of illness and school absence and ultimately to poor academic performance. These deficiencies can prevent school-aged children from realizing their full potential and perpetuate a vicious cycle of poverty and poor health.

Additionally, non-communicable diseases (NCDs) are a rapidly growing public health problem and impose a considerable burden on population health (11, 12). New research has revealed that the African populations have moved towards a disease profile similar to Western countries, with increasing proportions of deaths attributed to chronic, lifestyle-related diseases

(13) and overweight, replacing undernutrition as a risk factor (5, 14). Consequently, children are at an increased risk of compromised health due to a dual burden of diseases, which may hamper their development and wellbeing (11, 15). This dual burden constitutes a challenge for health systems in African countries. Although children are mainly affected by infectious diseases, they may already, at a young age, develop risk-factors predisposing them to NCDs in early adulthood (16, 17). With up to 80% of type 2 diabetes preventable through healthy eating and regular exercise, much more emphasis should be placed on prevention and awareness strategies (18). Therefore, Physical Education (PE) plays a critical role in the education of the child as a whole. To be physically active contributes to the development of physical competence and fitness, as well as to the cognitive, social and emotional development of the child. Children should undertake 60 minutes or more of moderate-to-vigorous physical activity (MVPA) daily. The Healthy Active Kids South Africa Report Card (2018) has shown that children, particularly from marginalized communities, do not achieve the minimal daily requirements of MVPA (19). Schools play an important role in making a meaningful contribution to the goal of achieving the recommended daily physical activity guidelines by incorporating physical education lessons into the school curriculum.

One plausible strategy to address this issue is to promote children's health through school-based health promotion programmes. An attempt by the Swiss and South African research team to increase health literacy in South African children at school was undertaken in the 'Disease, Activity and Schoolchildren's Health' (DASH) project (20). The study focused on fourth grade primary schoolchildren and the creation of healthy school environments by implementing a series of standardized intra-mural measures. The intervention programme consisted of four main components, including a medical examination, anthelmintic treatment, and in case of serious health risks, referral to the local clinic. Moreover, a special emphasis was put on nutrition supplementation, health education (e.g. hygiene, healthy nutrition) and physical activity (dancing and playful games).

After the implementation of the DASH research project, the next step pursued in the proposed study is to capitalize on the findings by scaling-up the intervention programme and by monitoring and improving the efficacy of the intervention programme further. Moreover, our experiences showed that many South African teachers suffer from cardiovascular risk factors (21, 22). This insight was also confirmed in a representative sample of South African educators (n=21,307) working in public schools, showing that educators reported considerably high stress levels, with significant associations occurring between stress, lack of job satisfaction and stress-related illnesses (23). In South Africa, non-communicable diseases

have steadily increased from 42.9% in total deaths in 2005 to 57.4% of total deaths in 2016 (24). In 2017 more than 1,826,100 cases of diabetes were recorded in South Africa, 5.4% of the adult population (25). Identify the potential for health improvement and knowing the important role of model teachers in the educational process of schoolchildren, in the project presented here, teachers are also involved and serving as key players and will undergo a workplace health intervention.

Goal and hypothesis

Given this background, the goal of this project is to assess how effective school-based intervention programmes are on communicable diseases, risk factors for non-communicable diseases, health behaviours (beliefs and actions relating to health and wellbeing) and psychosocial health in school-aged children in disadvantaged neighbourhoods in Port Elizabeth, South Africa. Additionally, we aim to develop and pilot-test a workplace health intervention for primary school teachers by using mobile technology.

A 12-month school-based health promotion programme in physical activity, health and nutrition education and deworming/referral to local clinics will contribute to improving clinical parameters among children from primary schools located in disadvantaged areas in Port Elizabeth, South Africa, taking into account adjustment to baseline covariates. Furthermore, a 6-month workplace health promotion programme will help enhance clinical parameters among teachers and positively affect children's health development.

Methods/Design

Study area

The proposed study will be conducted in historically black and coloured primary schools in Port Elizabeth townships (Motherwell, Zwide and New Brighton) and northern areas (Schauderville, Bethelsdorp and Gelvandale) (Figure 1). These schools and communities are detrimentally affected by poverty and high unemployment due to past colonial and apartheid policies as well as the current public health and economic challenges faced by the country (26) and its educational system correspondingly affected (World Bank, 2018). These schools often report both (a) institutional and (b) teacher-related PE barriers to education (27): (a) (i) A shortage of teachers, (ii) that PE is marginalized because priority is placed on other

(examinable) subjects, (iii) teachers lack the ability to integrate PE with other study areas within Life Orientation/Life Skills subject (personal and social wellbeing, creative arts and PE), (iv) large class sizes, (v) insufficient and inadequate infrastructure, and (vi) safety issues; and (b) (i) lack of qualification, (ii) lack of attitude, confidence and enthusiasm, and (iii) lack of accountability of the PE specialists (27).

Study design

For the children, the planned study is designed as a 12-months randomized controlled trial including an intervention (IG) and control group (CG) (Figure 2). Schools are randomly assigned to the intervention condition, while the control schools were selected on purpose. In each school, classes are randomly selected. After completion of the baseline assessment, learners of the intervention schools will take part in a school-based health promotion programme (32 school weeks, 1 physical education lesson of 40 min per week, 1 moving-to-music lesson of 40 min per week, 3 health education and 3 nutrition education lessons of 40 min per year across the whole study period). To test the efficacy of the school-based health promotion programme across time, learners will be assessed a second time after 12 months (Figure 3).

For the teacher, the planned study is designed as a 20-week randomized controlled trial. Schools are randomly assigned to the intervention or control condition. In each school, all teachers will be invited to take part in the study. After completion of the baseline assessment, all teachers will receive a personal health profile, providing an overview of cardiovascular health markers and mental health parameters (Figure 4). For each parameter, established internationally accepted cut-off values will be used to estimate teachers' health risks.

The intervention package consists of two main components. In more detail:

(i) The *KaziKidz* teaching material – a holistic educational and instructional tool for primary school teachers – aims to contribute to the reduction of the double burden that schoolchildren are facing. This teaching material was pilot tested at two elementary schools in August 2018 and feedback from teachers was obtained, followed by an intensive revision phase. Through the implementation of Physical Education (PE), Moving to Music, Health and Hygiene, and Nutrition education lessons the toolkit aims to enhance children's overall health in disadvantaged South African primary schools. This *KaziKidz* teaching material consists of lesson plans within each of the

three content pillars. The lessons have been designed in conjunction with South Africa's Curriculum and Assessment Policy Statement (CAPS). Ready-to-use exams can be found at the end of each section which may be integrated into formal assessments of learner performance and can supplement the school academic curricula. The aim is to lead learners through content, games and activities, partly supported by music, and conducted in a joyful manner that encourages and promotes a healthy lifestyle throughout childhood into adolescence. We suggest that by using the *KaziKidz* teaching material, teachers contributes to the wellbeing and health of the learners.

a. Physical activity: Regular physical activity opportunities, including one physical education lesson per week (40 min) and one moving-to-music lesson per week (40 min) will be incorporated into the main school curriculum. Moreover, a physical activity friendly school environment will be created. These measures are designed towards improving children's physical activity levels, and positively affecting their school satisfaction and psychosocial wellbeing. To make a meaningful contribution to health at schools, it is important for PE classes to be conducted at least twice a week: in our case 1 PE lesson (40 minutes) and 1 Moving-to-music lesson (40 minutes) during the 32 weeks of the school year ranging from grade 1 to grade 7. Establishing class procedures and routines at the beginning of the programme may encourage order in class. *Kazi* and lesson plans in blue will guide you through the physical education teaching material.
b. The moving-to-music classes have options for creating own music through drums or any other form of percussion or clapping. For schools or teachers that have a sound system available, there are songs with movement cues specifically tailored for the lessons. But these songs are optional and the lessons will still work without them. Within the lessons, direct speech is used to address the learners for easy application (28). *Kazi* and lesson plans in red will guide through the Moving to Music teaching material.
c. Health education: A series of classroom-based lessons will be developed to help increase the awareness for intestinal parasite infections among the schoolchildren and educate them on treatment and prevention methods, such as proper hygiene, sanitation habits and the importance of consuming clean water and food. By addressing these conditions through education about appropriate

health and hygiene behaviours for your school child (3 x 40 minute lessons per grade for grades 1 to 7), both you and the school child are at a reduced risk for infectious communicable diseases. The South African National School Nutrition Programme (NSNP) attempts to address micronutrient deficiencies and alleviate short-term hunger by providing food that supplies 30% of the daily energy requirements of a child. In order to complement this, the nutritional education lessons (3 x 40 minute lessons per grade for grades 1 to 7) should bring dietetics closer to the learners in a playful way. Furthermore, it aims to encourage sustainable healthy eating habits throughout their life. *Kazi* and lesson plans in green will guide you through the Health, Hygiene and Nutrition teaching materials. Nutritional education: A series of classroom-based lessons will be developed to help increase the awareness of the importance of healthy nutrition. In addition, an analysis of the school feeding programme will be done to identify ways to improve their current diet to be healthier. The cooks in the schools will also be trained in basic nutrition and hygiene during preparation of the school meals. During the preliminary DASH study, it was found that the knowledge of the persons who prepare the meals of the National School Nutrition Programme at the schools is poor, regarding health, hygiene and nutrition (29). In order to improve the nutritional health of the children, it will be necessary to improve the knowledge of these food preparers, because unhygienic circumstances and poorly prepared meals will lead to infections and low nutrient intake (30).

(ii) The *KaziHealth* is a workplace health promotion programme that educates and improves health behaviours in individuals. The programme starts with an individualised health risk assessment, followed by face-to-face lifestyle coaching sessions and self-monitoring and motivation through the *KaziHealth*. These tools are aimed at reducing the risks for cardiovascular diseases and improve physical activity and physical fitness, nutrition and diet, and psychosocial health. The *KaziHealth* mobile application (28) integrates three lifestyle interventions namely, physical activity, nutrition and stress management to guide individuals in achieving their personal health goals. Education, motivation and self-monitoring is provided within the *KaziHealth* application (28) to keep individuals motivated and informed, and to ultimately make healthier lifestyle choices and decrease health risks. Additionally, teachers of the intervention schools will have the possibility to participate in a 20-

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week workplace health promotion programme (Figure 5). Individually tailored lifestyle coaching workshops (2 sessions each) will be organised at the two intervention schools. A maximum of 20 people will take part in a workshop. In case of increased health risks, we will recommend the participants to contact a general practitioner for further medical clarifications and possible medical action. To test the efficacy of the workplace health promotion programme across time, teachers will be assessed a second time after six months.

Finally, *KaziCHAT* will be tested as a Comprehensive Health Assessment Tool. The purpose of the tool is to enable a healthcare practitioner/researcher to capture and analyse the data that is collected during the comprehensive baseline and follow-up health assessments of a client, in this case, specifically that of a school teacher.

Sample size and randomization

The sample size calculation for the study was based on obtaining sufficient accuracy in estimating effect sizes of the multidimensional physical activity intervention on continuous outcomes. To reach the required level of statistical power under the condition of cluster randomization, the design effect (DE) was calculated: DE = 1 + (n − 1) ρ = 23.35, based on an average number of children per school, n (cluster size), of 150, and an intra-class correlation coefficient (ICC) for the clustering of outcomes within schools, ρ, of 0,15. Furthermore, based on the assumption of a prevalence of obese children in South Africa *p*, of approximately 3% (31), and needing standard error of the respective prevalence, *SE*, not exceeding 2.5%, we calculated the necessary number of individuals m = 1,087 by using the following formula (32, 33):

$$m = \frac{p \cdot (1-p)}{SE^2}(1 + (n-1) \cdot \rho) \qquad \textbf{(1)}$$

Therefore, we calculated 7,24 clusters (schools). As a consequence, eight clusters (schools) are needed for the study.

From each these 4 township and 4 northern area schools, each one control school (not receiving any intervention at all) was selected based on further discussions of the future type of cooperation. For the remaining 6 schools, on the basis of sequentially numbered, opaque

sealed envelopes (SNOSE), the following intervention conditions were allocated: (i) only *KaziKidz* teaching material; (ii) *KaziKidz* teaching material together with workshops; and (iii) *KaziKidz* teaching material, workshops, teacher coaches and model teachers (*KaziHealth* and *KaziCHAT*) (Figure 6).

Study participants

The school authorities are informed about the project and asked for their consent. Interested schools will be visited, and the investigators will speak with the school administrators of these schools to find out if the school environment is conducive to conducting the study. Principals and teachers from selected schools will be informed about learning objectives, procedures and potential risks and benefits. Learners, parents or guardians of learners are informed and learners are invited to participate in the study. Prior to the start of the study, a patient information sheet will be provided in English to all potential participants and their parents / guardians, including translation into the local language (Xhosa or Afrikaans), which will explain the objectives, procedures and potential risks and benefits of the study, The verbal consent of each participating schoolchild is obtained and written consent of the parent/guardian is required. Participation is voluntary. Therefore, children can withdraw from the study at any time without consequences and other obligations.

In the *KaziBantu* study, "only" the intermediate phase (one randomly selected class per grade 4, 5 and 6) will be tested for the 8 schools (interventions are randomly assigned to either 4 Northern Area or 4 Township schools) (approx. 1,000 schoolchildren) although *KaziKidz* teaching material should be offered for all classes and all grades 1-7 and which is the primary goal of the Novartis Foundation.

School selection, participant recruitment and written informed consent

Of 103 quintile 3 primary schools (South African public schools are classified into five groups, with quintile five standing for the least poor and quintile one standing for the poorest. The quintiles are determined through the national poverty table, developed by the treasury (34). Areas are being ranked on the basis on income levels, dependency ratios and literacy rates in the area. The quintile ranking of a school determines the no-fee status of the school and also the amount of money that a school receives, with the poorest schools receiving the

greatest per-learner allocation.) located in historically disadvantaged areas in the Port Elizabeth district, 8 schools were selected based on the following criteria:

(i) Representation of the target communities: "township areas", inhabited predominantly by black African people and the "Northern areas", inhabited by predominantly coloured (mixed-race) people; both these communities needed to be represented equally;

(ii) Geographical location of schools (here, we were mainly interested in schools there were sufficiently well spread out to avoid cross-contamination between intervention and control schools);

(iii) Spoken language (Xhosa-, Afrikaans- or English); and

(iv) Commitment to support the project activities.

Participants will be invited to participate if they meet the following inclusion criteria: (i) are willing to participate in the study; (ii) have a written informed consent by a parent/guardian; (iii) are not participating in other clinical trials during the study period; and (iv) do not suffer from medical conditions, as determined by qualified medical personnel. Approximately 1000 Grade -6 primary schoolchildren, aged around 10 to 15 years, from 8 schools will be recruited during the *KaziBantu* baseline survey early 2019.

Assessment methods

The testing battery: (i) anthropometric measurements; (ii) questionnaires for assessment of psychosocial health; (iii) clinical examinations; (iv) physical fitness tests and self-reported physical activity; (v) cognitive performance, of this study is focused on its primary outcomes. Figure 7 summarises the assessment methods to be utilized in this study. For baseline and follow up survey, a suite of scientifically recognized procedures were selected and will be conducted by professional staff, adhering to standardised and quality-controlled protocol.

Anthropometric measurements

(i) From each child, body weight and height will be measured once by standing on a digital weighing scale and against a stadiometer with back erect and shoulders relaxed and then recorded to the nearest 0.1 kg, respectively to the nearest 0.5 cm. Sex-specific height or height-for-age and weight-for-age z-scores will be calculated from the current CDC/WHO growth reference data. Body mass index (BMI) and specific Z-scores will be calculated as follows: (i) BMI = weight (kg) / [meters (m)]^2; (ii) BMI for the elderly (older than 60 months) (BMIZ); an indicator for weight-for-height proportion (WHO

growth reference for children older than 60 months) (20); (iii) height-for-age (HAZ); an indicator of growth disorders (WHO growth reference for children older than 60 months).

(ii) A flexible measuring tape at the natural waist (midway between the ribcage and the iliac crest) will be used to determine the waist circumference of the child. After measuring the hip circumference, the waist-to-hip ratio will be built, a risk indicator for heart disease (the smaller the waist in comparison to the hips, the lower the risk of heart disease) (35).

Questionnaire

To gather information on children's social and demographic background, socioeconomic status (SES), perceived stress, school satisfaction, academic self-concept, self-reported physical activity behaviour and general health status, the following paper-and-pencil questionnaires will be applied:

(i) Demographic data and socioeconomic status of each participant will be interrogated.

(ii) The KIDSCREEN-10 examines children's physical and psychological well-being, moods and emotions, self-awareness, autonomy, parenting and family life, financial resources, peers and social support, school environment and bullying. The questionnaire comprises 10 points and has proven to be a valid tool for assessing the psychosocial health of children aged 8 to 18 years (36-38).

(iii) Three items from the HBSC survey will be used to assess individual perceived stress, school satisfaction and academic self-concept. Learners will be asked how they perceive the pressure of the school, including the homework that also was used to demonstrate the stress-buffering effects of physical activity in European adolescents (39). To estimate school satisfaction, learners are asked to respond to the question: "How they feel about school at present?" Furthermore, perceived academic performance will be gathered by comparing the school performance of the learners by estimation of the teacher.

(iv) The children are asked questions about experiencing physical activity: Doing sports, doing certain activities during school, playing with friends in their free time and attending school. The period over which information is requested is 7 days. The questions are adjusted using the Health Behaviour Surveys (HBSC), an instrument used to gain insights into young people's well-being, health behaviour and social context (40).

Clinical examinations

(i) The children's health review includes a detailed history and physical examination: It focuses on symptoms, abdominal pain and changes in bowel movements, as well as diabetes. It also discusses children's history and the evolution of cognitive and physical milestones. The body examination is directed towards the evidence of anaemia (e.g. conjunctival pallor) and detailed abdominal examination (e.g. sensitivity, hepatomegaly, and splenomegaly) and evidence of pulmonary hypertension (e.g. jugulovenous pressure and cardiac auscultation).

(ii) Regarding high blood pressure detection, each child's blood pressure is measured three times after the child has been sitting for about 5 minutes with a validated Omron® digital blood pressure monitor (Omron® M6 AC model, Hoofddorp, The Netherlands). The cuff is wrapped around the left arm so that only a finger can fit between cuff and arm. The bottom of the cuff is placed about 4 cm above the elbow with the palm facing up, while the blood pressure is taken. A children cuff size of 17-22 cm will be used (Omron® CS2 Small Cuff, Hoofddorp, The Netherlands). Since the first measurement often results in higher values, the average of the second and third measurements will be utilized to obtain values for systolic and diastolic blood pressure. To analyse the data, the children will be subdivided into a normotensive, pre-hypertensive or hypertensive group, based on percentiles, taking into account the age, sex and height of the children (normotensive: $<90^{th}$ percentile, pre-hypertensive: $\geq 90^{th}$ to $<95^{th}$ percentile, hypertensive: $\geq 95^{th}$ percentile).

(iii) To detect anemia, hemoglobin (Hb) concentration is measured once (to 0.1 g/l) with a HemoCue® Hb 301 system (HemoCue®AB; Ängelholm, Sweden). For each child, a fresh alcohol swab, a safety lancet and a microcuvette will be used. After the subject's fingertip will be soaked in alcohol, the investigator punctures with a safety lancet and gently pushes out two drops of blood. The first drop will be wiped with the alcohol swab, the second drop will be taken up by the microcuvette and read from the device. Blood will be used for several tests from only one finger prick.

(iv) For determination of the blood lipid profiles (total cholesterol [TC], low-density lipoprotein cholesterol [LDL-C], high-density lipoprotein cholesterol [HDL-C], triglycerides [TG], non-HDL cholesterol [non-HDL], cholesterol high-density lipoprotein ratio [C-HDL ratio]) and glycated hemoglobin (HbA1c), a point-of-care (POC) instrument utilizing the Afinion test (Alere Afinion AS 100 Analyzer; Alere

Technologies) will be used providing results within a maximum of 8 minutes. Remarkably, the HbA1c level reflects the average plasma glucose concentration levels over the last 8-12 weeks prior to the measurement without need for fasting. To control potential laboratory abnormalities, identical Afinion HbA1 control blood is used as an internal control and periodically tested.

Physical fitness tests

For the purposes of this study, selected tests from the Eurofit fitness battery (41) will be carried out.

(i) The cardiorespiratory fitness of the children is measured with the 20 m shuttle running test by Léger *et al.* (42). Shortly, a 20 m flat course will be measured with a measuring tape and marked with cones. Ten tracks are set. The pre-recorded sound signals are played to the children and they are prompted for the test run in two intervals (2 x 20 m). Once the children are familiar with the test procedures, they are asked to walk back and forth in groups of five or ten people on the 20-meter course, following the pre-set tempo of the sound signals. Starting at a speed of 8.5 km/h, the frequency of the signal is gradually increased so that the tempo increases by 0.5 km/h from minute to minute. If children do not follow the tempo for two consecutive intervals, they will be asked to stop, and the distance and distance travelled (full laps) will be recorded. The age of the participating child and the speed with which the child has stopped running are.

(ii) Upper body strength will be determined via the handgrip resistance test which measures the maximum isometric force that can be generated primarily by the forearm. Before the start of the test, the hand span (distance from the tip of the thumb to the tip of the little finger) of the child's dominant hand will be measured (to the nearest 0.5 cm) and the grip span on the dynamometer adjusted accordingly (43, 44). The field investigator also demonstrates how to grip the dynamometer to the child. Each child will have two tries (with a 30 sec rest in between) to grip the dynamometer as hard as possible with both hands and the maximum readings (measured to the nearest 0.5 kg) will be recorded. Additionally, the dominant hand will be noted. The child remains in a standard bipedal pose with fully outstretched arms holding the Saehan hydraulic dynamometer (MSD Europe BVBA; Tisselt, Belgium) without touching a part of the body with it. The dynamometer is adapted to gender and hand size of each child. The score is calculated as the average of the strength of the right and left handles. Higher values indicate better performance.

Cognitive performance

Two measures are considered as indicators of cognitive and academic performance, children's grades and the results of standardized national tests (ANA).

(i) In cooperation with the schools, we will receive school exam grades from the following subjects: English, Maths, Home Language and Life Orientation. The sum score of the four subjects is used to estimate the academic achievements.

(ii) The Annual National Assessments (ANA) are standardized tests for intermediate-phase literacy and numeracy (grades 4-6) and intermediate-level mathematics and languages (grades 4-6). As part of our studies, math and native language ANA scores are also used as a measure of academic achievement.

Data collection and management

Data to be collected include: (i) quantitative data on the prevalence of measurements of blood pressure, glycated hemoglobin and blood lipids, anthropometry and levels of physical fitness, cognitive performance and psychosocial health; (ii) socio-economic status and demographic data; and (iii) qualitative data on the feasibility and acceptability of the intervention measures implemented through focus group discussions.

The data is entered twice, matched with EpiData 3.1 (EpiData Association, Odense, Denmark) and merged with STATA version 13.0 (STATA Corp., College Station, TX, USA) into a single database. The data of the questionnaire are analyzed with the software package EvaSys (Survey Automation Suite, version 7.1).

Data analysis

These models include gender and age of the child, the socioeconomic status of the parents, or the health status or fitness of the baseline survey, as well as variables that were not perfectly randomized and therefore could interfere. Since intervention effects may also depend on the child's initial characteristics, stratified analyses and analyses with interaction conditions are performed. Potential effect modifiers tested include gender, age, socioeconomic status of the parent, health status, or physical fitness at the baseline test.

The primary objectives of the statistical analysis are: (i) to assess the physical fitness of the participants and their associations with cognitive performance and psychosocial health at the beginning and in the course of time; and (ii) the impact of interventions on disease status and

other health parameters. The secondary objective is to assess the feasibility and acceptability of the health measures implemented. Clinical and anthropometric indicators, physical fitness, cognitive performance, and psychosocial health values are characterized by their mean and standard deviation at normal distribution, and otherwise by their median and interquartile range. Questionnaire information on psychosocial health is expressed as a percentage. All indicators are compared between physically fit/unfit children and between intervention and control schools.

The following statistical methods are used to assess the impact of the various interventions on clinical and anthropometric indicators, physical fitness, cognitive performance and psychosocial health:

(i) Mixed logistic regression models with random sections for schools are used to compare binary data such as clinical indicators between the intervention and control groups.

(ii) Linear mixed models with random sections for schools are used for numerical data such as anthropometric measurements, physical fitness, cognitive performance and psychosocial health assessments as well as haemoglobin and lipid concentration measurements.

Ethical approval and considerations

Ethical approval for the study has been received from the following ethics committees in Port Elizabeth, South Africa: (i) The NMU Ethics Committee, Port Elizabeth, South Africa (reference no. H18-HEA-HMS-001; obtained on 26 March 2018); (ii) Eastern Cape Department of Education, Port Elizabeth, South Africa (obtained on 9 May 2018) and (iii) Eastern Cape Department of Health, Bhisho, South Africa (reference no. EC_201804_007; obtained on 5 June 2018). The study is registered at ethical review board of Northwestern and Central Switzerland (EKNZ) (reference no. R-2018-00047; registered on 1 March 2018).

The investigators will explain to each participant, children and teachers, the nature of the study, its purpose, the procedures involved, the expected duration, the potential risks and benefits it may entail. Each participant will be informed that the participation in the study is voluntary and that withdrawal of consent will not have any effects. All participants for the study will be provided with a participant information sheet and a consent form describing the study. Individual medical information obtained as a result of this study will be considered confidential. Subject confidentiality will be further ensured by utilizing subject identification

code numbers to correspond to treatment data in the computer files. For data verification purposes, authorised representatives of the EKNZ and the Nelson Mandela University Human Ethics Committee may require direct access to parts of the clinical records relevant to the study, including participants' medical history. At the end of the study, the results will be communicated to the Department of Health and the Department of Education, as well as the involved schools. All intervention materials will be made available to the control schools so that the whole school community can benefit from this project. Workshops will be offered to the control schools to prepare teachers to implement the school-based health promotion programme. Teachers of the control schools will have the possibility to take part in the lifestyle coaching programme after the second measurement.

Discussion

The preliminary findings suggest that the prevalence of parasitic worm infection was high in several schools (45); children infected with soil-transmitted helminths had lower maximal oxygen uptake compared to their non-infected peers (45); Albendazole is highly efficacious against roundworm, but lacks efficacy against whipworm (46); helminth infections and low physical fitness are significant predictors of low selective attention and poor academic achievement (47); physical activity is associated with health-related quality of life (48); almost one third of all schoolchildren were classified as hypertensive (49); and the physical activity intervention component resulted in a significantly delayed increase in children's body mass index (50). Finally, qualitative data revealed that the DASH intervention package was well received at all schools.

The *KaziBantu* project is aimed at contributing to healthy schools for healthy communities. Teachers as leaders in communities have an important role to play in this regard. Teachers as healthy role models will be able to promote better health behaviours and encourage a healthy, active and inspiring environment for their learners and peers at schools.

Various health professionals will empower teachers with knowledge related to clinical and non-communicable disease risk factors, physical activity and fitness, psychosocial health and nutrition indicators. This will be conducted through an electronic comprehensive health assessment tool – *KaziCHAT*. An automatic health risk profile will be generated, using easy to understand explanations through a traffic light system along with face-to-face personal feedback and relevant workshops. Teachers will be guided through three lifestyle interventions, namely, physical activity, diet and nutrition and stress management. Workshops

focusing on behaviour change will be facilitate by various health professionals and allow participants to set their own goals based on individual health risks. The *KaziHealth* mobile application is currently being developed to facilitate these three lifestyle interventions. Compliance, monitoring and motivation will be provided through the application. Improved health and wellbeing increases teachers' productivity, benefitting both the school and schoolchildren. This will result in less absenteeism, a reduction in stress and better coping with work demands.

Afrikaans, Xhosa and English are spoken by the communities in the study area. For example, some schoolchildren may want to speak and write English while others prefer the same school in Afrikaans. In addition, Xhosa-speaking children often said that the tests were conducted in English, with explanations in Xhosa. This may become difficult when managing questionnaires. However, questionnaires are pre-tested on some schoolchildren using the content of the questionnaires, especially those that focus on mental health indicators to match the educational attainment of schoolchildren, and help them to understand and answer the questions. To address these issues, we will hire native speakers to do the translation and test the translated questionnaires among teachers and students before the study starts. During the actual management of the questionnaires, we need help from teachers and volunteers who explain the questions to the children in their preferred language. The study is conducted in impoverished and harsh environments where illiteracy and violence are common (51, 52). In these challenging socio-economic circumstances, recruited schoolchildren are often exposed to inadequate care or neglect by their parents (53-55). Therefore, it will be difficult to obtain support and written consent from the parent / guardian, even if the students have given their verbal consent. It is difficult to predict the extent of the movement of people. Moving forward with the follow-ups and second phase of intervention, we might expect a substantial loss to follow-up as people show considerable mobility in this setting. Multiple imputation will be used to deal with missing data where appropriate.

In conclusion, the *KaziBantu* follow-up described here, by linking children's physical fitness with cognitive performance and psychosocial health, helps to highlight the health of children and teachers in South Africa and provides guidance for them to give further health measures. The implementation of recruitment-specific interventions further emphasizes the feasibility of these health interventions in the study area.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

To be included at the very end.

Acknowledgements

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Figures

Figure 1 Study area, Port Elizabeth, South Africa, and location of the 8 schools participating in the *KaziBantu* study.

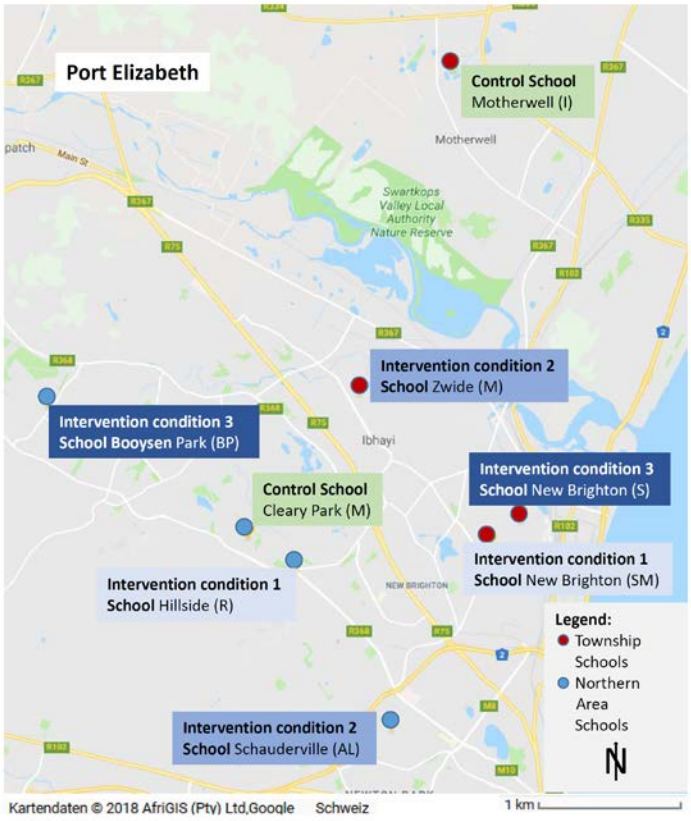
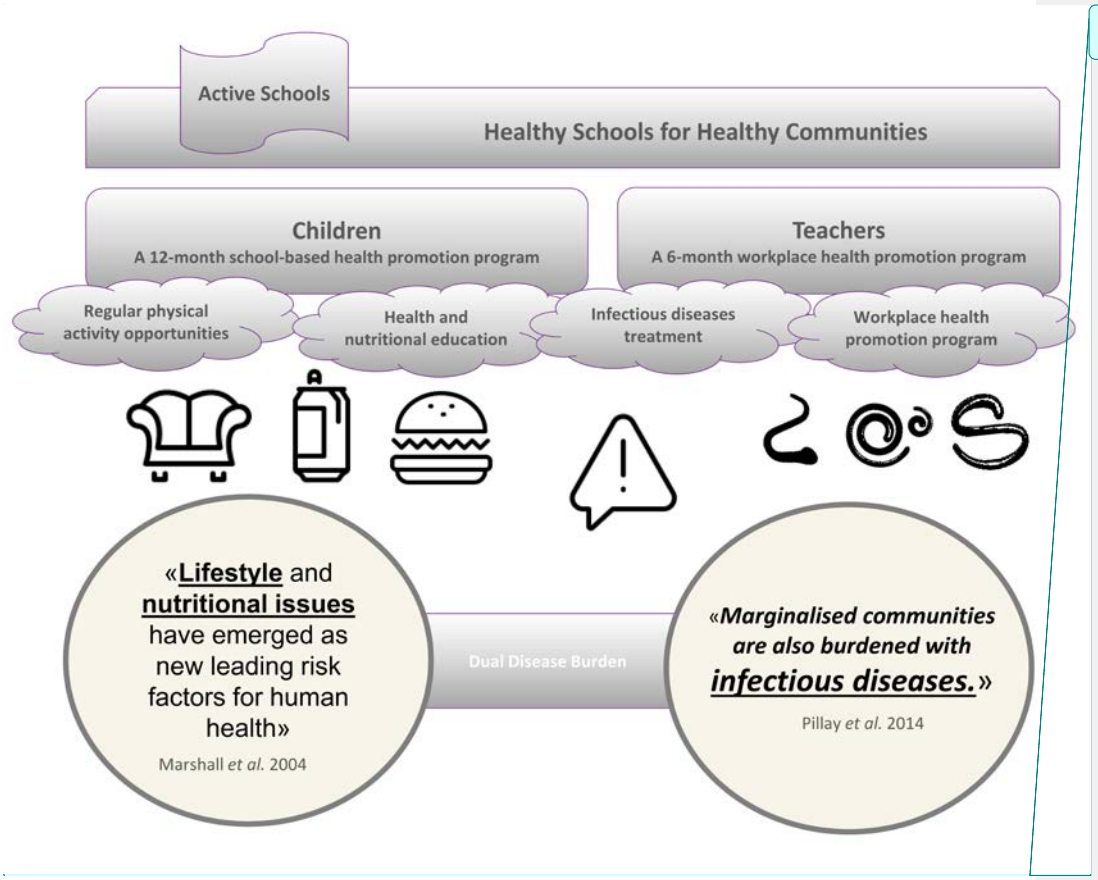


Figure 2 **A conceptual framework of the *KaziBantu* study.**



Comment [IMM2]: Also to be updated at the very end.

Figure 3 ***KaziBantu*** **study design of testing the** ***KaziKidz*** **teaching material.**

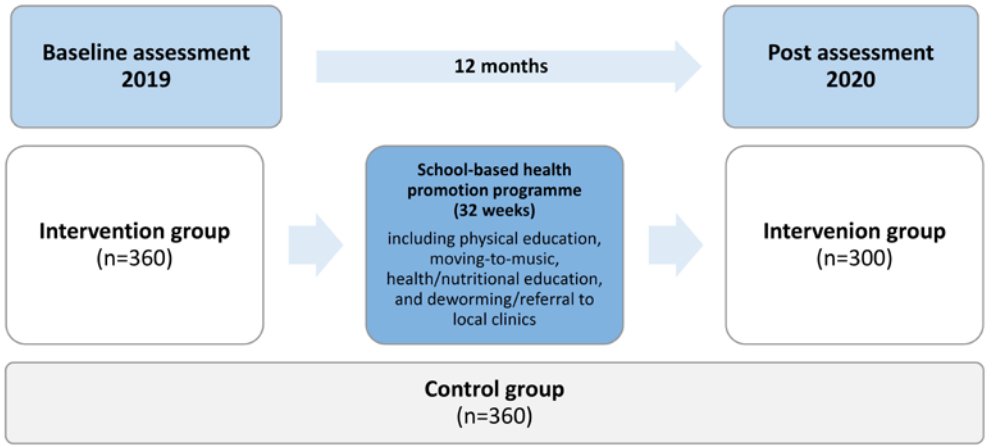


Figure 4 ***KaziBantu*** **study design of testing the** ***KaziHealth*** **tools.**

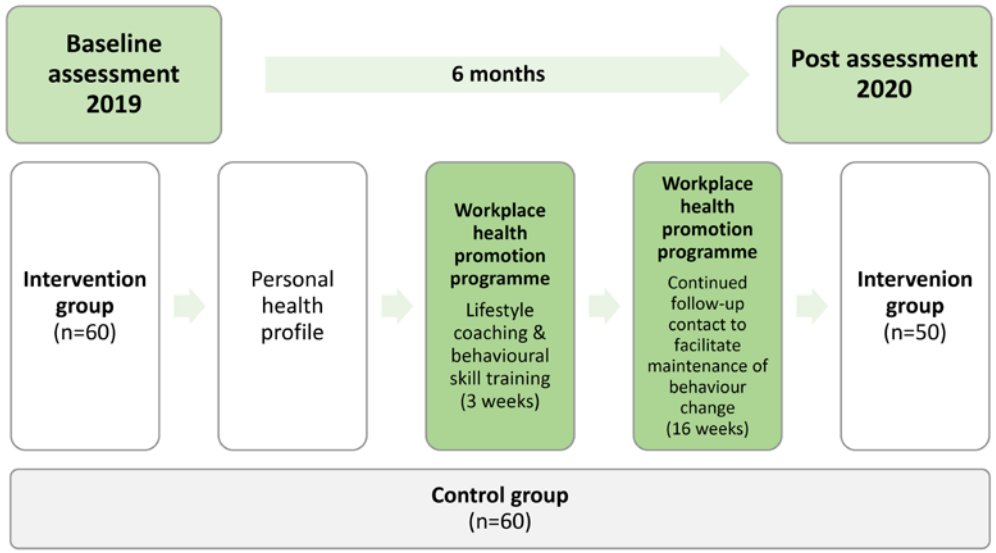


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Figure 5 **20-week workplace health promotion programme for teachers**

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Figure 6 **A pictorial display of the *KaziBantu* study design.**

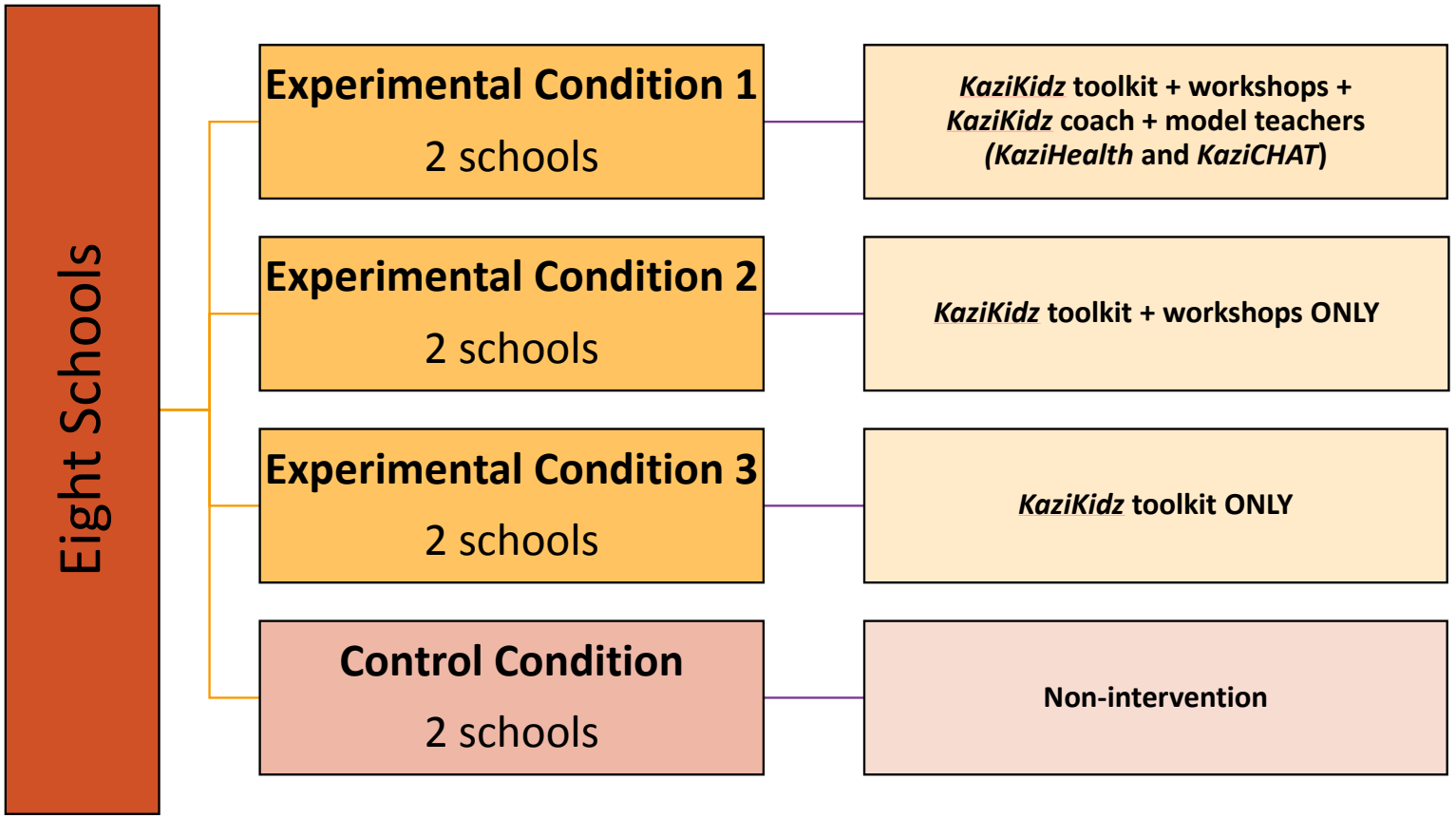
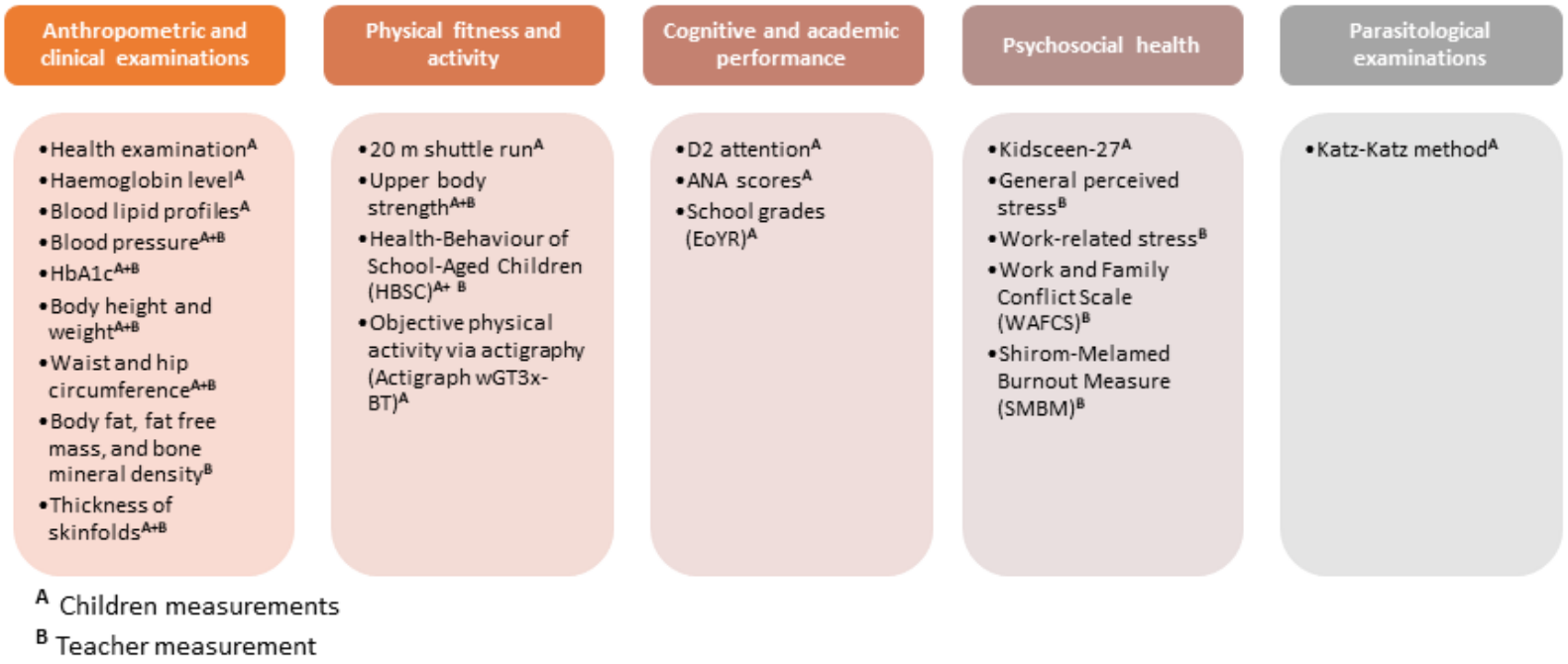


Figure 7 **Measurements and tests performed among schoolchildren[A] and teachers[B] in the *KaziBantu* study.**



Comment [IMM3]: Will be updated at the very end.