2018 – 2021

KaziAfya Project

Well-being, health, and health-related behaviours in primary schoolchildren living in South Africa

University of Basel

NELSON MANDELA UNIVERSITY

Swiss TPH

fondation BOTNAR

"Education is the most powerful weapon which you can use to change the world."

Nelson Mandela

KaziAfya

Schools for Active and Healthy Kidz

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2018 –2021

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.

1.1. Preface

Ensuring healthy lives and promoting well-being among children is a complex and challenging endeavour. Indeed, children's health depends on cultural, environmental, and socioeconomic factors as well as current living conditions and social and community networks (Dahlgren & Whitehead, 1991). 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 (Murray et al., 2012). For example, more than 1 billion people are infected with parasitic worms (helminths) (Colley, Bustinduy, Secor, & King, 2014; Yap et al., 2014). Helminth infections can cause abdominal pain, diarrhoea, and anaemia, and might impair cognitive and physical development (Utzinger et al., 2012), resulting in reduced fitness and work productivity (Yap et al., 2012). Moreover, helminth infections can have a negative impact on children's nutritional status (Hürlimann et al., 2014). 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 problems with motor development. This, in turn, can cause problems with 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 this leads to a greater risk of illness and school absence and consequently to poor academic performance. These deficiencies

Children engaging in a physical education lesson

School-based physical activity interventions are worthwhile because a considerable amount of children's daily physical activity is acquired during school hours.

can prevent school-aged children from realising 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 (Marshall, 2004). New research has revealed that African populations have moved towards a disease profile similar to Western countries, with increasing proportions of deaths attributed to chronic, lifestyle-related diseases (Steyn & Damasceno, 2006) and overweight, replacing undernutrition as a risk factor (Lim et al., 2012; Murray et al., 2012). Consequently, children are at an increased risk of compromised health due to a dual burden of diseases, which may hamper their development and well-being (Marshall, 2004; Santosa, Wall, Fottrell, Hogberg, & Byass, 2014). This dual burden constitutes a challenge for health systems in African countries. Although children are mainly affected by infectious diseases, they may at a young age already develop risk-factors predisposing

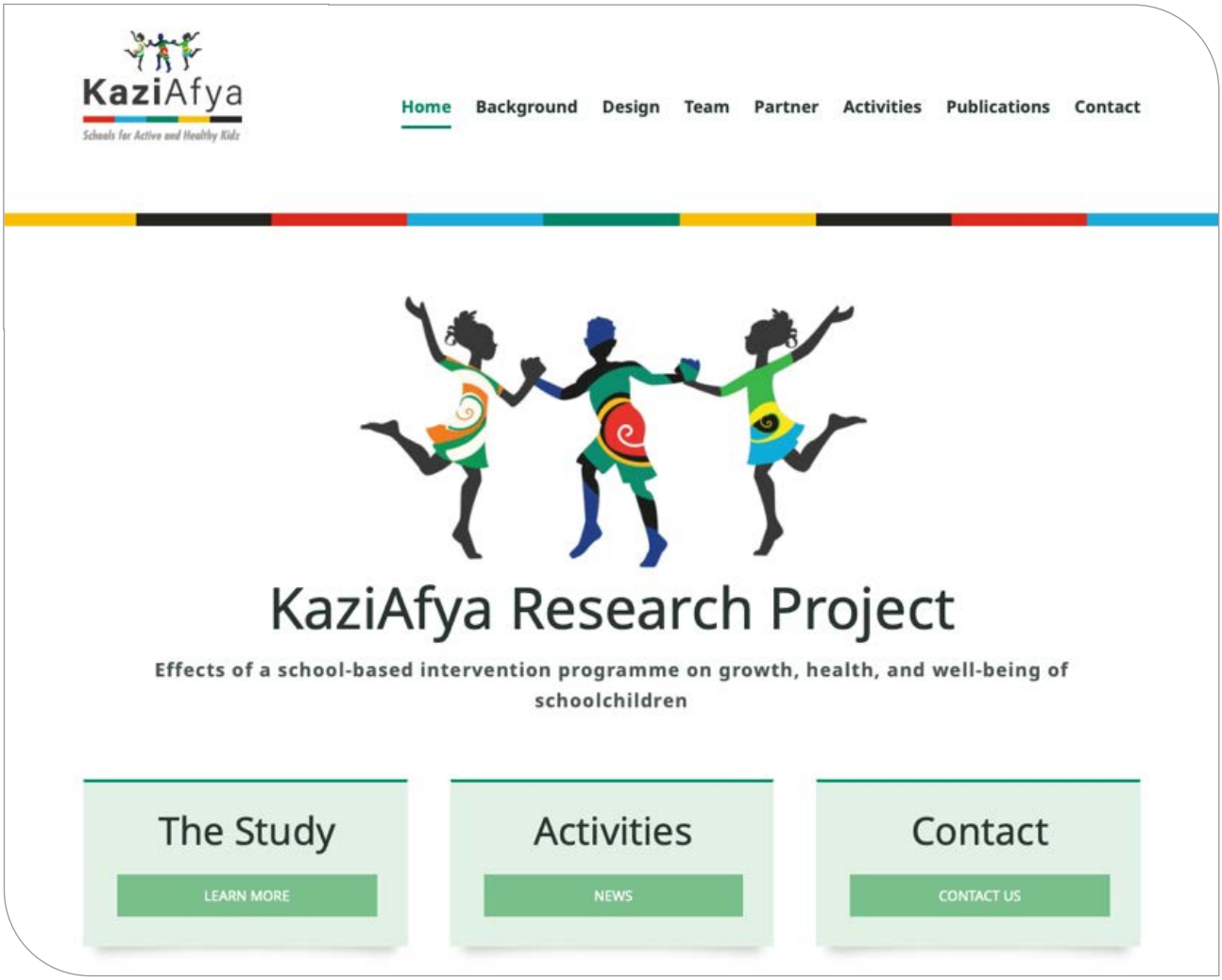
▲ Team at kick-off

them to NCDs in early adulthood (Alliance., 2016; Herman, Craig, Gauvin, & Katzmarzyk, 2009).

Given that (i) childhood physical inactivity is an independent risk factor for NCDs, which can lead to poor health outcomes in later life (Dwyer et al., 2009; Gerber, Börjesson, Ljung, Lindwall, & Jonsdottir, 2016; Walter & Du Randt, 2011), and that (ii) micronutrient status affects energy balance, hereby playing an important role in the development of obesity and obesity-related conditions (García, Long, 2009), one plausible strategy is to focus on the promotion of physical activity and multi-micronutrient supplementation.

School-based physical activity interventions are worthwhile because a considerable number of children's daily physical activity is acquired during school hours (Meyer et al., 2013). Moreover, school-based physical activity programmes are generally effective in increasing physical activity and physical fitness in children and adolescents aged 6-18 years (Dobbins, Husson, DeCorby, & LaRocca, 2013). For instance, a randomized controlled trial with Swiss primary schoolchildren (first and fifth graders) showed that physical activity and fitness could be significantly improved via a 1-year school-based physical activity intervention, whereas adiposity could be decreased (Kriemler et al., 2010).

Placing an emphasis on multi-micronutrient supplementation is justified because meta-analytic evidence suggests that (a) helminth infections and micronutrient deficiencies are highly prevalent in LMICs, (b) a strong relationship exists between helminth infections and serum retinol in school-aged children, and (c) micronutrient-supplementation randomised controlled trials (RCTs) showed a modest, but significant protective effect on helminth infection and reinfection rates (de Gier et al., 2014; Rousham et al., 2020).



▲ Information on the KaziAfya study is provided on the project homepage (www.kaziafya.org).

1.2. Purpose of the KaziAfya project

The goal of the KaziAfya project was to examine the prevalence of infectious diseases and inflammatory and cardiovascular health risk markers in three African countries (Côte d'Ivoire, South Africa and Tanzania) and to test low-cost preventive programmes, which combine multi-micronutrient supplementation with physical activity to promote health and well-being among African schoolchildren.

More specifically, three interrelated objectives were addressed:

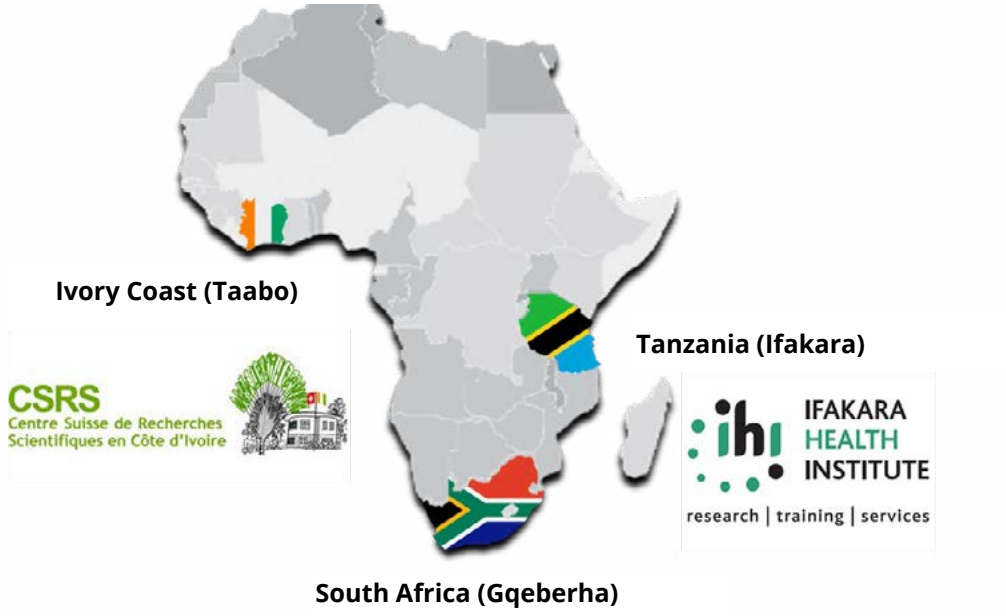
1. To assess and compare infection with helminths and intestinal protozoa, micronutrient deficiencies, and cardiovascular health risk markers (e.g., physical inactivity) in schoolchildren in the involved countries.
2. To determine the association between physical activity, physical fitness, helminth and intestinal protozoa infection, micronutrient status, overweight/obesity, cardiovascular risk markers, cognitive function, and health-related quality of life.

3. To examine the effects of a school-based health intervention (physical activity, multi-micronutrient supplementation, or both) on physical activity, physical fitness, incidence of helminth and intestinal protozoa infection, micronutrient status, overweight/obesity, cardiovascular risk markers, cognitive function, and health-related quality of life.

The study design envisaged that in each of the three countries involved, approximately 330 children participate either in the physical activity or multi-micronutrient supplementation intervention (or in a combination of both), and that 330 children per country constitute a placebo control group. In each country, baseline data of all children are used to assess the relationships between infections, micronutrient deficiencies, and cardiovascular health risk markers. Importantly, once the tools and strategies are validated from the three study sites, they can be brought to scale.

1.3. What does this report offer?

In this report, we provide general information about the project, give an overview of the variables assessed, present descriptive findings for all variables to document children's health state at baseline, and to visualize changes in health outcomes over time (baseline to follow-up), for the total sample, as well as separately for boys and girls and learners attending different grades. This report serves as project documentation for the funders, a source of information for the debriefing of different stakeholders, and reference values on schoolchildren's health for future studies in the three participating countries. What this report does not offer are detailed analyses of the various relationships between different variables and detailed analyses on the effects of the intervention. The reasons are that bi- and multivariate relationships and intervention effects need to be examined thoroughly with suitable statistical methods, which is beyond the scope of the present report. Moreover, due to the large number of variables, reporting only certain relationships would seem arbitrary. The examination of the relationships between variables and intervention effects will take more time and insights will be gained gradually. Some of these analyses have already been done and published in peer-reviewed international journals (see chapter 16). Further analyses will follow. An overview and update of publications associated with the KaziAfya study is provided on the project homepage (www.kaziafya.org).



Map of Africa with countries and institutions involved in the KaziAfya project

1.4. Study design

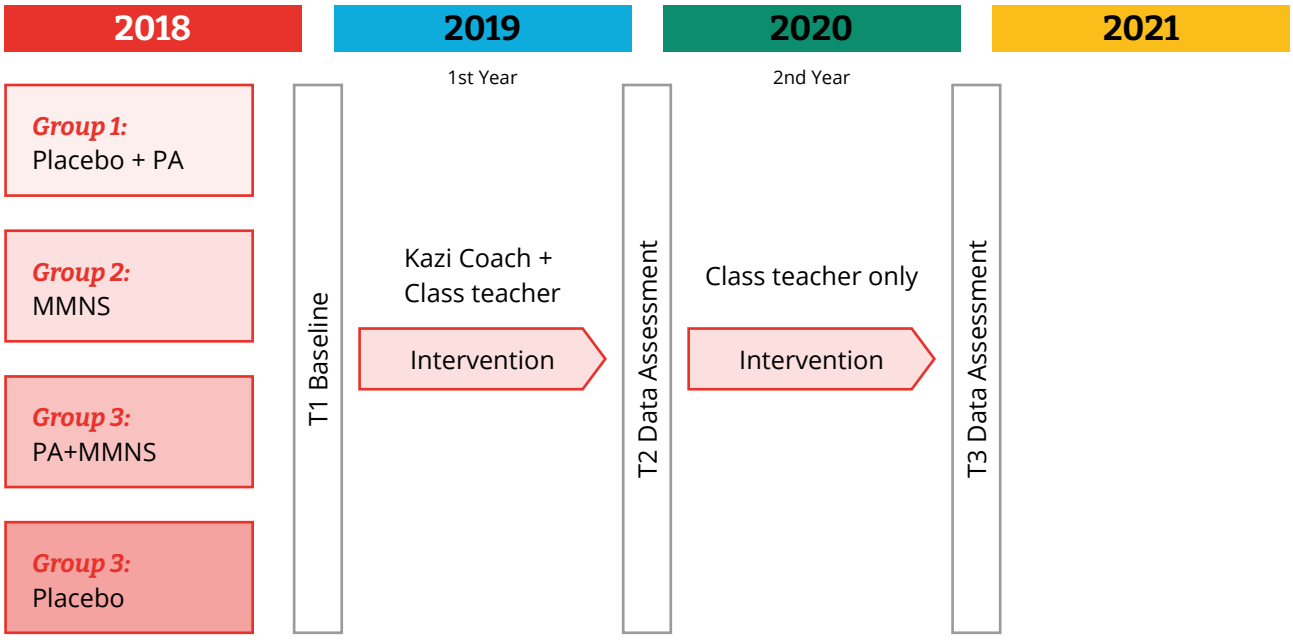
The KaziAfya project was designed as a randomised, double-blind, placebo-controlled trial to assess the effect of physical activity and/or multi-micronutrient supplementation on children's health and well-being. We assessed data at three time points (baseline, post and follow-up). At baseline, children were attending grades 1-4 (approximately 6 to 12 years old). It was planned that the intervention would last approximately 1.5 years and be implemented across two academic years. The project started in January 2018 and lasted until September 2023.

In each country, we recruited a total sample of approximately 1320 children class-wise from public schools, willing to take part in the project, hence providing written informed consent. We randomly assigned classes to one of four groups. The sample size was determined by means of power calculations, with the goal to be able to detect at least small effects in the outcomes.

In South Africa, the KaziAfya project was carried out in public primary schools in the area of Gqeberha (for more information about the study setting see chapter 2). We included children if they attended grade 1-4 classes, and if they were aged between 5 and 12 years. The study was restricted to this age group to avoid increased body composition variability due to differences in the onset of puberty in older children. Further inclusion criteria were (i) written informed consent by a parent/guardian; (ii) not participating in other clinical trials; and (iii) not suffering from medical conditions, which prevent participation in physical activity, as determined by qualified medical personnel. We excluded children from data analyses (but not from the intervention) if they (i) had a congenital or acquired alteration of the gastro-intestinal tract, which could impair absorption of the supplements, and (ii) had taken vitamin and mineral supplements in the past 6 months. Children were also excluded from the study and referred to local clinics if they suffered from severe malnourishment (as diagnosed by a study nurse, following national guidelines).

Types of data collected included (i) quantitative data on anthropometric measurements, parasitological status, cardiovascular health risk markers, physical

Figure Graphical representation of the initially planned study design, including timeline



PA = physical activity,
MMNS = multi-micronutrient supplementation.

Table 01.01 An overview of the measures taken at each of the three assessment time points

Measures	*T1*	*T2*	*T3*
Clinical examinations			
Disease history of child	■		
Physical examination			
Haemoglobin concentration (Hb)	■	■	■
Blood pressure (SBP, DBP)	■	■	■
Blood lipids (TC, HDL-C, LDL-C, TG)	■	■	■
Blood glucose level (HBA1c)	■	■	■
Micronutrient status (vitamin A, zinc, vitamin D, iron)	■	■	■
Anthropometric measurements			
Body weight	■	■	■
Body height	■	■	■
Body composition (body fat, muscle mass, bone mass)	■	■	■
Parasitological examinations			
Stool samples (A. lumbricoides, hookworm, T. trichiura, S. mansoni)	■	■	■
Physical fitness			
20 m shuttle-run test	■	■	■
Grip strength test	■	■	■
Physical activity			
Self-reported physical activity (parental survey and child self-report)	■	■	■
Objectively assessed physical activity (7-day accelerometry)	■	■	■
Dietary intake information			
Food insecurity assessment (parental survey)	■		
Dietary intake (parental survey)	■		
Cognitive and academic performance			
Executive function (Flanker-task)	■	■	■
School grades	■	■	■
Psychosocial health			
Socioeconomic and demographic profile (parental survey)	■		
KIDSCREEN-52 (Health-related quality of life)	■	■	■
Subjective health complaints (child self-report)	■	■	■
Sleep quality	■	■	■
Sleep environment	■		
School perceptions (child self-report)	■	■	■

▲ Blood pressure

▲ Filling in the questionnaires

▲ Accelerometers (red devices)

▲ Fitness/grip-strength test

▲ Stool sample testings

activity, fitness, cognitive performance and psychosocial health, and (ii) qualitative data, based on systematic observations and semi-structured interviews, on the programme implementation. The collected quantitative data was double-entered and validated using EpiData (version 3.1) and merged into a single database.

To determine the spectrum and magnitude of infectious diseases or cardiovascular health risk markers among study participants, we applied a combination of standardised, quality-controlled techniques. Table 01.01 provides an overview of the measures that we assessed at baseline (T1), post (T2) and follow-up (T3). Clinical examination of the children included history taking, physical examination, and pertinent investigations to assess for infection and complications of helminth infection. Features of disease history focused on fevers, constitutional symptoms, abdominal pain, change in bowel movements, and diabetes. The physical examination was directed towards evidence of anaemia, abdominal examination, and evidence of pulmonary hypertension.

Table 01.02 Distribution of intervention arms across schools and grade levels

	School 1	*School 2*	*School 3*	*School 4*
Grade 1	PA	Control	PA + MMNS	MMNS
Grade 2	MMNS	PA	Control	PA + MMNS
Grade 3	PA + MMNS	MMNS	PA	Control
Grade 4	Control	PA + MMNS	MMNS	PA

PA = Physical activity.
MMNS = Multi-micronutrient supplementation.

▲ Assessment day at a school.

1.5. Ethical considerations

KaziAfya was carried out in accordance with the protocol and with principles in the current version of the Declaration of Helsinki and the guidelines of Good Clinical Practice (GCP) issued by the International Conference of Harmonisation (ICH). Before the start of the data assessment, we received approval from all required authorities. In Switzerland, the study was approved by the Ethikkommission Nordwest- und Zentralschweiz' (EKNZ; reference number Req-2018-00608), in South Africa by the research ethics committee of the Nelson Mandela University in Gqeberha (formerly known as Port Elizabeth) (reference number: H18-HEA-HMS-006) and the Department of Education of the Eastern Cape Province. The intervention study has been registered in the ISRCTN registry (http://www.isrctn. com/ISRCTN29534081).

▲ Supplements

▲ Supplement pots

1.6. Contents of the intervention

The majority of the existing school-based interventions that aimed at improving schoolchildren's health have focused on a single type of intervention, such as physical activity or nutrition, and have primarily targeted children in their first 5 years of life. However, important processes of brain development continue during later childhood, and research is also needed to identify factors that impact on the development of primary schoolchildren living in marginalized areas. From the literature, it is currently unclear whether a combined physical activity and mult-micronutrient supplementation intervention would result in greater improvements in child development than a single intervention.

We therefore compared four treatment arms: (a) physical activity + placebo; (b) multi-micronutrient supplementation; (c) physical activity + multi-micronutrient supplementation; and (d) placebo (Table 01.02). The placebo only concerns the multi-micronutrient supplementation. For physical activity, no real placebo exists. Classes assigned to the placebo or multi-micronutrient supplementation condition followed their normal lesson plans. Therefore, we can ensure that students of these classes (without physical activity component) had the same amount of contact with schoolmates and teachers as students assigned to the physical activity or physical activity

Children's brain development continues into later childhood, and research is needed to identify factors that contribute to the brain development of primary schoolchildren living in marginalized communities.

+ multi-micronutrient supplementation conditions. Assignment of classes to condition was done via stratification to ensure that each intervention arm was represented at each grade across all schools (see Table 01.02).

Physical activity intervention

Regular physical activity opportunities were incorporated into the main school curriculum including two weekly 45-60 min physical activity lessons consisting of moving-to-music (one lesson) and physical education (one lesson). These intervention materials have been pilot-tested in 2015 and 2016 in the 'Disease Activity and Schoolchildren's Health' (DASH) study with fourth grade children in Gqeberha township areas. Qualitative data revealed that the DASH physical activity materials were well received at all schools. Meanwhile, the physical activity intervention materials have been expanded and now cover all primary school grades (KaziKidz toolkit). A detailed description of the KaziKidz toolkit can be found at www.kazibantu.org, including concrete and freely available lesson plans for grade 1 to 7. Sports equipment was provided in all schools along with a music center which allowed for the implementation of Moving-to-Musik lessons.

Multi-micronutrient supplementation intervention

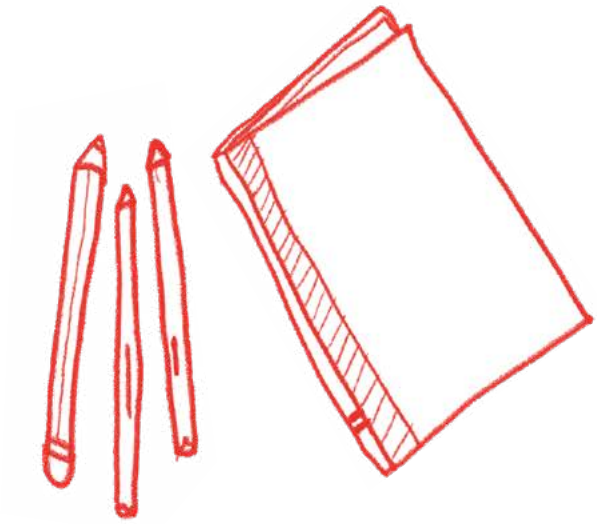
Participants allocated to the multi-micronutrient supplementation condition received a daily chewable tablet containing vitamins and trace elements. The multi-micronutrient supplement was provided (see Table 01.03) free of charge by DSM Nutritional Products Ltd. (Basel, Switzerland; see: www.dsm.com). The exact composition of the multi-micronutrient supplement is presented below. During school days, the supplement was taken at schools under the direct supervision of a teacher. To avoid the risk that supplements were exchanged between students or given to other family members during weekends or public holidays, no supplements were provided on non-school days. Children who did not receive multi-micronutrient supplementation (physical activity only and control conditions) received a placebo product. Thus, during school days, they received a daily chewing tablet, similar in taste and appearance to the multi-micronutrient supplementation and administered to the children from identical packages.

Table 01.03. Content of the multi-micronutrient supplementation chewing tablets

No.	*Nutrient*	*Average per 1 tablet*
1	β-carotene (as BetTab 20%S)	3.6 mg
2	Vitamin D	400 IU / 10 mcg
3	Vitamin E	9 mg TE
4	Vitamin K	30 mcg
5	Vitamin C	60 mg
6	Vitamin B1 Thiamine	1.1 mg
7	Vitamin B2 Riboflavin	1.3 mg
8	Vitamin B6 Pyriodoxine	0.5 mg
9	Vitamin B12	1.2 mcg
10	Folic Acid	200 mcg
11	Niacinamide	8 mg
12	Iron (added as Fe-EDTA)	8 mg
13	Zinc (added as Zinc Oxide)	5 mg
14	Selenium (added as Sodium Selenite Anhydrous)	20 mcg
15	Iodine (added as Potassium Iodate)	100 mcg

KaziKidz toolkit

Teacher workshop



The tablet did not contain any macronutrients or micronutrients, except sugar, citric acid, water and artificial flavour (orange) to mask the taste and to ensure similar appearance.

Deworming

Independently of the study arm allocation, children diagnosed with helminth infections received deworming medication after each data assessment. In selecting the treatment strategy for each school, consideration was given to both national and international guidelines, the latter established by the Department of Control of Neglected Tropical Diseases of the World Health Organization (WHO) (WHO, 2006). That is, if soil-transmitted helminth infection prevalence was below 20%, infected children were treated individually; if soil-transmitted helminth infection prevalence was between 20 and 50%, annual mass treatment was performed once per year; and if soil-transmitted helminth infection prevalence was ≥50%, annual mass treatment was administered; and if soil-transmitted helminth infection prevalence was ≥50%, mass treatment was administered twice a year.

1.7. Training of teachers and school staff

From previous experiences, we were aware that teachers needed considerable support for the physical education lessons. Simple lessons were prepared, and schools were provided with the basic sports equipment needed (e.g., balls, colour bands, beacons, whistle, stopwatches, skipping ropes, hula hoops, etc.). During the first year of intervention, teachers were taught simple class management techniques and assisted by a trained physical education (PE)-coach on a weekly basis. The PE-coach taught the first part of the lesson, and thereafter assisted the

> ***When planning the study, several potential risks were identified that could pose a challenge to the implementation of the study.***

teacher who taught the rest of the lessons. During the second year of intervention, it was envisaged that the physical activity intervention should be carried out by the teachers themselves.

1.8. Risk evaluation

When planning the study, several potential risks were identified that could pose a challenge to the implementation of the study. The technical risks included importing medical diagnostic equipment into partner countries, large class sizes, regular electricity supply and internet connection, exchange of blood samples beyond national boundaries, and the safe-guarding of expensive study materials. Another difficulty was related to daily hot temperatures that affected the performance of the study participants, especially in the physiological fitness tests. On an individual level, perceived shamefulness of the submission of stool samples by schoolchildren was identified as a further potential issue. Additionally, the application of albendazole and praziquantel (as a deworming treatment) resulted in some rare adverse events, but these were usually mild and transient, and disappeared in a few hours. On a societal level, South Africa has a stable, democratically elected government. Overcoming the inequalities of apartheid has been a challenge. Despite many developments, the growing inequality, poverty, high unemployment, crime and violence remain a concern. Based on previous experiences, we considered the following risks as particularly pertinent: longer-term strikes (e.g. the "Fees Must Fall" movement affecting universities) and work absences (e.g., teacher strikes, closing of schools protests), unresolved conflicts within communities leading to community unrest (e.g., service delivery protests, taxi protest).

COVID-19 pandemic

In March 2020, the COVID-19 pandemic surprised the project, which severely impacted the implementation of the intervention during the second year. Between March and June 2020, schools remained completely closed, followed by alternating school schedules until July 2021. Accordingly, half of the students in one class attended school Monday, Wednesday, and Friday, while the other half attended school Tuesday and Thursday. Each week, the schedule was switched. However, these restrictions contributed to a great deal of chaos at the organizational level, which resulted in higher rates of student absenteeism and dropouts in schools. Fortunately, the multi-micronutrient supplementation intervention was resumed in the first week of March 2021 until the final data assessment in September/October 2021. Yet, the initial goal of providing children with supplements on a daily basis was not achieved anymore. A severe blow, however, was the loss of the physical education intervention, because physical education lessons were now prohibited by COVID-19-restrictions.

1.9. Involved institutions

KaziAfya is a joint project of the Department of Sport, Exercise and Health (DSBG) of the University of Basel (Basel, Switzerland), the Swiss Tropical and Public Health Institute (Swiss TPH, Basel Switzerland), the Nelson Mandela University (NMU, Gqeberha, South Africa), the Centre Suisse des Recherches Scientiques en Côte d'Ivoire (CSRS, Abjdjan, Côte d'Ivoire) and the Ifakara Health Institute (IHI, Ifakara, Tanzania). The trial steering committee was composed of the sponsor-investigator (Prof. Dr. Markus Gerber, University of Basel), the director of the Swiss TPH (Prof. Dr. Jürg Utzinger), and the principal investigators of the three study countries (Prof. Dr. Cheryl Walter, NMU, Prof. Dr. Bassirou Bonfoh, CSRS and Prof. Dr. Honorati Masanja, IHI).

The DSBG at the University of Basel and the South African partners at the NMU University in Gqeberha have strong competencies in assessing physical fitness, physical activity, psychosocial health, cognitive performance and executive function, and in carrying out school-based health promotion programmes. The competencies of the South African partners include marketing, event management and sport management, as well as assessment of malnutrition in children and drivers of malnutrition in LMICs. Swiss TPH has a strong track record in transnational global health research consortia and experience in the diagnosis, epidemiology, management and control of infectious diseases and NCDs, including study design, power calculation, implementation and conduct of cohort studies, quality of life assessments and randomised controlled trials.

The School of Behavioural and Lifestyle Sciences, Nelson Mandela University (Gqeberha, South Africa)

Nelson Mandela University situated in Gqeberha (formerly known as Port Elizabeth), is the largest university in the Eastern and Southern cape, with more than 30 000 students, 500 study programmes, across seven campuses. While the majority of the students are South African (98%), the rest are international students from 43 different countries. Nelson Mandela University embraces the responsibility, and honour, of embodying the legacy and ethos of the late Nelson Mandela.

The University is committed to developing emergent African scholars and academics who bring a diversity of thought to traditional knowledge systems and paradigms. The Department of Human Movement Science is situated in the Faculty of Health Sciences, which offers clinical training, learning, research and health service delivery, integrated into a platform aiming to serve communities that are most in need. The Faculty of Health Sciences has about 4 000 students in eleven departments. Through our Interprofessional Education (IPE) project with the theme: "Transforming health sciences education to support equity in health", all of these departments will work together as a comprehensive learning, research, and health service delivery platform to serve communities in need. This was seen in the KaziAfya study, which brought together researchers and students in Human Movement Science, Biokinetics, Sport Management, Human Nutrition and Dietetics, Medical Laboratory Sciences, Nursing, Psychology, as well as the Faculty of Education. https://www.mandela.ac.za/About-us/Fast-Facts/Institutional-Indicators.

Department of Sport, Exercise and Health, University of Basel (Basel, Switzerland)

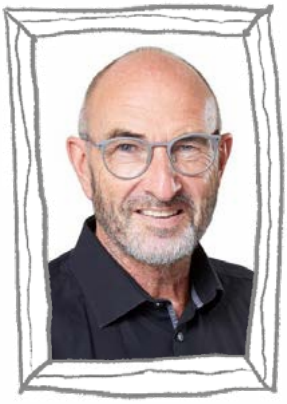
The mandate of the Department of Sport, Exercise and Health (DSBG) of the University of Basel is to investigate the relationships between physical activity and health across the lifespan, and to translate research into concrete action for the benefit of the people.

Prof. Dr. Markus Gerber

Principal Investigator, Main Applicant

Dr. Christin Lang

Study Coordinator



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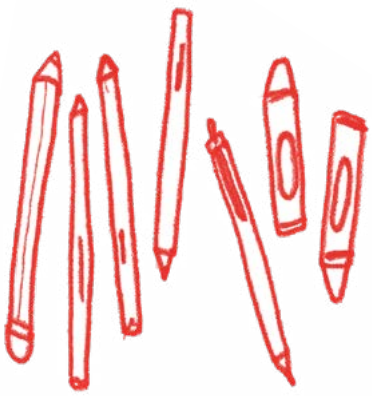

Swiss Tropical and Public Health Institute (Basel, Switzerland)

The mandate of Swiss TPH is to contribute to the improvement of population health nationally and internationally through excellence in research, services, teaching and training.

Prof. Dr. Jürg Utzinger

Co-applicant

Dr. Kurt Long

Co-applicant

Dr. Peter Steinmann

Project Consultant

1.10. South African research team

Prof. Dr. Cheryl Walter

Function and task:
South African PI for the KaziAfya project

- Part of the initial study design team
- Overall monitoring and coordination of the interdisciplinary components of the South African study
- Research ethics through Nelson Mandela University, and permission from the Eastern Cape Department of Education
- Supervision of doctoral study linked to the project
- Contribution to manuscripts and publications

Dr. Siphesihle Nqweniso

Function and task:
Project coordinator

- Oversight on implementation of the South African component of the project
- Research coordination and management of data collection and data analysis
- Monitoring of school intervention and organization of teacher workshops and training
- Preparation of study findings and presentation of research findings at conferences

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Prof. Dr. Annelie Gresse

Function and task:
Coordinator for nutrition intervention programmes, analysis of nutrition data

Prof. Dr. Rosa Du Randt

Function and task:
Co-researcher

- Co-responsible for research ethics through Nelson Mandela University, and permission from the Eastern Cape Department of Education
- Contribution to manuscripts and publications
- Co-supervisor of a doctoral study emanating from the data obtained from the South African cohort of participants involved in the study

Ms. Madeleine Nienaber

Function and task:
Research assistant

- Assistance with implementation of the South African component of the project
- Team leader (blood sampling)
- Coordination and management of data collection and data cleaning for the blood sampling team
- Assistance with school intervention, teacher workshops and training
- Contribution to manuscripts and publications

Ms. Sesethu Ncanywa

Function and task:
Research assistant

- Assisting with the implementation of the South African component of the project
- Assisting with data collection and data capturing
- Team leader for the questionnaire group
- Assisting with administrative tasks
- Assisting with school intervention, teacher workshops and training

Dr. Danielle Dolley

Function and task:
Research assistant

- Contribution to the implementation of the South African component of the project
- Supported the project coordinator with various administrative duties
- Team leader of a quantitative data collection group
- Assisting with the implementation of the school intervention, conducting teacher workshops, and providing training to teachers
- Contribution to the application for research ethics at nelson Mandela University
- Contributions to manuscripts and publications

Ms. Larissa Adams

Function and task:
Research assistant

- Assistance with implementation of the South African component of the project
- Team leader for two elements of data collection (anthropometry and Flanker-task)
- Coordination and management of data collection and data cleaning for anthropometry and Flanker teams
- Assistance with school intervention, teacher workshops and training
- Contribution to research ethics through Nelson Mandela University
- Contribution to manuscripts and publications

Mrs. Zaahira Ismail

Function and task:
Administrative research assistant

- Contribution to the implementation of the South African component of the project
- Management of the volunteers and assistant payments
- Team leader of data capturing
- Various administrative duties such as communicating with schools, compiling the Masterfile and merging data
- Responsible for the printing, filing and storing of data collection sheets and consent forms

UNESCO Chair

The KaziAfya project is carried out in close cooperation with the UNESCO Chair on Physical Activity and Health in Educational Settings. The UNESCO chair is a research and teaching unit at the University of Basel (Basel, Switzerland), and at the Nelson Mandela University (Gqeberha, South Africa).

- UNESCO Chair holder is Prof. Dr. Uwe Pühse (Switzerland). He is appointed to lead the activities of the Chair.
- UNESCO Co-Chair is Prof. Dr. Cheryl Walter (South Africa).

It is part of the UNITWIN/UNESCO Chairs Programme, which was launched in 1992 by decision of the UNESCO General Conference. Its aim is to promote and strengthen international cooperation, especially North-South, South-South and North-South-South cooperation between universities, colleges and research institutions. In this network, higher education and research institutions pool their human and material resources to address urgent challenges and contribute to the development of society. In many cases, the networks and chairs serve as think tanks and bridge builders between academia, civil society, local communities, research and policy. Today, more than 850 institutions in 117 countries are involved in the UNITWIN/UNESCO Chairs Programme.

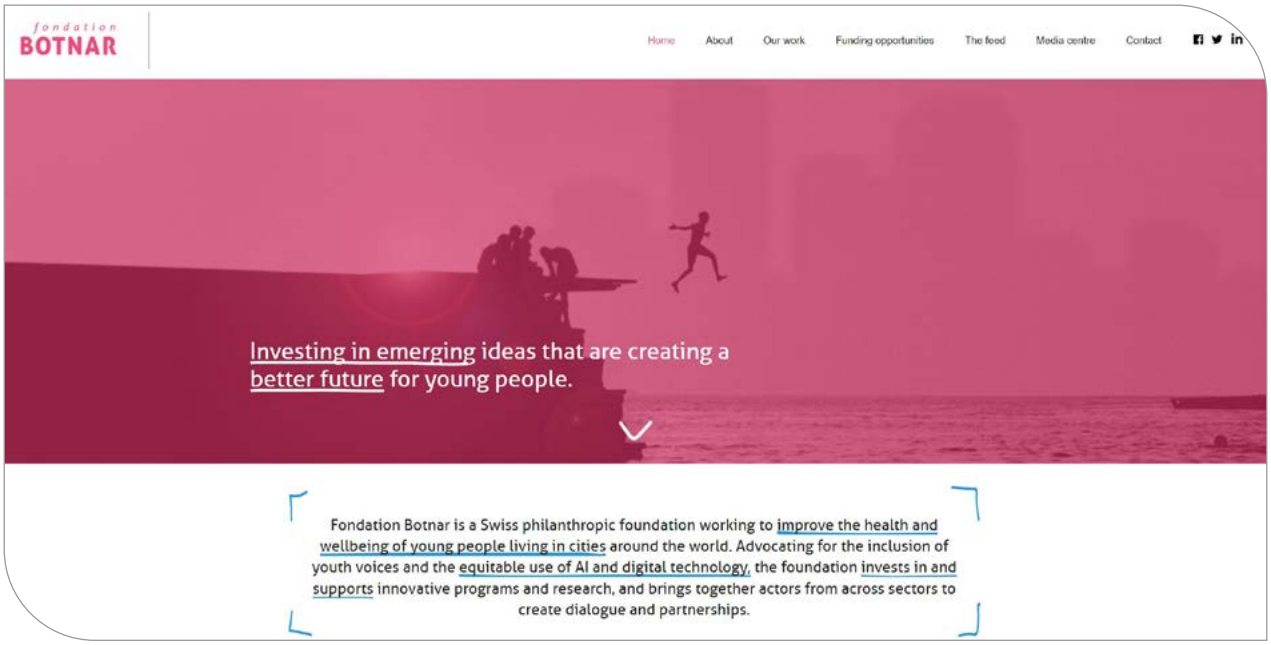
The Chair focuses on a range of topics surrounding 'Physical Activity and Health in Educational Settings'. The Chair is established by an agreement between UNESCO and the University of Basel. It has been installed in April 2019 and has been renewed in 2023.

UNESCO chair holders (Prof. Dr. Uwe Pühse and Prof. Dr. Cheryl Walter)

Funding

Fondation Botnar

The main funding for the KaziAfya project was provided by Fondation Botnar (Basel, Switzerland). The Fondation Botnar is a Swiss philanthropic foundation working to improve the health and well-being of young people living in cities around the world. Advocating for the inclusion of youth voices and the equitable use of artificial intelligence and digital technology, the foundation invests in and supports innovative programmes and research, and brings together actors from across sectors to create dialogue and partnerships.



▲ Fondation BOTNAR website (www.fondationbotnar.org)

DSM

The multi-micronutrient supplementation and the placebo products were sponsored by DSM Nutritional Products Ltd. (Basel, Switzerland).

South African National Research Foundation
Dr. Siphesihle Nqweniso's salary was partly financed by the South African National Research Foundation.

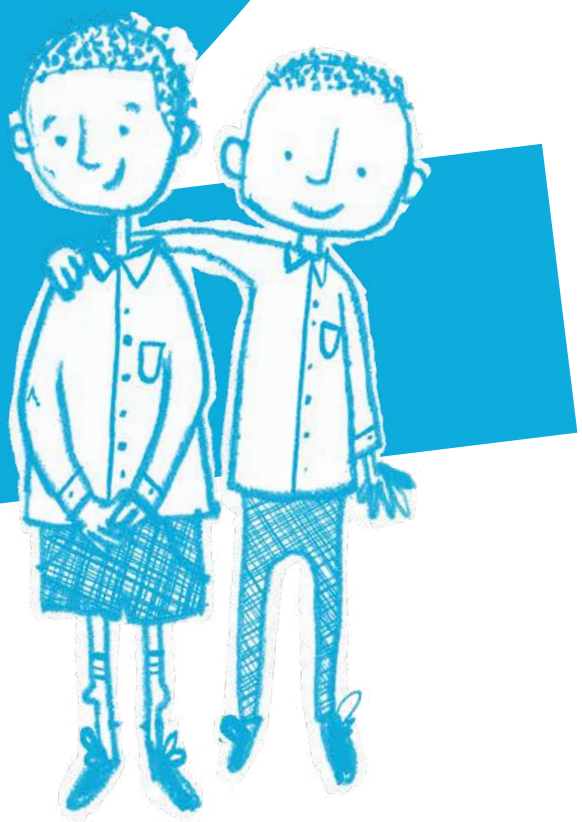
Novartis Foundation
The KaziAfya teaching material is based on (or an extension of) the development of the KaziKidz teaching material, an initiative financially and technically supported by the Novartis Foundation since 2017.

All children received a KaziKidz T-shirt

Children listening to instructions during a physical education lesson

Study sites and schools

02



▲ Map of South Africa and location of study area Gqeberha

2.1. Eastern Cape Province and Gqeberha

The Eastern Cape is one of the nine provinces of South Africa and the second largest province in the country (at 168,966 km^2) after Northern Cape. Its two largest cities are Gqeberha and East London. The population of Eastern Cape Province is 6,676,691, of whom 86.3% are Black, 8.3% are Coloured, 4.7% are White and 0.4% are Indian/Asian. Eastern Cape has the highest proportion of elderly persons aged 60 years and above (11.5%), as well as the second highest proportions of persons younger than 15 years (32.7%). It is the poorest province in South Africa and has the highest unemployment rate in the country. About 31.1% of households have no access to water and 12.7% of households do not have access to any form of sanitation. Subsistence agriculture predominates in the former homelands, resulting in widespread poverty.

Like all areas in South Africa Gqeberha, the then Port Elizabeth, was subject to a raft of apartheid laws, including the Population Registration Act (1950) which categorized each individual into a race group, giving effect to the Group Areas Act (1950), the Separate Amenities Act (1953) and the Bantu Education Act (1953). These acts ensured that people classified into different races not live in the same area, or go to the same schools or share the same amenities, resulting in forced removals. In the late 1960s and 70s, communities were forced by the apartheid government to move to new areas far removed from the centre of town. These apartheid laws saw the growth of areas set aside for people classified as coloured (generally called the Northern Areas in Gqeberha), and areas set aside for black African residents, (generally called the Township Areas). These areas were historically disadvantaged under apartheid and still often have poor basic services, or remain without access to basic services, including adequate water and sanitation, in the post democratic era.

Within Gqeberha, the KaziAfya project worked in these two marginalised and under-resourced areas, where we randomly selected four schools (two in each area). The four project schools are Isaac Booi and David Vuku located in the Townships and Alpha and Greenville, located in the Northern Areas.

2.2. School neighbourhoods

Isaac Booi Senior Primary School

Zwide, Gqeberha, South Africa

Isaac Booi Senior Primary School is a public primary school located in Zwide, one of the Township Areas in Gqeberha. The school is a quintile 3 school. The schools in the lower quintiles (1-3) are fee-free, since they receive a majority of funding from the government, whereas schools in quintiles 4 and 5 receive a small amount of funding from the government and are therefore allowed to charge fees.

The deputy principal of the school, Ms Nobomvu, who has been at the school for seven years and is in her fourth year as deputy principal said the KaziAfya project was extremely important in terms of focusing on children's health and well-being. In a brief statement, she said the following:

"The KaziAfya project has made an important contribution to the school because it made learners excited to come to school. It improved the morale at the school. The project also helped the school staff and parents in taking care of the health of the children. The Zwide community has a high unemployment rate and most of the children in our school have younger parents and some live with their grandparents. We find that the grandparents are the ones that cooperate and engage with the school, whereas we find little cooperation from the younger parents, and I believe the learners suffer when looked after by their biological parents. I think the project helped, as the children need more than they get in the classroom, because they look forward to doing things outside. The children were so keen and eager to come to school when the project ran, and they also enjoyed getting the freebies (Kazi t-shirts)."


ISAAC


LITERACY
CENTRE

Alpha Primary School

Gelvandale, Gqeberha, South Africa

Alpha Primary School, founded in 1961, is a public primary school located in Gelvandale in the Northern Areas of Gqeberha. Alpha is a non-fee-paying school in a sub-economic community, which accommodates predominantly Coloured learners from the poor communities around the area. It is classified under quintile 3. The principal, Dr Hendricks has taught at the school for 17 years, of which she has been principal for seven years. In a brief statement, she said the following:

"The KaziAfya project has been a blessing in disguise because the researchers were able to test children's stool samples and I was amazed at how many children were infected. After getting the results of the worm infections after the first round of testing in 2019, I called a parent meeting and did a presentation to highlight the problem that our children face. The parents were shocked and pleased that the majority of the children who had worms were dewormed by the researchers. The schoolteachers were very happy with the project and appreciated the help given in terms of the activities and techniques used in the project. The physical education coach, Siba, was wonderful and she showed the teachers what could be done. Before the project, there were no opportunities for structured and supervised outside play because of shortage of staff. I am very positive about the sustainability of the project, and it will go on, I have a plan. I believe that with the support of two or three enthusiastic teachers working as a team, they can carry on. Lastly, the teachers at the school asserted that there were less disciplinary problems during the time of the project and these effects are still noticeable."


RESPECT
RESPONSIBILITY
ALPHA PRIMARY SCHOOL
PHYSICAL ADDRESS:
BELL ROAD
GELVANDALE
PORT ELIZABETH
6020
PRINCIPAL
Dr C.A. HENDRICKS
ALPHA PRIMARY
TRUTH
Est. 1961
POSTAL ADDRESS:
PO BOX 16324
GELVANDALE
PORT ELIZABETH
6016
CONTACT DETAILS:
TEL. 041-4523255
FAX. 041-4563406
FAIRNESS
CARING

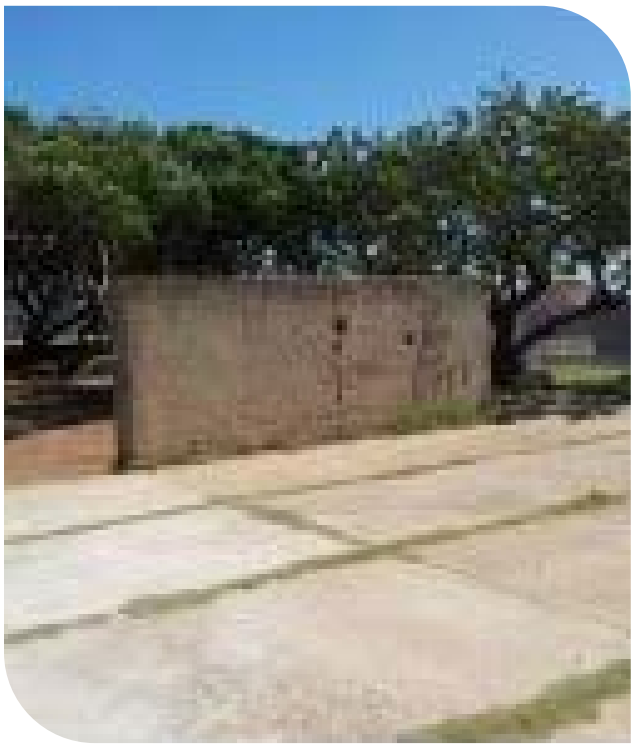
Greenville Primary School

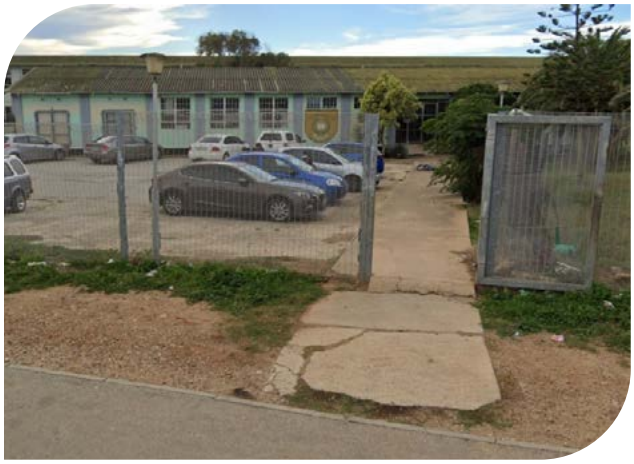
Bethelsdorp, Gqeberha, South Africa

Greenville Primary School is a public primary school located in Bethelsdorp, Gqeberha. The school is a non-fee-paying school in an impoverished community which accommodates predominantly Coloured learners from communities around the school.

The principal, Mr Josephs, has been a principal at the school for 12 years. The school is one of the poorest, cash-strapped schools in the Northern Areas, with constant vandalism and a shortage of teachers. The school also faces constant protests by parents and the community due to the dilapidated infrastructure and dire condition of the school.

- https://www.news24.com/news24/southafrica/news/thieves-using-long-weekends-to-target-eastern-cape-schools-16-chalkboards-stolen-in-recent-incident-20220504, https://www.news24.com/news24/community-newspaper/pe-express/schools-suffer-under-constant-vandalism-20220613
- https://www.heraldlive.co.za/news/2022-02-28-you-can-help-turn-ugly-duckling-greenville-primary-into-a-swan-to-be-proud-of/





David Vuku Primary School

New Brighton, Gqeberha, South Africa

David Vuku Primary School is a public primary school located in New Brighton, Gqeberha. The school is located in a community that has challenges of unemployment, housing shortages, low income, and crime (burglary). The principal of the school, Mr Koliti shared that he appreciated that the project helps the school with early identification of problems – not only academic, and that physical education is good for children, especially the moving-to-music lessons. In a brief statement, he said the following:

"The physical education teachers at the school appreciate the project as it assists them with physical education lessons and the fact that it helps with health issues. I would like the project to be sustainable, but I think our school does need some resources. Teachers must do physical education as it is in the syllabus, and they don't need money to do something that is in the syllabus.


DAVID VUKU
PRIMARY
SCHOOL

Project timeline and sample characteristics

03

Informed consent was obtained from 1369 parents and guardians. Most of these children attended Isaac Booi school (n=468, 34.2%), followed by Alpha (n=418, 30.5%), Greenville (n=242, 17.7%) and David Vuku (n=241, 17.6%).

Some children dropped out until the baseline data assessment (mainly because they left the school due to relocation). In total, 1309 children participated in the data assessment at baseline. Hereof, 682 children were boys (52.1%) and 627 children were girls (47.9%) (see Table 03.01). The distribution across school grades was very similar, with 324 children (24.8%) attending grade 1, 325 children (24.9%) grade 2, 329 children (25.2%) grade 3, and 326 children (25.0%) grade 4.

Most of the children indicated that they speak Xhosa language at home (n=530, 58.6%), followed by Afrikaans (n=325, 35.9%) and English (n=160, 17.7%). Approximately half of the children had Black (n=662, 50.6%) and Coloured ethnic background (n=628, 48.0%), whereas children with Indian/Mixed, White and other backgrounds formed a minority.

In total, 908 parents/guardians (69.4% of the total baseline sample) completed the parental survey. The parental survey was most frequently completed by the mother (n=687, 75.3%), followed by a grandparent (n=79, 8.7%), the father (n=54, 5.9%), a sibling (n=8, 0.9%) or a relative (n=17, 1.9%).

1309

children participated in the data assessment at baseline.

682

children were boys.

627

children were girls.

Information about the living conditions of the participating children is shown in Table 03.01. Most families had access to electricity (n=868, 95.6%), to a mobile phone (n=731, 80.6%), a TV (n=734, 80.8%), and a fridge (n=662, 72.9%). Most of the children lived in a RDP house (n=313, 34.5%), a council house (n=195, 21.5%), a backyard shack/room (n=97, 10.7%) or a privately built house (n=94, 10.4%). Relatively few children (n=30, 3.3%) reported that they lived in a shack in informal settlements. Only 40.3% of the children (n=366) had access to a toilet inside their house. Most of the children had access to water either via a tap inside their house (n=554, 61.2%) or a tap in the yard (n=494, 54.6%).

Table 03.01 Sample characteristics

	Total sample	
Sex	***n***	***%***
Boys	682	52.1
Girls	627	47.9
Grade level	***n***	***%***
Grade 1	324	24.8
Grade 2	325	24.9
Grade 3	329	25.2
Grade 4	326	25.0
School	***n***	***%***
Isaac Booi	468	34.2
Alpha	418	30.5
Greenville	242	17.7
David Vuku	241	17.6
Intervention arm	***n***	***%***
Placebo	335	25.7
MMNS	325	24.9
PA + Placebo	347	26.6
PA + MMNS	297	22.8

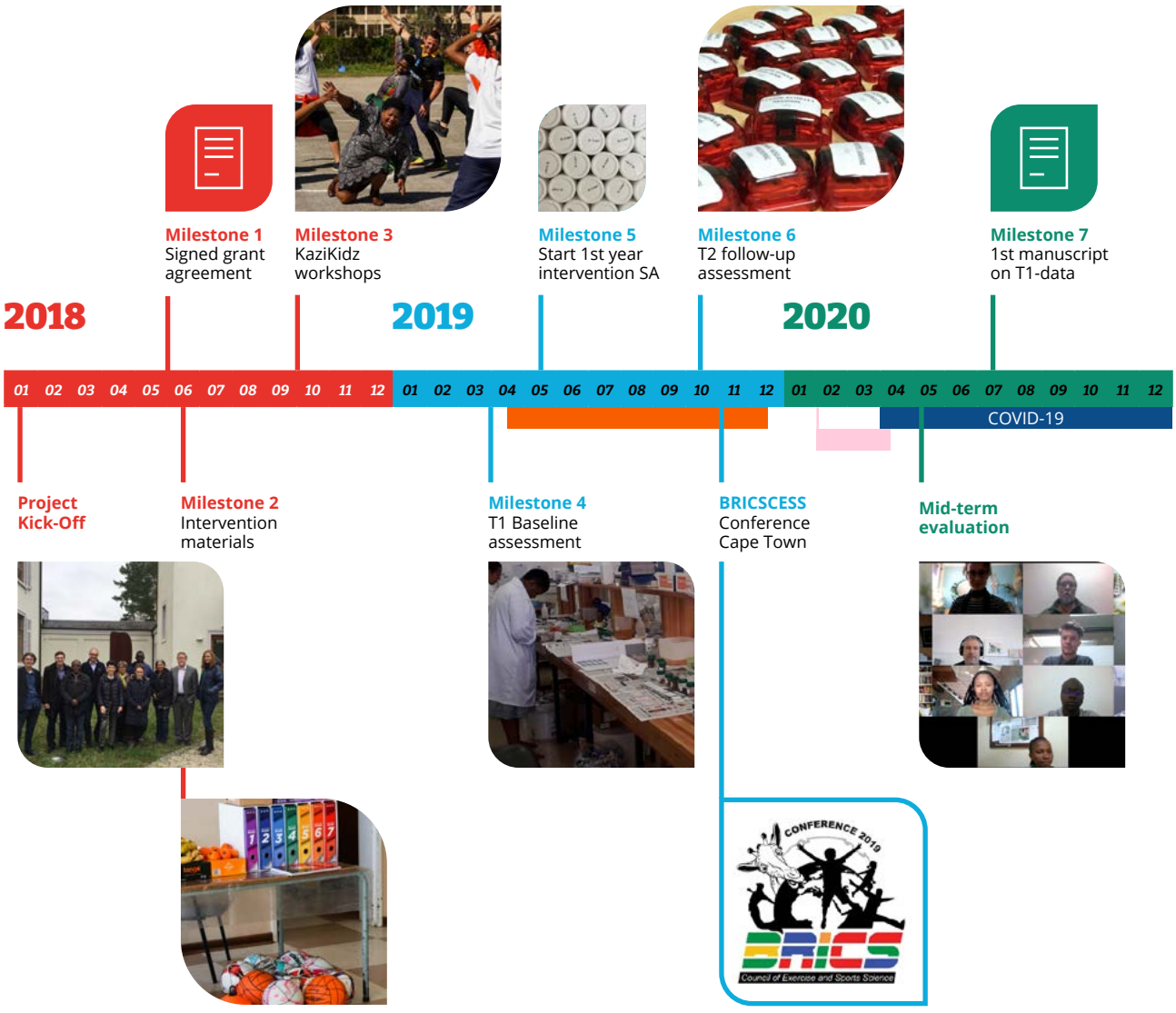
Language spoken*	***n***	***%***
Afrikaans	325	35.9
English	160	17.7
Northern Sotho	3	0.3
Xhosa	530	58.6
Zulu	4	0.4
Other	10	1.1
Ethnic background	***n***	***%***
Black	662	50.6
Coloured	628	48.0
Indian/mixed	14	1.1
White	2	0.2
Other	3	0.2
Caregiver	***n***	***%***
Mother	687	75.3
Father	54	5.9
Grandparent	79	8.7
Sibling	8	0.9
Relative	17	1.9
Other	9	1.0
Information missing	57	6.3

▲ South African project coordinator (left) explaining the purpose of the KaziAfya study

Living and housing conditions	*n*	*%*
Car	142	15.6
Mobile phone	731	80.5
Computer	123	13.4
Oven	449	49.4
Fan	147	16.2
Fridge	662	72.9
Freezer	232	25.6
Motorbike	9	1.0
Phone	30	3.3
Radio	382	42.1
TV	734	80.8
Washing machine	460	50.7
Electricity	868	95.6
Toilet inside house	366	40.3
Type of toilet	*n*	*%*
Bucket	36	2.9
Communal toilet	23	1.3
Flush toilet	828	92.3
No toilet	3	0.3
Pit toilet	1	0.1
Other	5	0.6
Information missing	33	3.6
Type of house	*n*	*%*
Backyard shack/room	97	10.7
Council house	195	21.5
Privately built house	94	10.4
RDP house	313	34.5
Shack in informal settlement	30	3.3
Other	75	8.3
Information missing	104	11.5
*Access to water**	*n*	*%*
Borehole with water pump	4	0.4
Communal tap / shared tap	31	3.4
Taps inside the house	554	61.2
Tap in the yard	494	54.6
Water tank	22	2.4
Other	3	0.3

PA = Physical activity,
MMNS = Multi-micronutrient supplementation.

A timeline of the project



Key:

- 1nd year intervention
- 2nd year intervention
- COVID-19
- Continuation of MMNS intervention

Milestone 9
Manuscripts on T1 / T2-data

Milestone 10
T3 follow-up assessment

Milestone 13
Update project progress

2021 **2022** **2023**

01 02 03 04 05 06 07 08 09 10 11 12 | 01 02 03 04 05 06 07 08 09 10 11 12 | 01 02 03 04 05 06 07 08 09 10 11 12

COVID-19

Milestone 8
1st manuscript on T2-data

Project coordinator retreat
Basel

Milestone 11
1st manuscript on T3-data

Milestone 12
Manuscripts on T3-data

Milestone 13
Final report

SES Household types in SA

Shack in informal settlement

Typical shacks you can see in Gqeberha with communal toilets and taps

Backyard shack/room

A backyard shack (usually made of corrugated iron) is normally a one or two room built at the backyard of an RDP or privately built house. These backyard rooms usually have an outside toilet and a tap outside attached to the main house.

RDP house

Government subsidy housing (commonly known as RDP houses). These are houses that have been built by the government and are given to low income families. When sufficient space is available, some people extend their homes so that they can add more rooms.

Council house

Council houses are the sub-economic houses built during apartheid times.



Privately built house

These are typical privately built houses in the areas we work with. Some families extend their houses to have more rooms or include a garage or have flats in the backyard.



Essentials

KaziAfya Project
2018 –2021

Ensuring healthy lives and promoting well-being among children is a complex and challenging endeavour. In Africa, children are at an increased risk of compromised health due to a dual burden of diseases, which may hamper their development and well-being. Although children are mainly affected by infectious diseases, they may at a young age already develop risk-factors predisposing them to non-communicable diseases in early adulthood. Therefore, the main purpose of the KaziAfya project was to examine the prevalence of infectious diseases and cardiovascular health risk markers in three African countries and to test low-cost preventive programmes, which combine multi-micronutrient supplementation with physical activity to promote health and well-being among African schoolchildren.

The KaziAfya project was designed as a randomised, double-blind, placebo-controlled trial to assess the effect of physical activity and/or multi-micronutrient supplementation on children's health and well-being. In South Africa, a total of 1369 children attending grades 1-4 were recruited and assessed three times. Several indicators of growth, mental and physical health were assessed. The project started in January 2018 and lasted until September 2023.

Overall, our data reveal that children were quite satisfied with their overall health. More than 80% of the children rated their overall health as good, very good or excellent, whereas only 5% of the children rated their health as poor. Moreover, children's subjective representation of well-being improved over time and, even after the outbreak of the COVID-19 pandemic, no substantial decreases in children's well-being were observed. Similar developments were seen in boys and girls. In line with their overall positive health assessment, relatively few children reported daily subjective health complaints. The most frequently reported complaints were difficulties falling asleep, headache, and stomach ache, which more than 15% of the children perceived once per week. As reported in the international literature, girls reported more complaints than boys.

Between 1270 and 1280 children had valid data for self-reported sleep complaints. The most frequently reported single sleep complaints were being very tired at bedtime (40%) and not feeling restored in the morning (21%). Learners from grade 4 felt more often that they did not get enough sleep and that they were not fully restored in the morning, and children from grade 1 felt most tired at bedtime. Based on approximately 800 parental reports, most of the children slept between 9–11 hours during weekdays and between 9–12 hours during weekends. During weekdays, average bedtime was 20:23 pm, whereas

1287

children participated in the clinical examination, in total.

average wake time was 06:17 am. During weekends, bedtime was delayed by approximately half an hour (20:55 pm), whereas children usually got up at 07:43 am. In summary, most children seem to get enough sleep in purely quantitative terms, but approximately a quarter of the children complained about recurring sleep problems. Sleep changed slightly with age, in the sense that older students tended to go to bed a little later and sleep less.

In total, 1287 children participated in the clinical examination. The most prevalent disease symptoms at the time of the examination were cough (40%), fever (23%), diarrhea (17%), breathing difficulties (14%) and allergies (13%). Symptoms of jaundice, splenomegaly and hepatomegaly were not observed in the present sample. Pulmonary and cardiac auscultations were also rare, whereas skin lesions were found relatively frequently (in 14% of the children), particularly scratch or ringworm lesion. Almost one third of the children had taken medication in the week prior to the assessment. The intake of antibiotics was relatively rare (1%). The majority of the children were non-anaemic (81%), whereas 12% presented with mild, and 7% with moderate anaemia. With regard to weight status, 5% of the children were classified as underweight, 79% as normal weight, 10% as overweight and 6% as obese. This indicates that in peri-urban neighbourhoods, overnutrition is now a bigger health problem than undernutrition. Interestingly, girls were overrepresented among both under- and overweight/obese children. Eight percent of the children were classified as (low weight-for-height), whereas 9% were stunted. Girls were more likely to be wasted, whereas no sex differences occurred for stunting (low height-for-age). Moreover, based on systolic blood pressure assessments, 9% of the children were identified as pre-hypertensive, and 18% as hypertensive. In addition, 17% of the children were classified as prediabetic. LDL-cholesterol levels decreased over the course of the study, while HDL cholesterol levels increased. The increase in triglycerides was deemed critical. With regard to the development of blood lipid concentrations over time, there were no significant differences between boys and girls. In summary, within the framework of the clinical examinations, despite the generally positive health assessment by the children, various health complaints and risk factors for later cardiovascular diseases were identified in the present population.

Children's overall school performances were satisfactory, with only few children being unable to keep up in the first four grades. However, fewer students than the grading system would suggest fell into the top performance levels. Girls seemed to have an advantage over boys when it comes to academic performance. This may be the reason why boys perceived more pressure at school. In terms of school enjoyment, no differences were observed between the different grade levels at baseline.

Based on actigraphy data, boys accumulated 93 min of MVPA per day, whereas girls engaged only for 70 min per day in at least moderately intensive physical activity. More than 75% of the children accumulated sufficient amounts of physical activity and thus met international physical activity standards, with boys being more likely to meet recommended levels of

More than 30% of the children reported that they went to bed hungry on the day before the data assessment.

physical activity. According to the parents' reports, 54% of the children engaged in at least 60 minutes of physical activity per day on every day of the week, and more than two thirds of the children engaged in sports, dance and other playful games at least two times per week (both during weekdays and weekend days). At the same time, however, time spent in sedentary activities gradually increased from grade 1 (587 min) to grade 4 (613 min). Finally, more than two thirds of the learners did not receive physical education lessons, and among those who received physical education, four out of ten reported that the physical activity dose/intensity during the lessons was very low. Overall, children seem motivated to engage in physical activity during school time as almost half of the learners ran and played during recess or lunch time. With regard to their cardiorespiratory fitness levels, the performances observed of the present sample were comparable to those of previous child studies in South Africa, and correspond to a 50 centile rank on an international level (Lang et al., 2018).

With regard to food security, more than 30% of the children reported that they went to bed hungry on the day before the data assessment, approximately 25% of the children only got one meal (or less) the day before the data assessment, and approximately one quarter of the parents/guardians felt that their household members would not have access to enough food on every day. On average, children consumed approximately 24 items from 6 different food groups per day. The most frequently consumed food groups were cereals, flesh meat, green vegetables, milk, sweets, fruits and roots. With regard to micronutrient status, many children presented with a vitamin A (97%), a vitamin D (69%) or an iron (43%) deficiency. With regard to zinc, a deficiency was observed in 11% of the children, whereas the majority (68%) presented with abnormally high zinc levels. These findings contradict those of other studies conducted among children in South Africa. We also analyzed soil and water samples from these areas, but the higher zinc levels could not be explained.

With regard to the effects of the intervention, the results seem more complicated than expected. For instance, whereas the findings of our study showed no direct impact of the intervention arms on moderate-to-vigorous physical activity, the findings suggest that the promotion of physical activity and multi-micronutrient supplementation in school-based interventions may be an effective strategy in reducing childhood overweight and obesity and increasing fat-free mass in LMICs partly through the effects on micronutrient status.

Mental and physical well-being

KaziAfya Project
2018 –2021

Background

Subjective representations of mental and physical well-being are important aspects of children's health-related quality of life (Ravens-Sieberer et al., 2006). Subjective representations of well-being can be used as a benchmark for monitoring population health, to identify subgroups that require specific attention, and to measure the impact of public health interventions within specific populations (Ravens-Sieberer et al., 2001). As a consequence, subjective representations of mental well-being have become an important factor in the medical and caring sciences (Haraldstad et al., 2011). In children, perceived mental and physical well-being proved to be important predictors of health and for estimating health care costs in later life (Seid et al., 2004). Early interventions to improve mental and physical well-being seem important as these constructs are characterised by a remarkable stability over time (Meade & Downswell, 2016). As shown in previous research, many factors can negatively influence subjective well-being, including lower socioeconomic status (von Rueden et al., 2006) or being overweight or obese (Chen et al., 2014). Additionally, mental and physical well-being seem to decline from childhood to adolescence (Bisegger et al., 2005; Michel et al., 2009), and with increasing age, girls tend to report lower well-being than boys (Bisegger et al., 2005; Helseth et al., 2015; Michel et al., 2009).

Although South Africa has well-developed reporting systems and reasonable data on children's objective living conditions, there is a serious lack of data on subjective indicators - that is, what children think and feel and how they evaluate their whole life and various aspects of their lives (Savahl et al., 2023). In South Africa, a strong and persistent relationship was observed between low socioeconomic status and impaired well-being among children living in disadvantaged neighbourhoods (Ataguba et al., 2011). Children from low-income families often have poorer access to education, health care and other resources, which can negatively influence their well-being (Du Plessis & Conley, 2007; Fleisch, 2008). South Africa has high rates of violence and crime, which can negatively impact children's well-being. Children who experience violence or abuse often suffer from psychological and emotional problems that can affect their academic performance and overall well-being (Mathews et al., 2013). By contrast, having a supportive social environment is important for children's well-being. Family, friends and community can play an important role in supporting children and helping them to cope with challenges (Naidoo & Muthukrishna, 2016).

How did we measure mental and physical well-being?

To assess children's subjective representations of their mental and physical mental and physical well-being, we applied the 10-item KIDSCREEN. This instrument assesses children's moods and emotions, self-perception, autonomy, parent relation and home life, financial resources, peers and social support, school environment, and bullying experiences. The KIDSCREEN proved to be a valid instrument to assess

The school playground is a safe and enclosed area for children to play

Participating children in the survey

psychosocial health of children aged 8-18 years across various countries (Ravens-Sieberer et al., 2008). The construct validity of the KIDSCREEN has been evaluated in an African context (Taliep & Florence, 2012). We previously used the KIDSCREEN in the DASH study, where we found satisfactory psychometric properties of this instrument (Salvini et al., 2018). The KIDSCREEN also allows to calculate an overall index. Following recommended procedures, item scores were first summed up to obtain raw scores and then transformed into Rasch person parameter estimates. These steps resulted in T-values with a scale mean of 50 and a standard deviation (SD) of 10. Higher mean scores generally reflect higher health-related quality of life.

Results

In total, the KIDSCREEN was completed by 1281 children. As shown in Figure 05.01, children were quite satisfied with their overall health. Taken together, 84% of the children rated their overall health as good, very good or excellent. Eight percent of the children felt that their overall health was only "quite good", whereas 5.5% of the children rated their health as "poor".

As shown in Table 05.01 and Figure 05.02, the scores were relatively high across all items. The highest mean scores were found for "fun with friends", "ability to pay attention to teachers" and "got on well at school". The lowest score was observed for "enough time for yourself". Table 05.01 also shows the mean scores separately for boys and girls. Statistically significant differences were found for "felt full of energy" and "ability to pay attention at school". While boys felt more energetic than girls, girls felt that they were more attentive to their teachers.

Figure 05.01 Perceptions of general health among the total sample

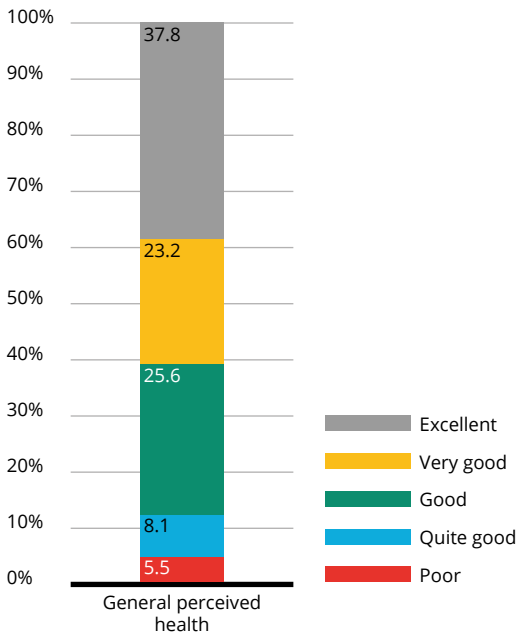
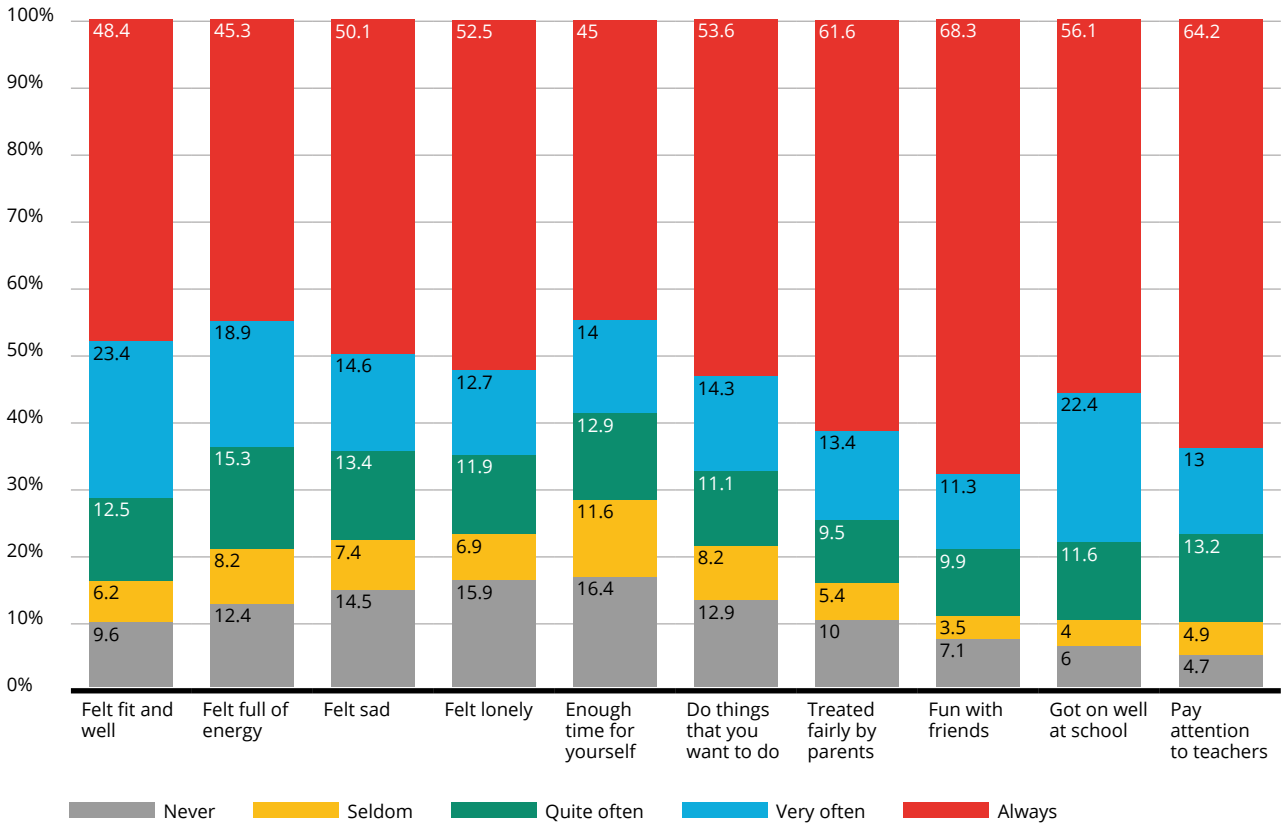


Figure 05.02 Mental and physical well-being of the total sample



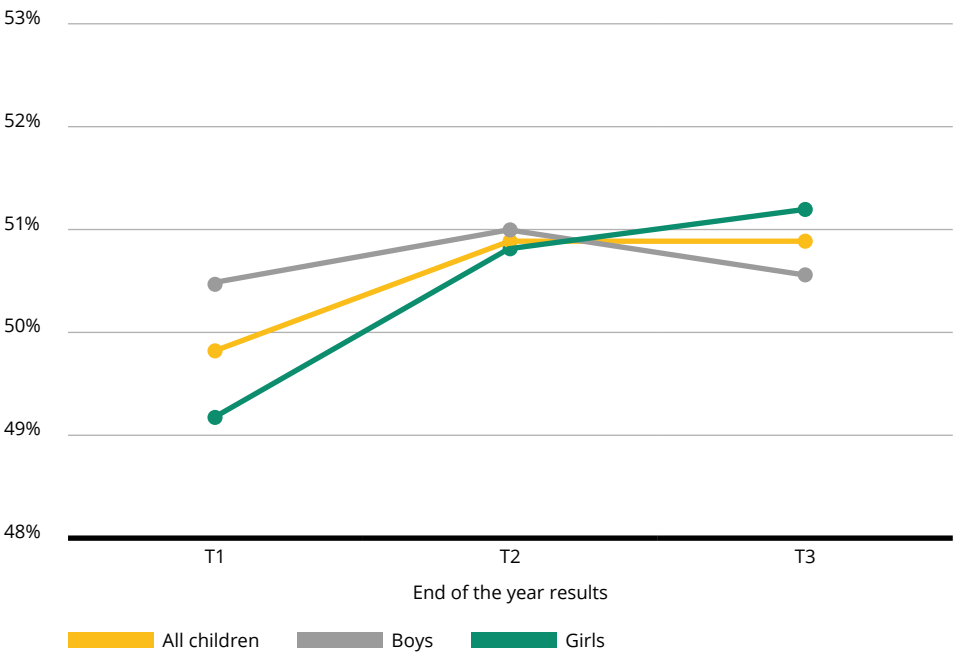
As shown in Table 05.01, learners in grade 1 and 2 more often felt fit and well than their older peers. Similarly, they perceived that they had more time to do the things they want to do during their free-time. Learners in grade 1 also felt that they were treated more fairly by their parents than their older peers. However, no clear gradient was found for this variable. In line with these findings, grade 1 and 2 learners also reported higher overall well-being than their older counterparts. For the other variables, no statistically significant differences were observed with regard to sex and grade level.

Overall, 800 children completed the instrument three times and had a valid KIDSCREEN-10 total score across all measurement time points. As shown in Figure 05.03, the total scores increased statistically significantly from T1 to T2 and then remained stable from T2 to T3. This pattern did not differ between boys and girls although descriptively the increment was somewhat stronger for girls than boys.

Conclusion

Overall, a positive picture emerged with regard to the mental and physical well-being of the participating children. Only 5.5% of the learners rated their overall health as negative. This is also reflected in the various subareas of mental and physical well-being, in which only a maximum of 28% of the children expressed criticism. In most subareas, between 80-90% of the children felt comfortable. Moreover, children's subjective representation of well-being improved over time and, even after the outbreak of the COVID-19 pandemic, no substantial decreases in children's well-being were observed, despite the restrictions associated with the COVID-19 pandemic. Similar developments were seen in boys and girls.

Figure 05.03 Development of the KIDSCREEN total score (1-100) across the study period, for the total sample and separately for boys and girls



▲ Housing in Gqeberha

Table 05.01 Mental and physical well-being, separately for boys and girls and learners attending different grades

	Total sample		*Boys*		*Girls*		*Grade 1*		*Grade 2*		*Grade 3*		*Grade 4*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
General perceived health	3.79	1.19	3.83	1.19	3.76	1.18	3.78	1.14	3.95	1.25	3.68	1.13	3.77	1.20
Felt fit and well	3.95	1.31	4.01	1.29	3.88	1.33	4.11	1.19	4.08	1.29	3.90	1.30	3.72	1.41
Felt full of energy	3.77	1.41	3.90	1.36	3.62	1.45	3.91	1.28	3.74	1.44	3.70	1.47	3.69	1.46
Felt sad	3.78	1.48	3.75	1.50	3.82	1.46	3.92	1.37	3.65	1.56	3.71	1.47	3.84	1.52
Felt lonely	3.79	1.52	3.78	1.51	3.80	1.53	3.76	1.51	3.63	1.54	3.91	1.47	3.83	1.56
Enough time for yourself	3.60	1.54	3.63	1.52	3.56	1.56	3.65	1.51	3.69	1.50	3.41	1.59	3.63	1.54
Do things that you want to do	3.88	1.46	3.92	1.43	3.83	1.48	4.17	1.31	3.95	1.42	3.75	1.48	3.64	1.56
Treated fairly by parents	4.11	1.35	4.18	1.31	4.04	1.39	4.25	1.23	4.22	1.23	3.86	1.49	4.12	1.41
Fun with friends	4.30	1.21	4.29	1.22	4.31	1.20	4.43	1.10	4.28	1.24	4.26	1.25	4.24	1.25
Got on well at school	4.18	1.16	4.15	1.18	4.22	1.13	4.18	1.14	4.38	1.03	4.15	1.3	4.38	1.08
Pay attention to teachers	4.27	1.15	4.18	1.19	4.37	1.10	4.16	1.12	4.19	1.19	4.18	1.22	4.21	1.12
Health-related quality of life	50.16	10.49	50.53	10.69	49.77	10.27	51.36	9.81	50.85	11.58	48.81	9.94	49.62	10.40

Subjective health complaints

KaziAfya Project
2018 –2021

Background

Subjective health complaints (or psychosomatic complaints) refer to physical symptoms or illnesses that are caused or influenced by psychological or emotional factors (Simonsson et al., 2008; Sumter & Baumgartner, 2017). These symptoms occur when the body reacts to stress, fear, grief or other psychological stress (Cozzi et al., 2021). The importance of these complaints in children is that they can indicate unresolved emotional conflicts or mental stress (Berntsson & Gustafsson, 2000; Tanaka et al., 2000). Children may have trouble expressing or understanding their feelings and may develop physical symptoms instead. These complaints can also be an expression of a disturbed balance between body and mind. It is important to take psychosomatic complaints in children seriously and treat them appropriately (Ibeziako & Bujoreanu, 2011). A holistic approach that takes into account both the physical and psychological aspects can help to identify and resolve the underlying emotional conflicts (Forde et al., 2022). Early intervention can help children develop healthy coping mechanisms and avoid long-term effects on their physical and mental health.

"Sub-Saharan African societies are confronted with rapid and major changes. How this affects the lifestyle and health of children has so far been little researched. It is often assumed that children in Africa get enough physical activity, which is why physical education at school is neglected. By using an interdisciplinary approach, KaziAfya has the potential to show that the promotion of a healthy and physically active lifestyle has similarly positive effects on South African schoolchildren's growth and health as known from research with children in higher income countries."

Prof. Dr. Markus Gerber
Director of DSBG, University of Basel, principal investigator

▲ Children during clinical examination, performing blood pressure assessment

"KaziAfya addresses the difficulties associated with communicable and non-communicable diseases faced by children in low-income communities, and drives positive and sustainable changes in health within disadvantaged schools located in these communities. The study's notable engagement and collaboration with interdisciplinary academics and researchers from other African countries added immense value, providing intellectual stimulation and enriching the overall research endeavour."

Dr. Danielle Dolley
Research assistant, Nelson Mandela University

How did we assess subjective health complaints?

As part of the clinical examination, a research assistant interviewed each child to obtain information about their disease history and psychosomatic complaints. In the present study, we used seven items of the HBSC-survey to measure subjective health complaints (Haugland & Wold, 2001), including headache, abdominal pain, backache, feeling low, irritability/bad temper, sleeping difficulties, and dizziness. Evidence for the reliability and validity of this measure has been provided previously (Haugland & Wold, 2001). An overall complaint score was built by calculating the mean score across all assessed complaints.

Girls reported more complaints than boys in all domains, with the exception of backache and irritability/bad temper.

Results

Valid data were available for 1286 children. As shown in Figure 06.01, the most frequently reported health complaints (>once per week) were difficulties getting to sleep (17.9%), followed by headache (17.1%), stomach ache (15.3%), irritability/bad temper (14.5%) and feeling low/sad/depressed (13.0%). Backache (5.5%) and feeling dizzy (8.2%) were less frequently reported.

Girls reported more complaints than boys in all domains, with the exception of backache and irritability/bad temper. Headache was more frequently reported by grade 1 and 2 learners compared to their older counterparts, whereas irritability/bad temper was more frequently observed in grade 3 and 4 learners. Please see Table 06.01 on the following page for mean values separately for boys and girls and grade levels.

1286

children had valid data available.

Figure 06.01 Prevalence of subjective health complaints in the total sample

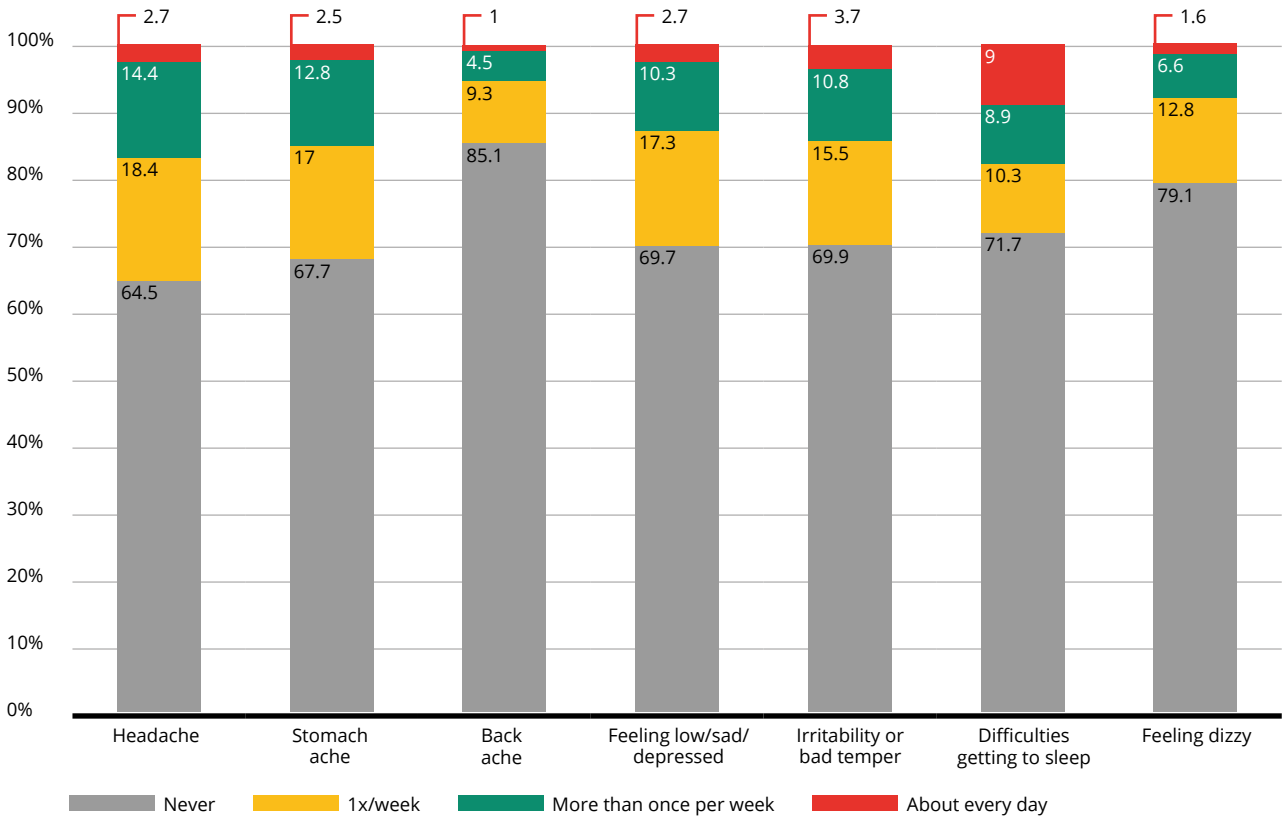


Table 06.01 Subjective health complaints, separately for boys and girls and learners attending different grades

	Total sample		*Boys*		*Girls*		*Grade 1*		*Grade 2*		*Grade 3*		*Grade 4*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Headache	1.55	0.84	1.48	0.79	1.64	0.88	1.67	0.91	1.54	0.83	1.50	0.79	1.50	0.81
Stomach ache	1.50	0.81	1.41	0.78	1.59	0.83	1.56	0.87	1.49	0.81	1.54	0.82	1.42	0.74
Back ache	1.21	0.57	1.21	0.57	1.21	0.56	1.27	0.63	1.22	0.57	1.15	0.46	1.21	0.58
Feeling low/sad/depressed	1.46	0.79	1.41	0.75	1.51	0.82	1.43	0.80	1.47	0.84	1.46	0.76	1.49	0.76
Irritability or bad temper	1.48	0.83	1.48	0.85	1.49	0.82	1.45	0.80	1.38	0.73	1.50	0.84	1.60	0.93
Difficulties getting to sleep	1.55	0.98	1.49	0.92	1.62	1.05	1.48	0.93	1.48	0.92	1.62	1.05	1.61	1.02
Feeling dizzy	1.31	0.66	1.26	0.61	1.35	0.71	1.38	0.72	1.25	0.60	1.32	0.68	1.28	0.64
Overall complaint score	1.44	0.48	1.39	0.46	1.49	0.48	1.46	0.50	1.41	0.46	1.44	0.47	1.45	0.48

▲ Physical education, rope skipping

Conclusion

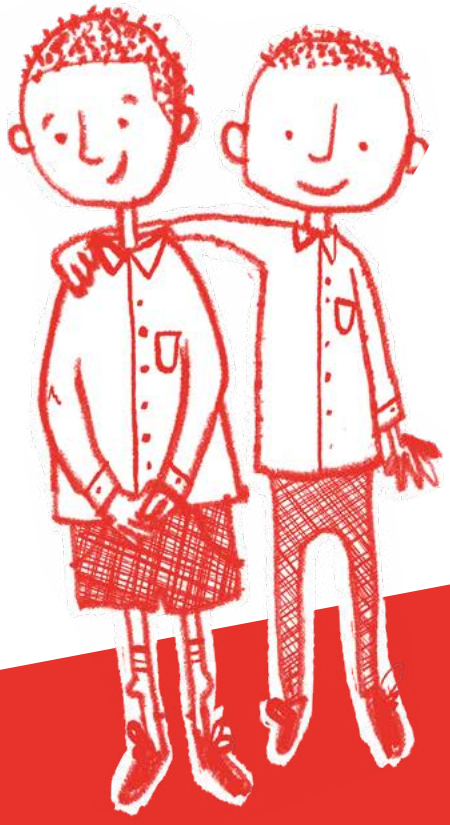
In summary, relatively few children reported daily subjective health complaints. This fits with the overall positive health assessment of the children (see chapter 5). In line with the international research literature, more complaints were reported by girls than boys.

> ***Relatively few children reported daily subjective health complaints.***

"Partnership is key to promoting global health. The KaziAfya project is a concrete example of how innovation embedded in partnership can create measurable impacts on young lives and their school communities. An innovative approach of combining physical education with multi-micronutrient supplementation not only has the potential to boost the growth and health of primary schoolchildren in South Africa, Tanzania and Côte d'Ivoire, but it also shows how transnational partnerships are positively changing the lives of young people."

Prof. Dr. Jürg Utzinger
Director of Swiss TPH

Disease symptoms, helminths infections and medication



07

Background

Disease symptoms and infectious diseases can impact on children on both a physical and psychological level. Children with physical health problems may experience limitations in their daily lives, such as limited physical activity, difficulties in school, or social interactions, which in turn can lead to reduced quality of life (Belfer, 2008). Chronic or recurring disease symptoms can also lead to psychological distress such as anxiety, depression or low self-esteem (Pinquart, 2020). Studies have further shown that certain childhood health conditions can be associated with long-term effects in adulthood (Hoftun et al., 2013). In Sub-Saharan Africa, helminth infections are still widespread among children (Müller et al., 2011). Helminth infections are caused by parasitic worms that infect the intestines or other organs in humans (Hotez et al., 2008). In children, several health risks associated with helminth infections have been identified: For instance, helminths can absorb nutrients from the child's diet and thereby lead to malnutrition, which in turn can impair the physical development (Papier et al., 2014). Studies have also shown that children with helminth infections are, on average, shorter and have a lower body weight than children without infections (Raj et al., 2022). Helminths can affect the child's immune system and weaken the immune response to other infections (Helmby, 2009). This can lead to an increased risk of other infections, such as diarrhea and respiratory infections (Melese et al., 2023). There is evidence that helminth infections can also impair cognitive development (Gall et al., 2017; Pabalan et al., 2018). Another widespread health issue in African children is anemia (Adeyemi et al., 2019; Simo et al., 2020). Anemia is a condition in which the body does not produce enough healthy red blood cells or they do not function properly (Allali et al., 2017). This can cause various health problems in children such as impaired physical development (Aynalem et al., 2022), impaired cognitive function (e.g., attention, memory and academic performance) (Grantham-McGregor et al., 2007; Mohammed Teni, 2017), decreased physical performance (e.g., reduced cardiorespiratory fitness) (Mani et al., 2005; Tsai et al., 2019), and increased risk of infections (e.g., respiratory infections and diarrhea) (Chandyo et al., 2015; Mourad et al., 2010).

How did we assess disease symptoms, use of medication and helminth infections?

As part of the clinical examination, a research assistant assessed children's disease history in a face-to-face interview. Features of disease history focused on fevers, abdominal pain, change in bowel movements, and diabetes. Additionally, a qualified nurse conducted an abdominal examination. To assess children's anaemic status, we used fingerprick methodology to collect one drop of capillary blood, which was then analysed via a HemoCue® Hb 301 system according to the manufacturer's instructions. Based on the haemoglobin (Hb) concentration, children were classified in four different groups (non-anaemic, mild, moderate, severe anaemia)

based on established cut-offs. For parasitological examinations, a researcher visited the schools and distributed pre-labelled plastic containers to each class for the children to take home and use to collect a stool sample. These plastic containers were returned to the research assistant in the morning of the following day. To reduce discomfort, paper bags were provided along with the containers. All stool samples were processed on the day of collection at the study site. We used the Kato-Katz technique to detect parasitic infections with regard to the three main soil-transmitted helminths (Ascaris lumbricoides, hookworm and Trichuris trichiura), and Schistosoma mansoni. Stool samples (at least 10–15 g) were first visually examined for the presence of blood, mucus and diarrhoea. Thereafter, duplicate 41.7 mg Kato-Katz thick smears were prepared from each stool sample, and a random sample of 10% of the Kato-Katz slides was re-examined by a senior technician for quality control. In case of discordant results, the slides were read a third time, and the results discussed among the technicians until agreement was reached.

Figure 07.01 Prevalence of disease symptoms and use of medication in the total sample

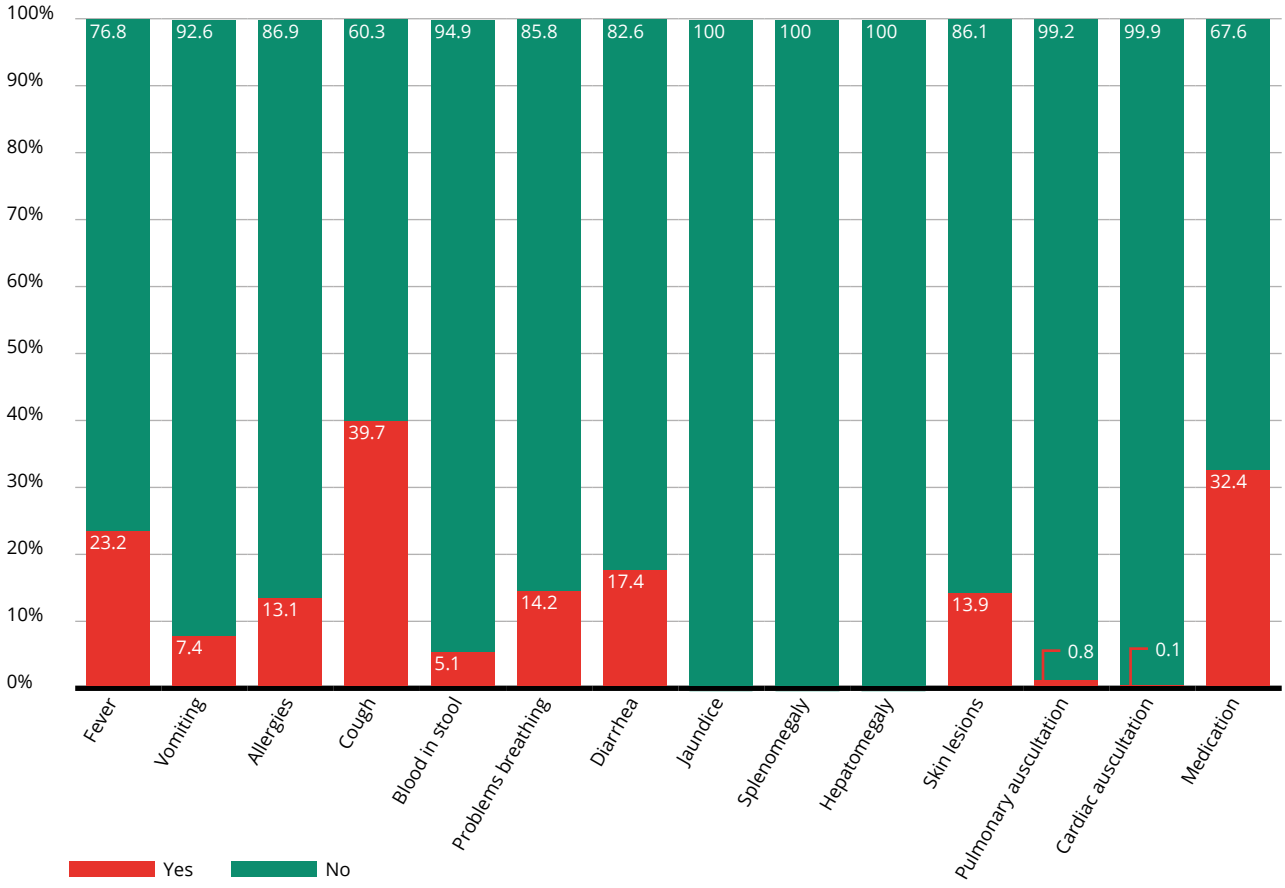
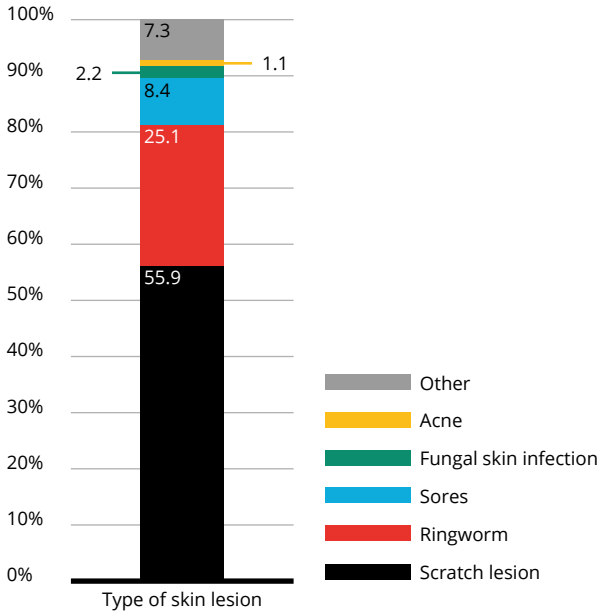


Figure 07.02 Reported types of skin lesions in children with detected skin lesion



1287

children participated in the clinical examination.

Results

In total, 1287 children participated in the clinical examination. Figure 07.01 provides an overview of the most prevalent disease symptoms. 39.7% of the children had a cough, 23.3% had a fever at the time of the examination, 17.4% had diarrhea, 14.2% had difficulty breathing and 13.1% had allergies. Less common (<10%) were nausea/vomiting and traces of blood in the stool. Jaundice, splenomegaly and hepatomegaly were not found in the present sample of children. Pulmonary and cardiac auscultations were also rare. On the other hand, skin lesions were found relatively frequently, which were observed in a total of 13.9% of the children. Among those 179 children who presented a skin lesion, the most frequent lesions were scratch lesions (55.9%), followed by ringworm lesions (25.1%), and other types of sores (8.4%) (Figure 07.02). As shown in Figure 07.01, almost one third of the children (32.4%) indicated that they were taking a medication during the past week. The most frequently reported types of medication were drugs against allergies (24.8%), fever, flu or pain (22.9%) and coughing (20.7%). In addition, 8.2% took drugs against stomach ache, 6.5% against worm infections, and 5.8% against headaches. The intake of antibiotics was relatively rare (1.2%) (see Figure 07.03).

The results of a comparison between boys and girls (Table 07.01 on the following page) indicate that boys were more likely to present with fever (54.4% vs. 45.6%) and skin lesions (16.1% vs. 11.5%), whereas nausea/vomiting (57.9% vs. 42.1%) and diarrhea (54.0% vs. 46.0%) were more prevalent among girls. No statistically significant differences were found with regard to the other variables. Vomiting/nausea (12.4%) and blood in the stool (11.8%) were more frequently observed in grade 1 learners than in children from higher grades (Table 07.01). Additionally, grade 1 learners were also overrepresented among children who took medication (43.8%).

With regard to anaemic status, the majority of the children were classified as non-anaemic (80.9%), whereas 11.6% presented with mild, 7.4% with moderate and 0.1% with severe anaemia (Figure 07.03). Compared to girls, boys were overrepresented

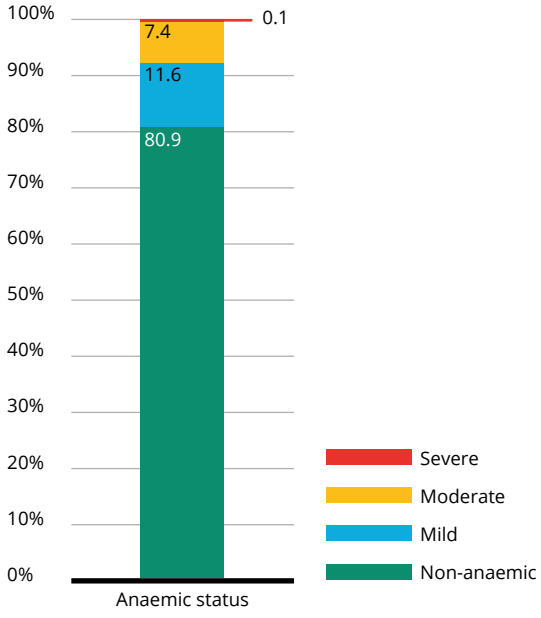
Table 07.01 Disease symptoms and use of medication. separately for boys and girls and learners attending different grades

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Fever	298	23.2	136	20.3	162	26.3	77	24.5	77	24.2	64	19.7	77	23.9
Vomiting	95	7.4	40	6.0	8.9	57.9	39	12.4	16	5.0	17	5.2	23	7.1
Allergies	169	13.1	77	11.5	92	14.9	34	10.8	12.6	24.2	11.4	22.4	54	16.8
Cough	510	39.7	261	39.0	249	40.4	139	44.3	117	36.8	128	29.4	122	37.9
Blood in stool	65	5.1	36	5.5	29	4.7	37	11.8	14	4.5	6	1.8	7	2.2
Problems breathing	182	14.2	84	12.5	98	15.9	53	16.9	43	13.5	39	12.0	46	14.3
Diarrhea	224	17.4	103	15.4	121	19.6	67	21.3	58	18.2	53	16.3	45	14.0
Jaundice	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Splenomegaly	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Hepatomegaly	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Skin lesions	179	13.9	108	16.1	71	11.5	47	14.9	41	12.9	50	15.4	38	11.8
Pulmonary auscultation	10	0.8	7	1.0	3	0.5	2	0.6	4	1.3	3	0.9	1	0.3
Cardiac auscultation	1	0.1	1	0.1	0	0.0	0	0.0	0	0.0	1	0.3	0	0.0
Medication	415	32.4	200	29.9	215	35.0	137	43.8	96	30.3	96	29.5	82	25.6

▲ Children during the KaziKidz lessons

An example of the living conditions in one of our township study areas

Figure 07.03 Prevalence of mild. moderate and severe anaemia in the total sample (in %)

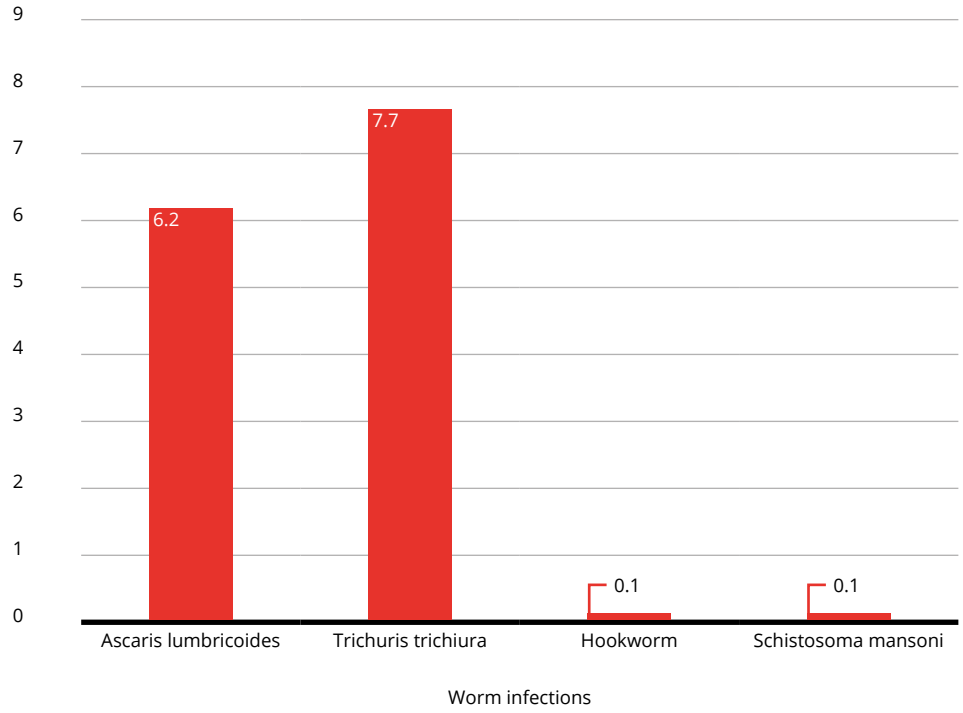


in the group with moderate anaemia (9.7% vs. 5.1%), whereas girls were more frequently classified as non-anaemic (83.2% vs. 78.5%). Mild (17.2%) and moderate anaemia (10.3%) were also more prevalent among grade 1 learners compared to children from higher grades. The prevalence of worm infections in the total sample is shown in Figure 07.04.

Conclusion

In summary, although the health assessments of the children were generally positive, various health complaints were identified during the clinical examinations. Approximately 7.5% of the children were found to have moderate or severe anaemia (Figure 07.03). Other complaints included coughs, fevers, diarrhea, breathing difficulties, allergies, and skin lesions. Nearly one third of the children reported taking medication in the past week. The use of medicines for allergies, fever, and cough was particularly widespread (see Figure 07.05 on the

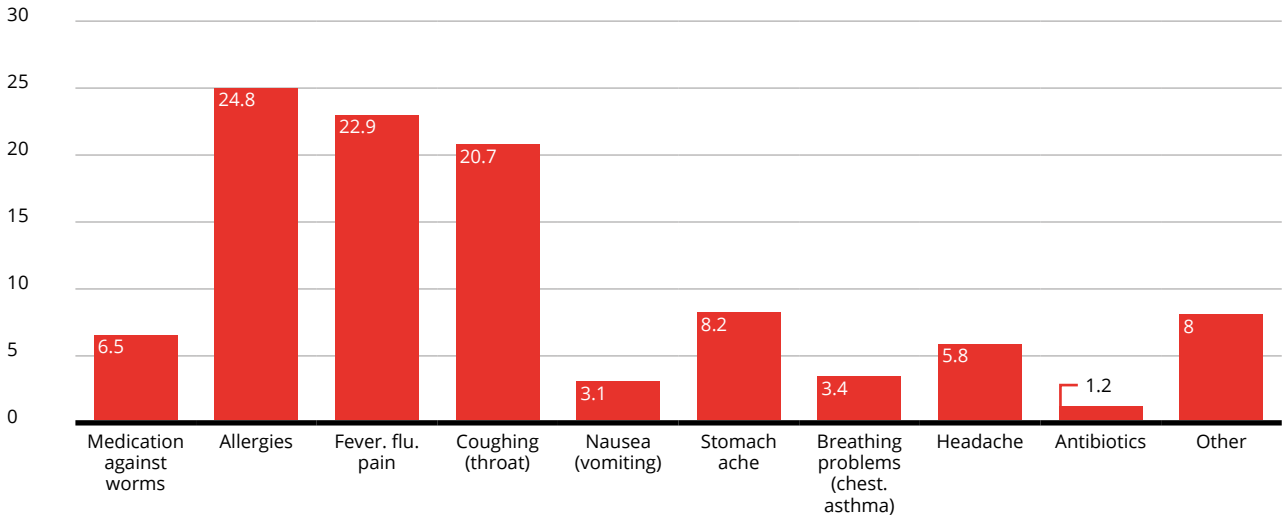
Figure 07.04 Prevalence of worm infections in the total sample (in %).
Multiple infections possible



▲ Stool sample collection

▲ Stool lab team at work at the Nelson Mandela University

Figure 07.05 Reported types of medication in children who report medication intake (in %). Multiple answers possible



Growth and body composition

KaziAfya Project
2018 –2021

1.8

Background

Worldwide, there are serious concerns regarding the increase in overweight and obesity of children and adolescents, especially in urbanised populations and economically developed countries (de Onis & Blössner, 2000; Wang & Lobstein, 2006). Already at pre-school age, the prevalence of overweight and obese children has increased steadily during the past decades (de Onis et al., 2010). At a global scale, the prevalence of obesity increased at an alarming rate from 0.9% in girls and 0.7% in boys in 1975 to 7.8% in girls and 5.6% in boys in 2016 (Blüher, 2019). However, childhood overweight and obesity have also increased in developing nations due to the nutrition transition (Armstrong et al., 2011). The estimated childhood prevalence of overweight/obesity in Africa was 8.5% in 2010 and was expected to be 12.7% in 2020. This is a significant increase given that the prevalence was only 4.0% in 1990 (de Onis et al., 2010). Moreover, the increase in childhood overweight/obesity is expected to be markedly higher in Africa compared to Asia or high-income countries (Mokabane et al., 2014). Importantly, approximately three of four overweight children aged less than 5 years live in LMICs (Black et al., 2013). From a public health perspective, these figures are alarming given that overweight/obese children have a markedly higher clustered cardiovascular risk (Nyberg et al., 2011; Sardinha et al., 2016).

The increase in childhood overweight/obesity is expected to be markedly higher in Africa compared to Asia or high-income countries.

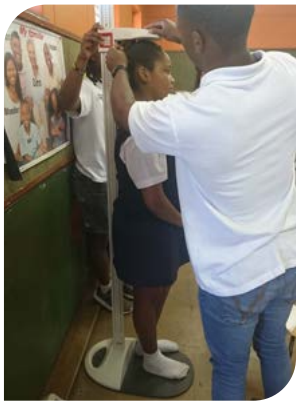
The WHO defines children as stunted, if their height-for-age is two standard deviations below the WHO child growth standards median (de Onis, 2007). Therefore, linear growth is an important indicator of children's nutritional status and healthy development. In school-aged children, stunted children are at increased risk of having higher school absenteeism and dropout rates, and of underperforming academically (Ezeamama et al., 2018; Liu et al., 2015). Moreover, for reasons that are still poorly understood, stunting seems to be more prevalent among boys than girls, particularly in the lower socioeconomic strata (Wamani et al., 2007).

▲ Physical education warm-up activities

For reasons that are still poorly understood, stunting seems to be more prevalent among boys than girls, particularly in the lower socioeconomic strata.

▲ "You can't teach a hungry child" is the slogan of the South African school feeding association, which provides hot meals to school children.

▲ Body composition



▲ Measuring height

How did we assess growth and body composition?

We assessed children's body composition via bioelectrical impedance analysis (BIA) with a wireless body composition monitor (Tanita MC-580, Tanita Corp.; Tokyo, Japan). We asked the participants to fast for 3 h before the data assessment, to void their bladder immediately before the assessment, and to wear only light sport clothing (≤1 kg). We also used the MC-580 to assess body weight, which was measured to the nearest 0.1 kg. With shoes off, each child stood against a stadiometer with the back erect and shoulders relaxed. Body height was taken to the nearest 0.1 cm. Sex-specific height or length-for-age and weight-for-age z-scores were computed from the CDC/WHO growth reference data (Ogden et al., 2002).

"Globally, children's physical activity levels are declining due to changing lifestyles, including increased media use and sedentary behaviour. South Africa has not escaped this trend. Thus, in 2011, Cheryl Walter and I discussed the alarming situation of physical education lessons in South African schools, which was integrated into Life Orientation, diminishing its significance, particularly in marginalized communities, which face a number of challenges in the implementation of physical education. In the subsequent years, our shared passion for supporting physical education led us to the development of the KaziKidz toolkit. I am delighted to see its expansion in South African schools based on the KaziAfya study, but also the translation of the toolkits and their implementation in primary schools in Tanzania and Côte d'Ivoire, which will demonstrate its wider impact."

Prof. Dr. Uwe Pühse
UNESCO Chair of Physical Activity and Health in Educational Settings, University of Basel

Results

At baseline, height and weight were assessed in 1245 children. The mean BMI was 16.01 kg/m² (Table 08.01 on page 77). Whereas boys and girls did not significantly differ with regard to their BMI, BMI scores were higher in learners attending more advanced grades. In 509 children, BMI was assessed across all measurement time points. As shown in Figure 08.01, average BMI increased from T1 to T3, with a significantly higher increase in girls.

1245

At baseline, BMI was assessed in 1245 children.

Due to missing information on age, information on weight status was available only for 1228 children. As shown in Figure 08.02, 4.6% of the learners were classified as underweight, 79.4% as normal weight, 9.7% as overweight and 6.4% as obese. As shown in Table 08.02 (page 77), significant differences occurred between boys and girls. While girls were more likely to be underweight than boys (7.2% vs. 2.1%), they were overrepresented in the overweight (11.3% vs. 8.2%) and obese (8.9% vs. 3.9%) groups. In contrast, boys were overrepresented among normal weight children (85.8% vs. 72.6%). With regard to grade level, no statistically significant differences were observed.

Information on wasting and stunting was available for 1069 and 1231 children, respectively. As shown in Figure 08.03, 8.0% of the children were classified as wasted, whereas the percentage of stunted children amounted to 9.1%. Girls (11.4%) were at higher risk for wasting than boys (4.8%) (Table 08.01). No significant sex differences were found with regard to stunting. Grade level was unrelated to both wasting and stunting.

Figure 08.01 Development of BMI (kg/m²) across the study period, for the total sample and separately for boys and girls

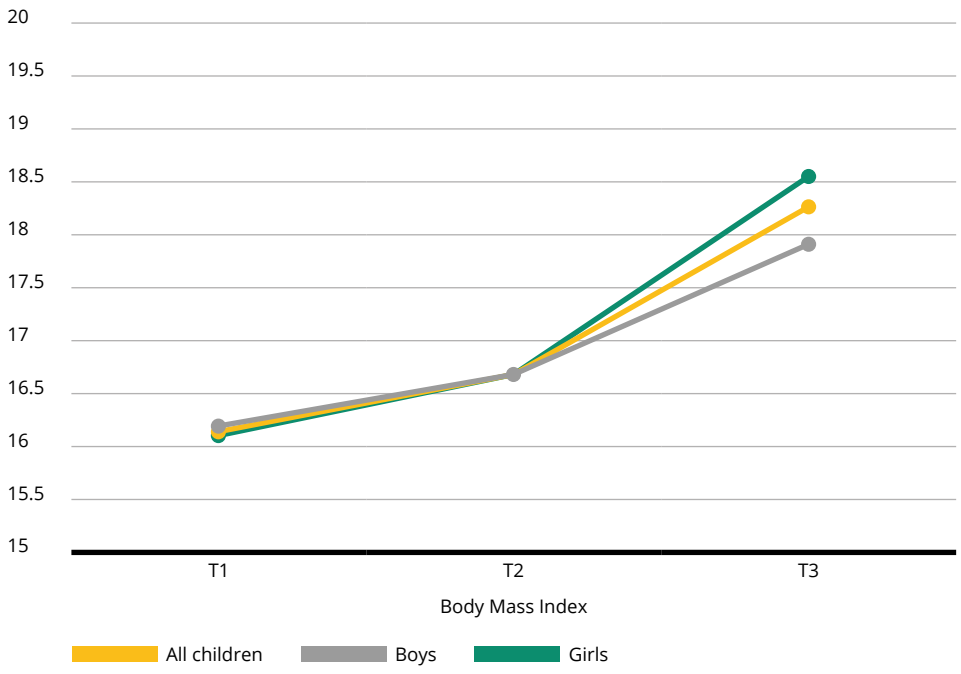


Table 08.01 Weight status, stunting and wasting, separately for boys and girls and learners attending different grades

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Weight status														
Underweight	56	4.6	13	2.1	43	7.2	13	4.3	12	3.9	13	4.1	18	6.0
Normal weight	975	79.4	543	85.8	432	72.6	236	77.9	258	83.5	256	80.8	225	75.3
Overweight	119	9.7	52	8.2	67	11.3	40	13.2	24	7.8	26	8.2	24.4	9.7
Obese	78	6.4	25	3.9	53	8.9	14	4.6	15	4.9	22	6.9	27	9.0
Stunted	112	9.1	26	4.8	60	11.4	25	8.2	25	8.1	26	8.9	10	6.1
Wasted	86	8.0	48	7.6	64	10.7	30	9.8	9.4	9.4	23	7.3	30	10.0

Figure 08.02 Prevalence of normal weight, underweight, overweight and obesity (in %)

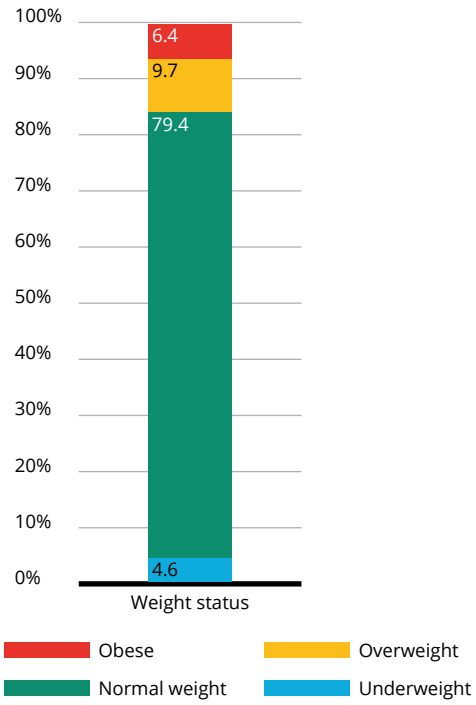
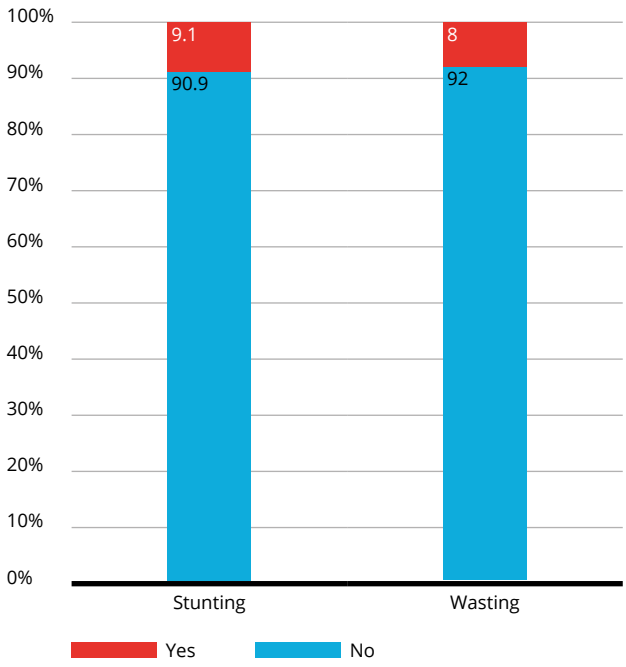


Figure 08.03 Prevalence of stunting an wasting (in %)



Body composition was assessed in 1270 children. At baseline, the mean weight of the children was 25.39 kg and the mean height 124.70 cm (Table 08.02). While boys and girls did not differ with regard to body weight, boys were slightly taller. Expectedly, body weight and height were significantly higher in learners from more advanced grades (grade 1: 20.98 kg, 115.64 cm; grade 4: 30.60 kg, 133.79 cm). As shown in Table 08.02, mean body fat at baseline was 22.57% in the total sample, and 20.80% in boys and 24.46% in girls. Relative and absolute body fat was significantly higher in girls than boys. By contrast, boys had higher relative muscle mass, higher absolute bone mass, absolute fat free mass, and total body water. Boys also had a significantly higher basal metabolic rate than girls. Absolute (but not relative) fat mass was higher among students from more advanced grades. Absolute muscle mass also increased from grade 1 (15.14 kg) to grade 4 (22.04 kg), which was also true for absolute bone mass (increase from 0.93 kg to 1.27 kg), fat-free mass (from 16.07 kg to 23.31 kg), and total body water (from 11.77 kg to 17.06 kg).

Data on body composition was available for 515 children across all measurement time points. While body weight increased similarly in boys and girls from T1 to T2, the increase was stronger in girls from T2 to T3. A similar pattern was observed for body height, indicating that initial differences (with boys being taller) nearly disappeared until T3. As shown in Figure 08.04, initial sex differences in relative body fat became more substantial from T2 to T3. A similar pattern was also observed for absolute body fat, whereas differences in muscle mass remained relatively stable across time, with boys having higher absolute muscle mass (data not shown). Differences in absolute bone mass (with boys having higher scores at T1) became smaller until T3. No significant time by sex differences occurred for absolute fat free mass, body water, and basal metabolic rate (kcal), with boys having higher scores than girls across all measurement time points.

Conclusion

Expectedly, average BMI increased from T1 to T3, with a significantly higher increase in girls compared to boys. With regard to weight status, 5% of the children were classified as underweight, 79% as normal weight, 10% as overweight and 6% as obese. This suggests that in our sample, overnutrition presented a bigger health issue than undernutrition. Girls were overrepresented among both under- and overweight/obese children. 8% of the children were classified as wasted, whereas 9% were stunted, with girls being more likely to be wasted. Higher relative and absolute body fat was found in girls than boys, whereas boys had higher relative muscle mass and basal metabolic rate.

Figure 08.04 Development of body fat (in %) across the study period, for the total sample and separately for boys and girls

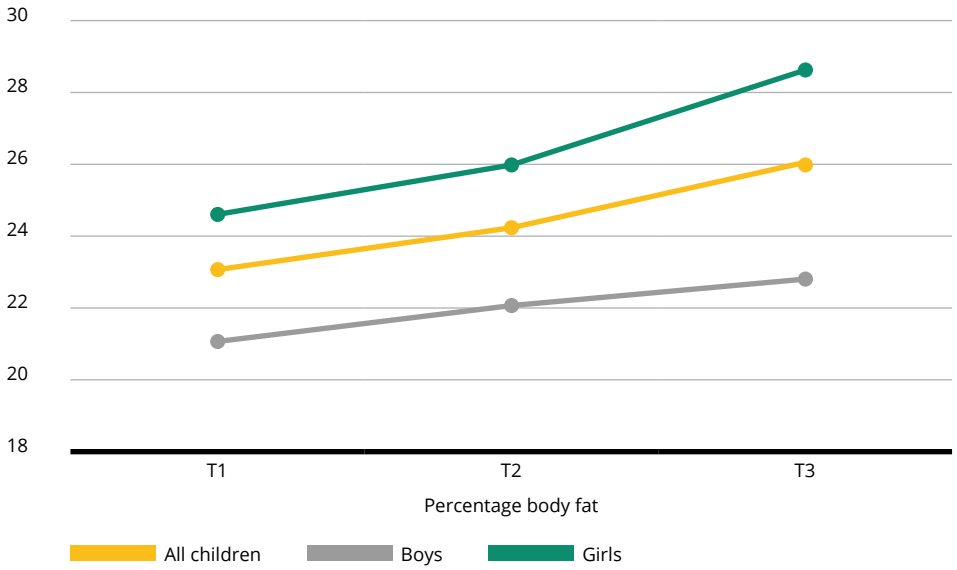


Table 08.02 Growth, body composition, and basal metabolic rate, separately for boys and girls and learners attending different grades

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
BMI (kg/m²)	16.07	2.61	16.01	2.41	16.13	2.80	15.55	2.14	15.59	2.13	16.27	2.69	16.87	3.13
Weight (kg)	25.39	6.87	25.55	6.61	25.22	7.14	20.98	4.41	23.07	4.66	26.83	6.17	30.60	7.51
Height (cm)	124.70	9.24	125.34	9.00	124.02	9.45	115.64	6.09	121.32	5.87	127.95	6.08	133.79	6.92
Body fat (%)	22.57	5.31	20.80	4.80	24.46	5.17	22.83	4.71	22.35	4.37	22.41	5.56	22.67	6.34
Body fat (kg)	5.95	3.20	5.51	3.02	6.42	3.33	4.93	2.23	5.29	2.29	6.26	3.31	7.29	4.07
Muscle mass (kg)	18.36	4.05	18.89	3.97	17.80	4.06	15.14	2.44	16.77	2.60	19.44	3.24	22.04	3.89
Bone mass (kg)	1.09	0.22	1.17	0.19	1.01	0.21	0.93	0.15	1.01	0.16	1.14	0.19	1.27	0.21
Fat-free mass (kg)	19.44	4.26	20.05	4.17	18.80	4.27	16.07	2.57	17.78	2.75	20.58	3.41	23.31	4.08
Body water (kg)	14.24	3.12	14.68	3.05	13.76	3.13	11.77	1.90	13.02	2.02	15.06	2.49	17.06	2.99
Basel metabolic rate (Kcal)	4441	488	4715	414	4150	381	4200	334	4285	392	4519	480	4755	525

In our sample, overnutrition presented a bigger health issue than undernutrition.

▲ Children during a physical education lesson

Cardiovascular risk factors

KaziAfya Project
2018 –2021

Background

On a global level, non-communicable diseases are the leading causes of death and disability (WHO., 2015), and cardiovascular diseases often have their origin in childhood (Berenson et al., 1998). Studies have shown that children who present with cardiovascular disease risk factors are at higher risk for fatty streaks and fibrous plaques, for artery calcification, and for common artery intima media thickness in adulthood (Mahoney et al., 1996; Raitakari et al., 2003). As a consequence, early screening for cardiometabolic complications is considered important both from a clinical and public health perspective (Magnussen et al., 2012; Sardinha et al., 2016). Developing countries are faced with a double disease burden, with non-communicable diseases adding to a persistently high burden of infections (Assah et al., 2015). This is critical as healthcare resources are limited in these countries. Thus, although communicable diseases will remain a predominant health issue in Sub-Saharan Africa, concerns have been raised regarding the rapid increase of non-communicable diseases such as hypertension, heart disease, diabetes, particularly in more urbanized settings (Unwin et al., 2001). Blood pressure, total cholesterol, high-density lipoprotein cholesterol (HDL), triglycerides, insulin, glucose, and body fat have been identified as the most recognised cardiovascular disease risk factors among children and adolescents (Ruiz et al., 2016). Moreover, previous research showed that exercise training intervention with children and adolescents can have a positive impact on cardiovascular risk factors, as long as they are sufficiently long and take place on a regular basis (Mountjoy et al., 2011).

Developing countries are faced with a double disease burden, with non-communicable diseases adding to a persistently high burden of infections. This is critical as healthcare resources are limited in these countries.

Which cardiovascular risk factors did we assess?

For the detection of hypertension, we measured blood pressure of each child three times within 3 min while the child was seated for 5 min with the Omron® digital blood pressure monitor. A cuff-size appropriate to the arm-circumference of the child was chosen. For the assessment of blood lipid profiles (total cholesterol [TC], low-density-lipoprotein cholesterol [LDL-C], high-density-lipoprotein cholesterol [HDL-C], triglycerides [TG], we analysed capillary samples for blood lipid by Alere Technologies. One drop of blood was taken up by the test strip and read by the machine. For the measurement of glycated haemoglobin (HbA1c) level, we used a point-of-care instrument employing the Afinion test (Alere Technologies). Of note, the HbA1c level reflects the average plasma glucose concentration levels over the previous 8-12 weeks before measurement with no prior fasting required. We also used finger prick technique to determine children's micronutrient status/deficiencies (concentrations of Vitamin A, Vitamin D, iron, zinc; see chapter 13).

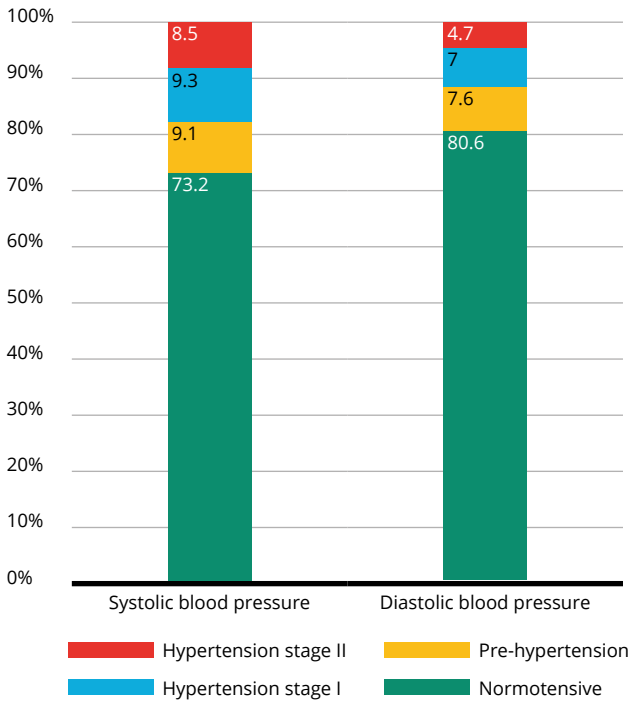
On a global level, non-communicable diseases are the leading causes of death and disability (WHO, 2015), and cardiovascular diseases often have their origin in childhood.

Results

▲ Finger prick blood testing to screen for risk markers (blood sugar, cholesterol levels, hemoglobin levels, micronutrient status)

In total, 1204 children had valid blood pressure data. As shown in Figure 09.01, based on systolic blood pressure, 73.2% of the children were classified as normotensive, 9.1% as pre-hypertensive, and 17.8% as hypertensive (9.3% stage I, 8.5% stage II). Based on diastolic blood pressure, the percentage of normotensive children was slightly higher (80.6%). The percentage of normotensive children was similar in boys (systolic: 72.7%, diastolic: 83.2%) and girls (systolic: 73.6%, diastolic: 77.9%), as well as in children from different grades. Average baseline blood pressure for the total sample, boys vs. girls and different grade levels are shown in Table 09.01. A total of 750 children had valid blood pressure data across all measurement time points. These data show that for systolic blood pressure, a significant increase occurred between T2 and T3 (Figure 09.02A), whereas for diastolic blood pressure, an increase was observed between T1 and T2 (Figure 09.02B).

Figure 09.01 Prevalence of hypertension in the total sample (in %)



1204

children had valid blood pressure data.

"The KaziAfya project is unique in simultaneously testing the efficacy of physical activity promotion and multi-micronutrient supplementation on children's health and well-being across three study sites in a school-based randomized controlled trial. It will determine how effective these individual or combined interventions are in addressing differences in nutritional status and disease burden given differences in children's physical activity and dietary patterns across the study sites. These results can lead to important public health initiatives that promote integration of these interventions in school-based public health programmes to improve child nutrition, well-being and long-term health in sub-Saharan communities and countries that are rapidly changing."

Dr. Kurt Long
Co-applicant, Swiss TPH

Figure 09.02A Development of blood pressure across the study period for systolic blood pressure (in mm Hg)

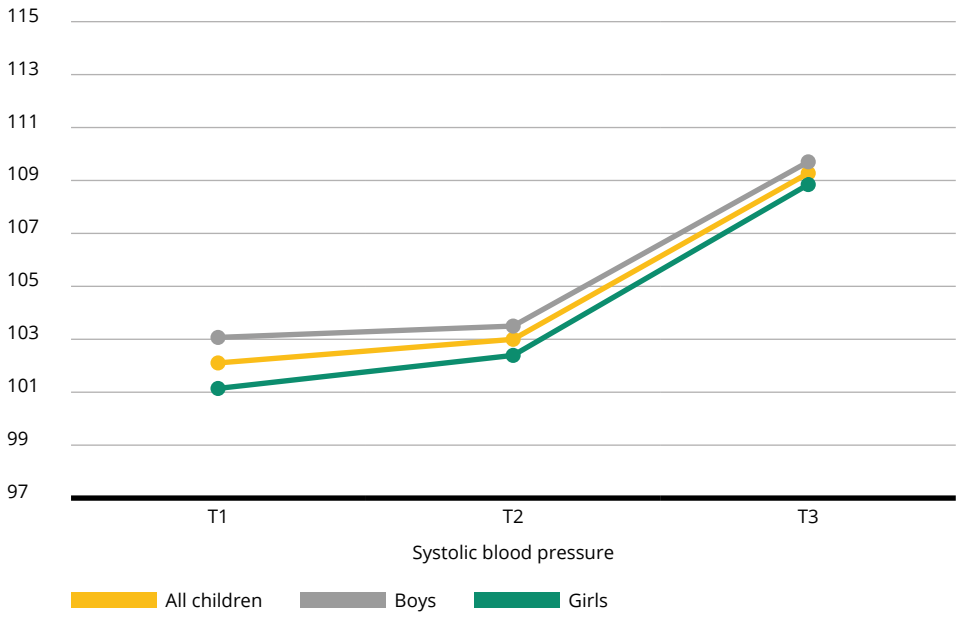
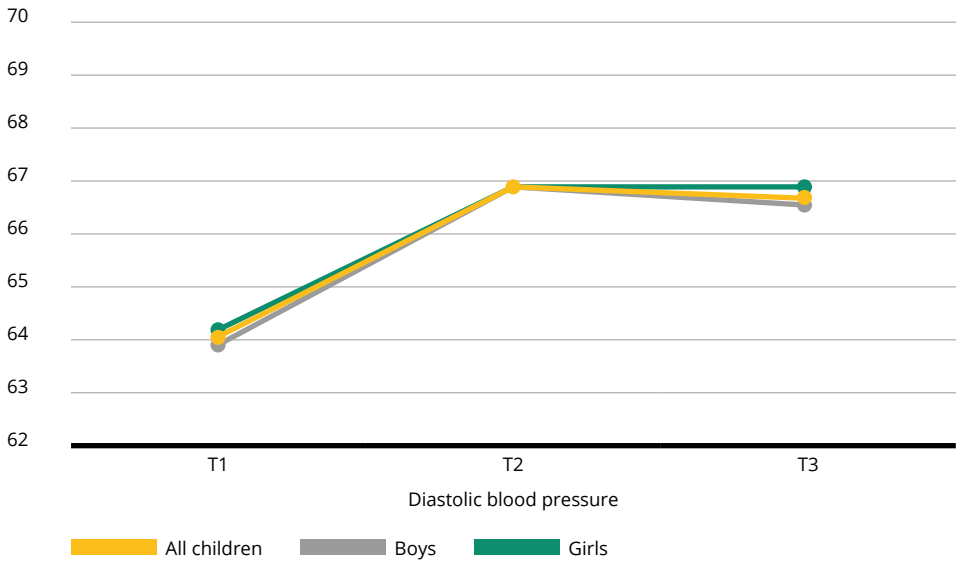
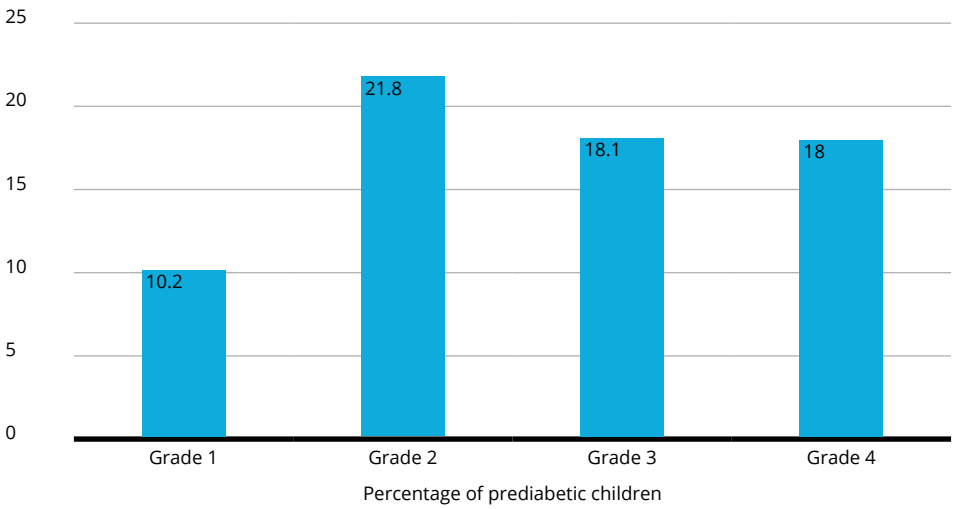


Figure 09.02B Development of blood pressure across the study period for diastolic blood pressure (in mm Hg)



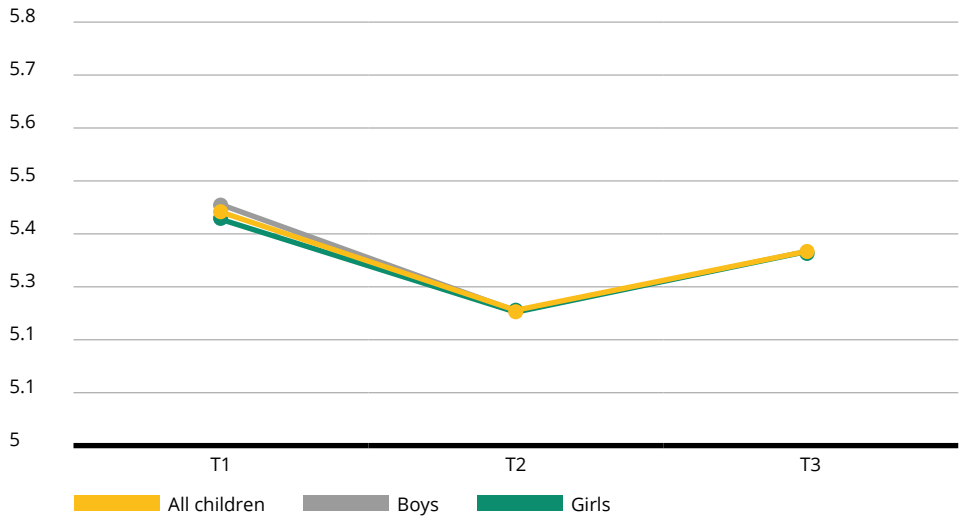
▲ Blood assessment setup

Figure 09.03 Prevalence of prediabetic children across different grades (in %)



In those 1002 children with valid baseline data on blood glucose (HbA1c), 83.0% were classified as normoglycemic, whereas 16.9% presented with prediabetes. Only one learner (0.1%) was classified as diabetic. The percentage of prediabetic children was similar in boys (18.6%) and girls (15.2%), whereas the percentage was significantly higher in grade 2-4 learners compared to grade 1 learners (Figure 09.03). As shown in Figure 09.04, HbA1c levels decreased from T1 to T2, and increased again from T2 to T3.

Figure 09.04 Development of HbA1c across the study period (in %), a marker for diabetes type II



Depending on the specific outcome, between 973 and 991 children had valid baseline data for blood lipids.

Depending on the specific outcome, between 973 and 991 children had valid baseline data for blood lipids. Mean scores are shown in Table 09.01, separately for boys and girls, and children from different grades. Girls had significantly higher values for LDL cholesterol, and lower values for HDL cholesterol. No significant differences were found for total cholesterol and triglycerides. Total cholesterol was lower among grade 1-2 learners compared to grade 3-4 learners. This was mainly due to the fact that HDL values were higher among learners from higher grades.

▲ Children waiting for blood testing

Across all measurement time points, 476 children had valid total cholesterol data. The course over time is shown in Figure 09.05A, pointing towards an increase from T1 to T2, and a stabilisation between T2 and T3. A similar pattern was found for HDL cholesterol (Figure 09.05B) and triglycerides (Figure 09.05D), whereas LDL cholesterol steadily decreased from T1 to T3 (Figure 09.05C).

476

children had valid total cholesterol data, across all measurement time points.

▲ Blood pressure assessment

"It has been a privilege to be a member of the KaziAfya research community over the past few years. I have found it exciting and inspiring witnessing the collaborative alliance between four countries grow, fueled by steadfast support and mutual learning exchanges between the research staff, doctoral and master students, as well as school principals, teachers, parents, and children. As I have listened to children's stories and learned about their everyday challenges and dreams, I have been deeply humbled. I have observed how children and researchers alike enjoyed participating in the physical education lessons, demonstrating once again how sports and physical activity have the ability to connect and enliven individuals of all ages. Thus, the COVID-19 restrictions and school closures adversely affecting children's physical and mental health have highlighted the importance of promoting an active healthy lifestyle and the role that schools play in this regard."

Dr. Christin Lang
Overall project coordinator, University of Basel

Total cholesterol

Figure 09.05A Development of total cholesterol (in mmol/l) across the study period, for the total sample and separately for boys and girls

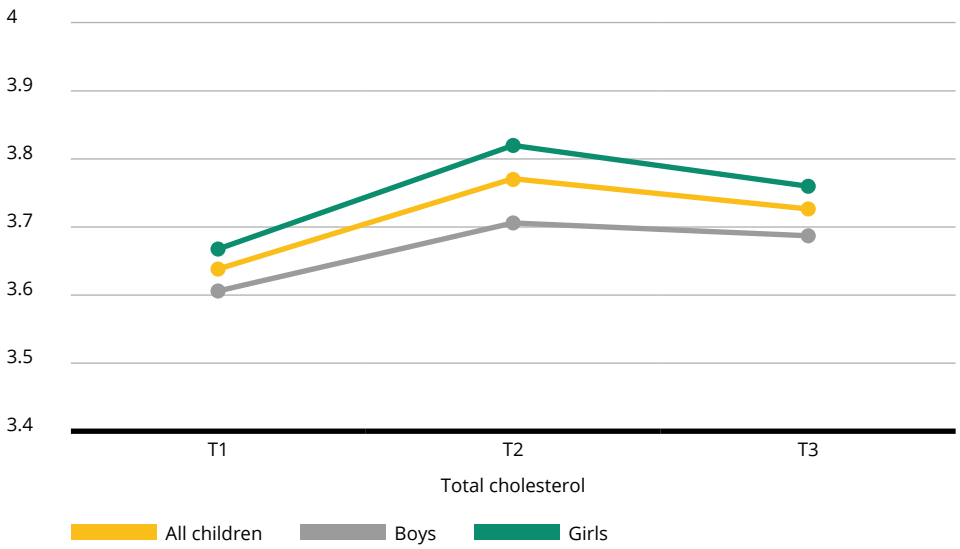


Figure 09.05B Development of HDL cholesterol (in mmol/l) across the study period, for the total sample and separately for boys and girls

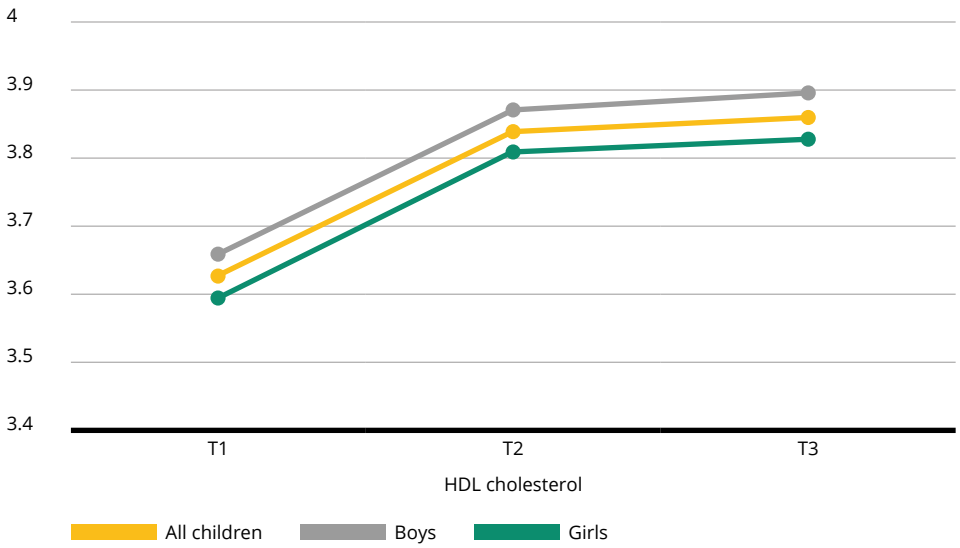


Figure 09.05C Development of LDL cholesterol (in mmol/l) across the study period, for the total sample and separately for boys and girls

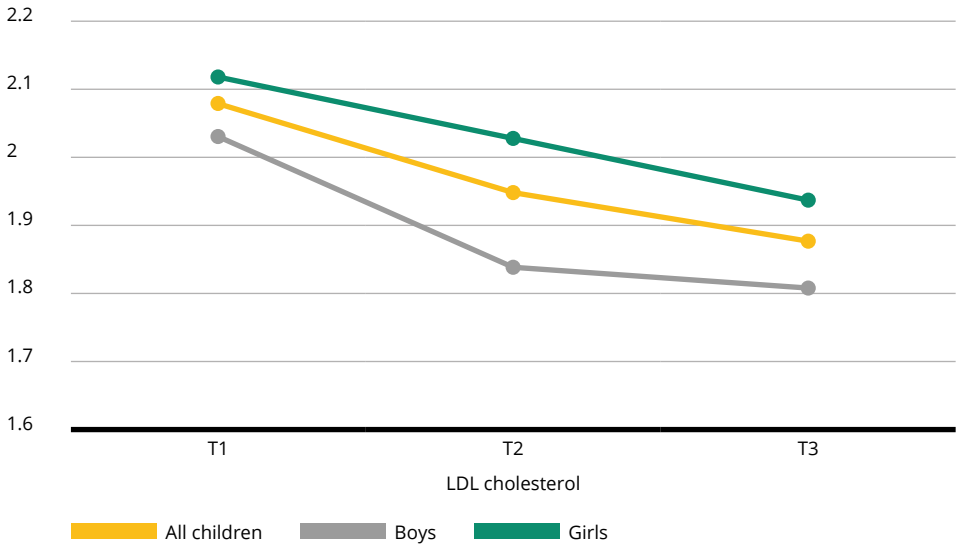
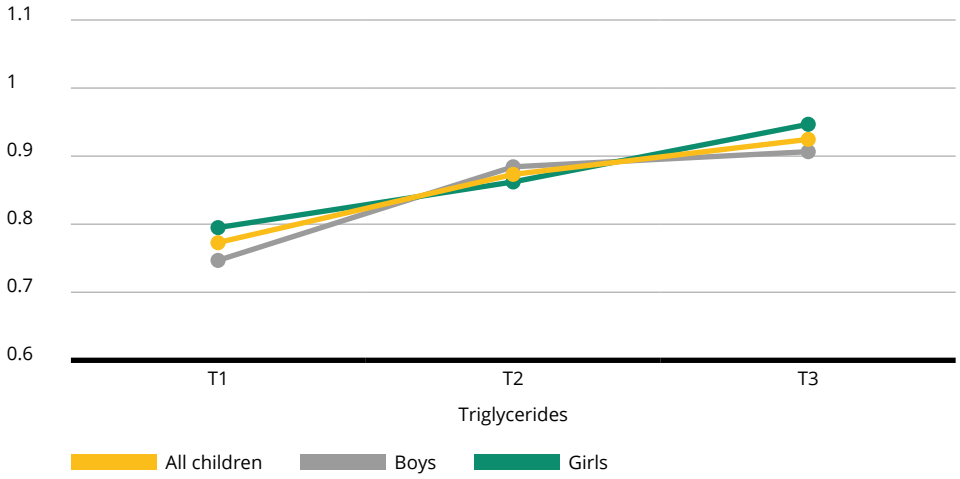


Figure 09.05D Development of triglyderides (in mmol/l) across the study period, for the total sample and separately for boys and girls



Conclusion

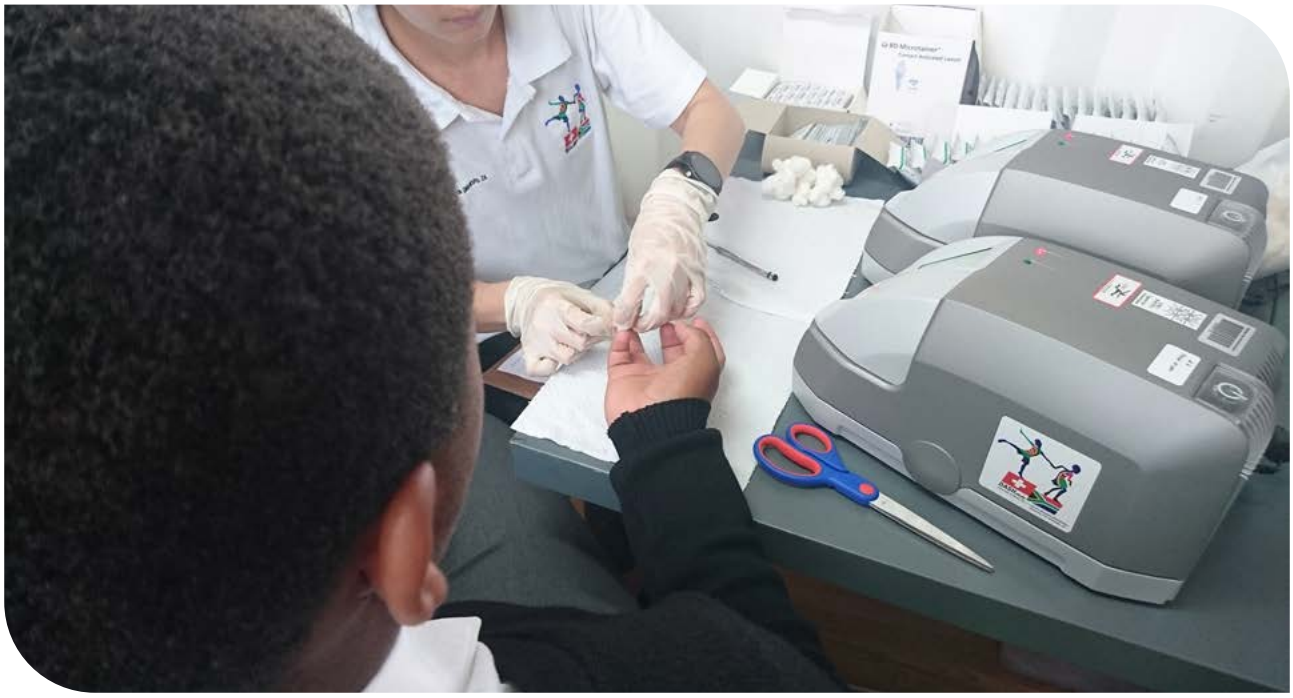
Hypertension appears to be an important cardiovascular risk factor in South African children. Between 12-18% of the children were classified as hypertensive. Diabetes was diagnosed in only one case. However, around 17% of the children were identified as prediabetic. It is positive to note that LDL-cholesterol levels decreased over the course of the study, while HDL cholesterol levels increased. The increase in triglycerides, on the other hand, is critical. With regard to the development over time, there were no significant differences between boys and girls.

Around

17%

of the children were identified as prediabetic.

> ***Hypertension appears to be an important cardiovascular risk factor in South African children.***



▲ Blood testing taking place at one of the participating schools

Table 09.01 Cardiovascular risk factors, separately for boys and girls and learners attending different grades

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Systolic blood pressure (in mm HG)	102.05	11.72	102.47	11.77	101.60	11.67	98.91	12.64	101.2	10.4	103.34	12.02	104.66	11.04
Diastolic blood pressure (in mm HG)	63.73	9.32	63.16	9.08	64.34	9.54	62.09	9.63	62.78	8.59	64.45	9.65	65.57	9.03
Total cholesterol (in mmol/l)	3.63	0.64	3.61	0.64	3.65	0.63	3.52	0.60	3.58	0.62	3.74	0.69	3.70	0.62
LDL cholesterol (in mmol/l)	2.07	0.53	2.03	0.53	2.10	0.54	2.03	0.50	2.03	0.53	2.14	0.57	2.07	0.53
HDL cholesterol (in mmol/l)	1.23	0.31	1.25	0.32	1.21	0.30	1.17	0.30	1.22	0.33	1.26	0.31	1.28	0.29
Triglycerides (in mmol/l)	0.77	0.32	0.75	0.26	0.78	0.36	0.75	0.38	0.75	0.25	0.77	0.27	0.80	0.34
Blood glucose (Hba1c) (in %)	5.43	0.33	5.43	0.28	5.42	0.38	5.36	0.24	5.45	0.25	5.48	0.47	5.41	0.30

▲ Children waiting for blood pressure measurements

It is positive to note that LDL levels decreased over the course of the study, while HDL cholesterol levels increased. The increase in triglycerides, on the other hand, is critical.

Sleep and sleep environment

KaziAfya Project
2018 –2021

Background

For several reasons, sleep is key for children's health and development (Schlieber & Han, 2021). First, sleep can impact growth and development. Thus, during sleep, the body produces growth hormones, which are crucial for the growth and development of children (Verrillo et al., 2011). In addition, adequate sleep supports the growth of bones, muscles and organs (Casazza et al., 2011; Lamon et al., 2021). Second, sleep has the potential to strengthen children's immune system (Garbarino et al., 2021). During sleep, immune cells are produced that fight infection and protect the child from diseases. Third, sleep has an important influence on brain development (Yang et al., 2022). During sleep, memories are processed and the brain regenerates. Adequate sleep improves cognitive function, learning, concentration and attention span (Lokhandwala & Spencer, 2022). Fourth, a lack of sleep can lead to emotional issues such as irritability, depressed mood or anxiety (Asarnow & Mirchandaney, 2021). Adequate sleep helps children better regulate their emotions and maintain positive mental well-being. Fifth, children who get enough sleep have more energy and are more active during the day (Ahmadi & Omidvar, 2022; Lang et al., 2016). Good sleep improves physical performance, coordination and motor skills (Manacero & Nunes, 2021). Therefore, parents should ensure that their children get enough sleep and provide conducive sleep environments. The recommended amount of sleep varies by age, but in general, preschoolers need about 10-13 hours of sleep per night, while the recommended sleep duration is 9-12 hours for older school-aged children (Paruthi et al., 2016).

There is limited information on the sleep behaviour of South African primary schoolchildren. There are several factors that can influence the sleep behaviour of South African primary schoolchildren. Existing research shows that sleep duration of primary schoolchildren in South Africa seems to be in the recommended range (Wood & Rampf, 2023). As shown bey Rae et al. (2021), insufficient sleep can have detrimental consequences for children's health such as increased BMI. Furthermore, a study with young people from South Africa showed that sleep was closely associated with mental health issues (depression, anxiety, adverse childhood experiences, and alcohol-use risk) (Draper et al., 2022).

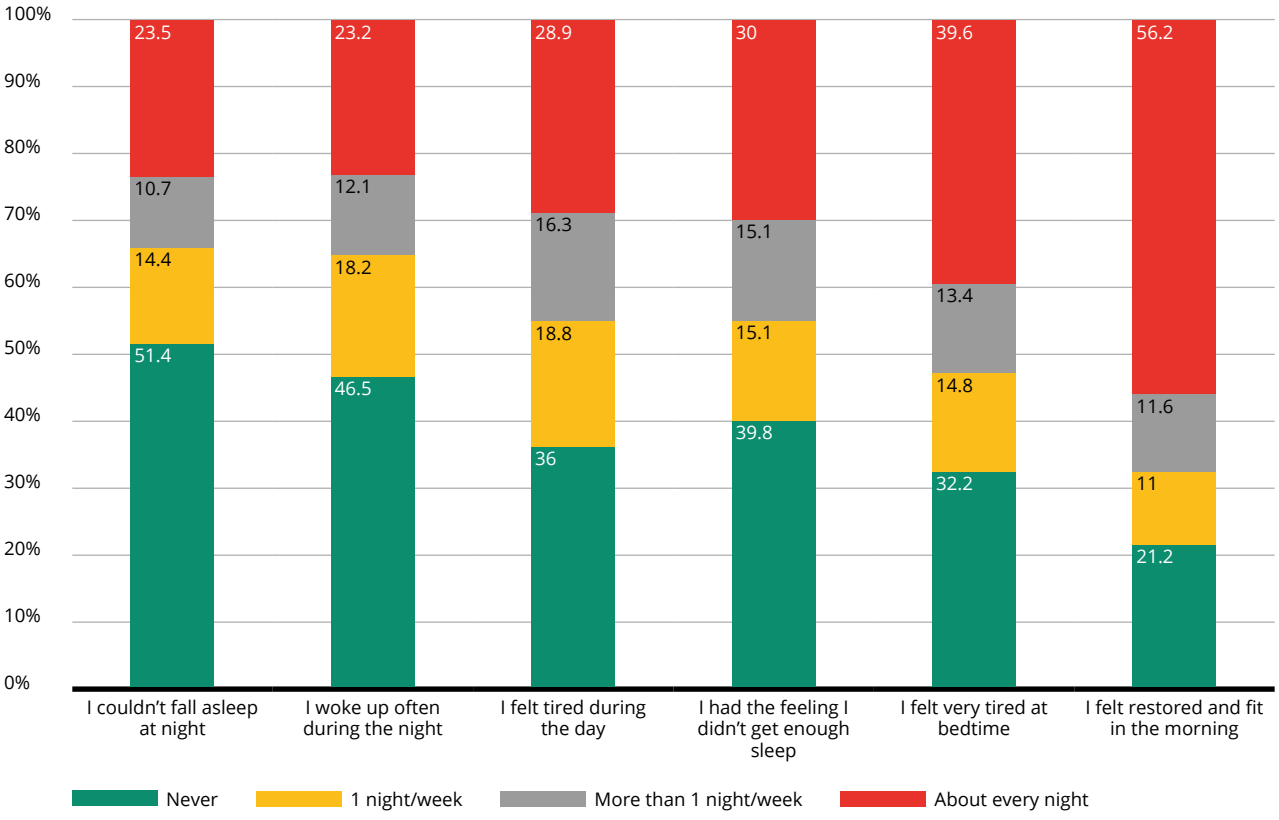
How did we measure sleep and sleep environment?

To assess sleep quality, we applied several (adapted) questions from the Pittsburgh Sleep Quality Index (PSQI). To screen for sleep disturbances, three items of the Insomnia Severity Index asked about difficulty falling asleep, staying asleep and waking up too early in the morning. To assess further information about sleep quality and daytime functioning, we invited children to rate their overall sleep quality and to report how restored they feel in the morning, how tired they feel during the day and how exhausted they feel in the evening. Children also provided basic information about their sleep environment (e.g., room, type of bed, and people sleeping in the same room/bed). To gather information about children's sleep duration, we asked parents/guardians to report the time at which their child goes to bed and wakes up in the morning on school nights and school days.

During sleep, the body produces growth hormones, which are crucial for the growth and development of children. In addition, adequate sleep supports the growth of bones, muscles and organs.

▲ Child sleeping at school

Figure 10.01 Prevalence of children reporting different symptoms of sleep complaints (in %)



Results

Between 1270 and 1280 children had valid data for self-reported sleep complaints. As shown in Figure 10.01, the number of children who reported single symptoms of sleep complaints varied between 21.2% (feeling restored in the morning) and 39.6% (very tired at bedtime). About every fourth child reported problems falling asleep at night or frequent awakenings during the night. As shown in Table 10.01, no significant differences were found between boys and girls. Students in grade 1 and 4 felt more tired during the day than students from the other grades, whereas students from grade 4 felt more often that they did not get enough sleep and that they are not fully restored in the morning, and children from grade 1 felt most tired at bedtime.

During sleep, immune cells are produced that fight infection and protect the child from disease.

Information about the sleep environment of the children is provided in Figure 10.02, showing that 32.4% of the children slept in their own room and that 38.8% slept in a single bed. Additionally, 15.7% of the children indicated that their bedroom was also used for cooking, 35.1% had a ceiling fan in their bedroom, and 15.3% slept on a mattress on the floor.

About every fourth child reported problems falling asleep at night or frequent awakenings during the night.

Figure 10.02 Characteristics of the sleep enviromenment across the total sample (in %)

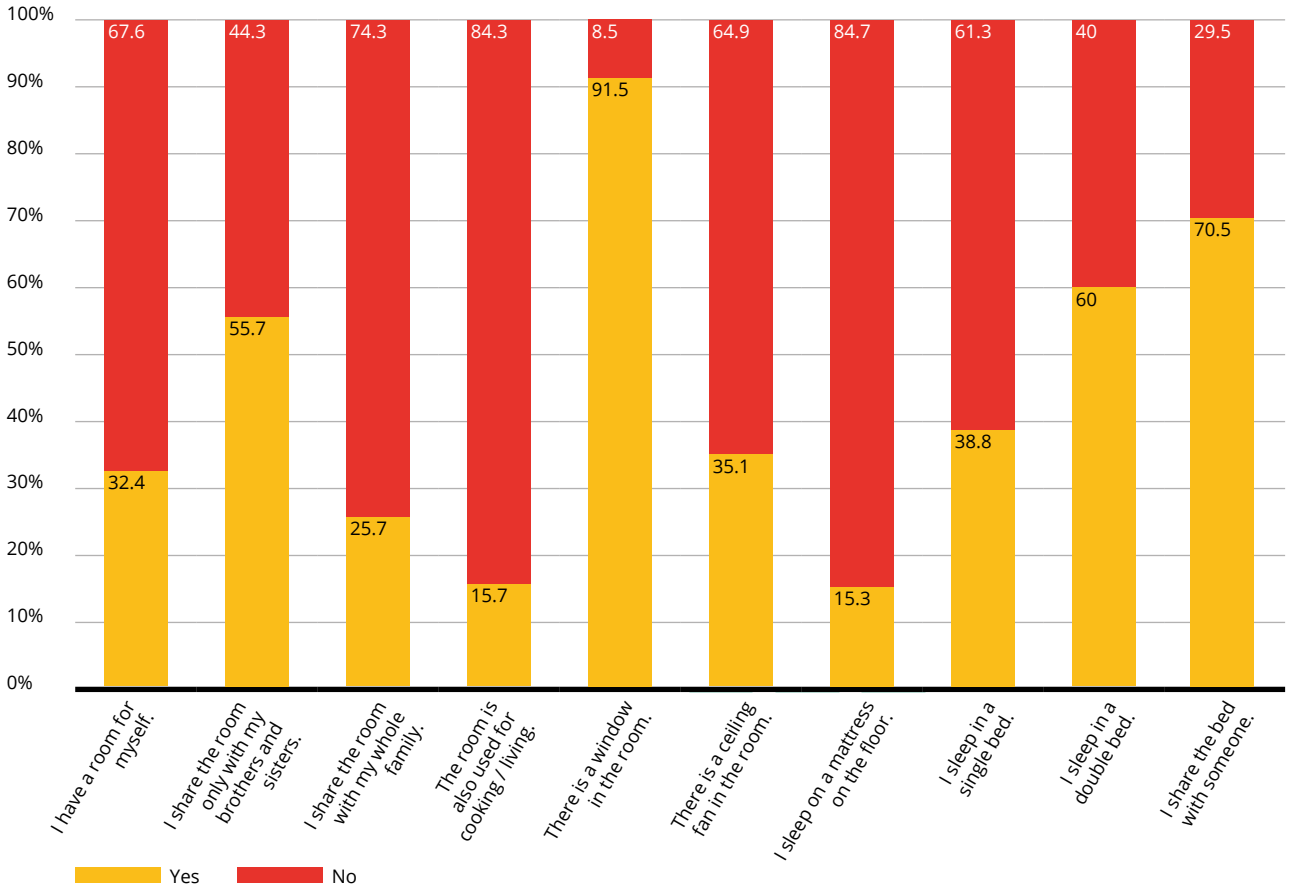
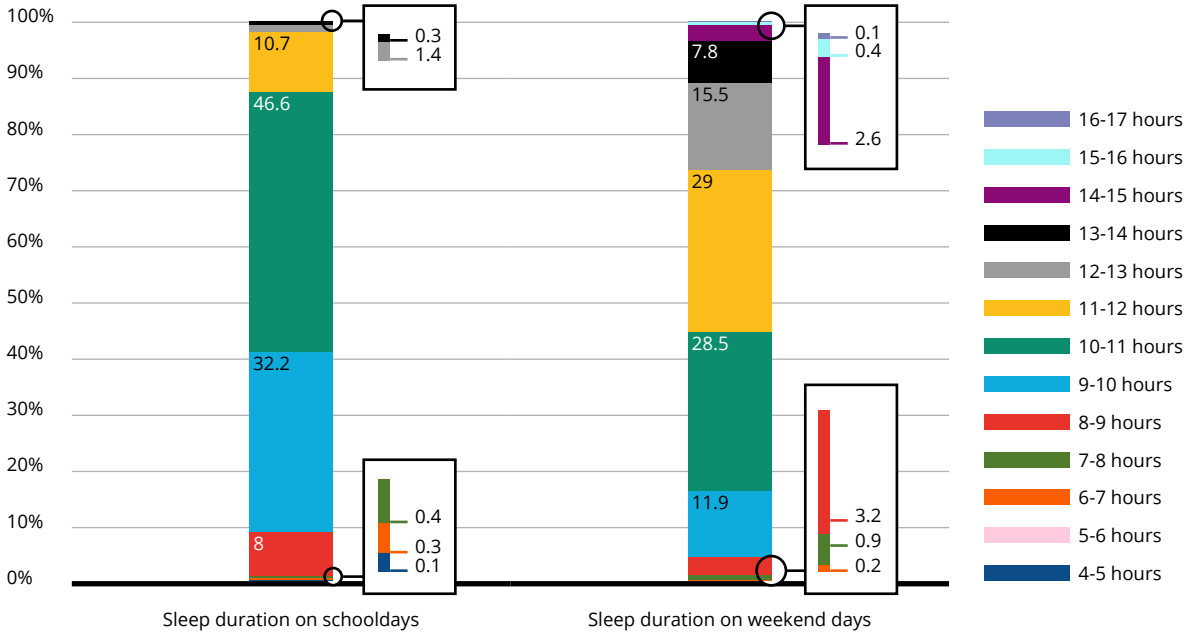
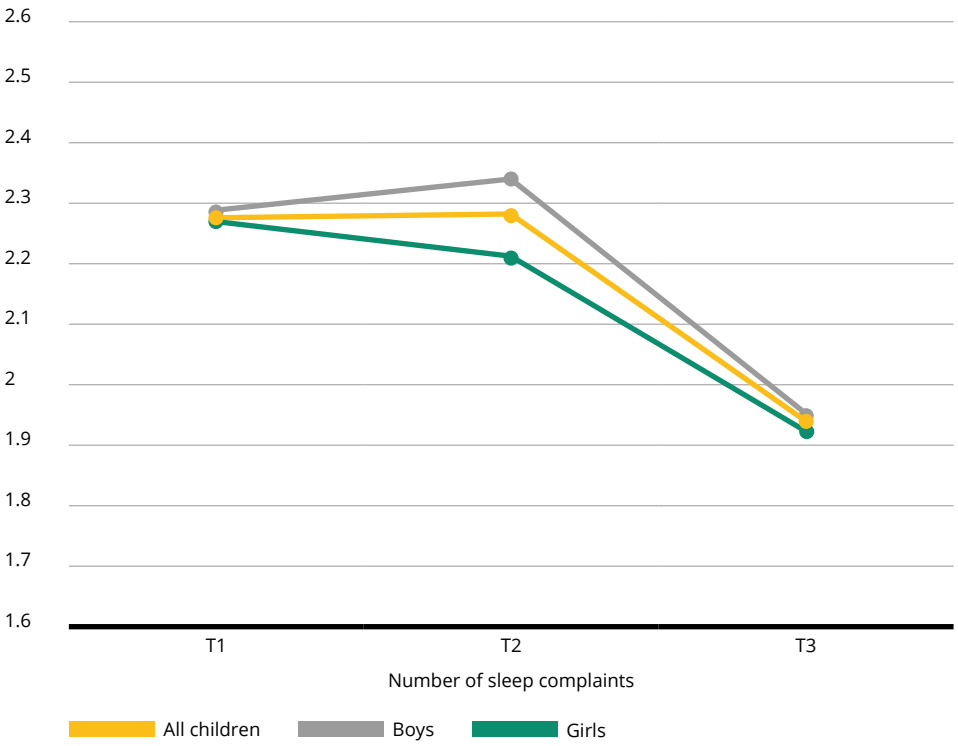


Figure 10.03 Percentage of children with different sleep duration during weekday and weekend nights, in the total sample (in %)



Based on approximately 800 parental reports, most of the children slept between 9–11 hours during weekdays and between 9–12 hours during weekends (Figure 10.03). Average sleep duration was 9.90 hours during weekdays and 10.95 hours during weekends (Table 10.01). During weekdays, average bedtime was 20:23 pm, whereas average wake time was 06:17 am. During weekends, bedtime was delayed by approximately half an hour (20:55 pm), whereas children usually got up at 07:43 am. Compared to younger learners, children attending grade 4 got up earlier in the morning and showed slightly decreased sleep duration. Additionally, children from higher grades went to bed later during weekends. As shown in Figure 10.04, the number of sleep complaints reported by the children of present sample decreased from baseline to follow-up, particularly after the T2 data assessment. This pattern was similar in boys and girls.

Figure 10.04 Development of total number of self-reported sleep complaints across the study period, in the total sample and separately for boys and girls



Conclusion

Overall, most children seemed to get enough sleep (between 9–12 hours per night) in purely quantitative terms. This applies equally to girls and boys. Nevertheless, about a quarter of the children complained about recurring sleep problems. Sleep changed slightly with age, in the sense that older students tended to go to bed a little later and sleep less.

Sleep changed slightly with age, in the sense that older students tended to go to bed a little later and sleep less.

Table 10.01 Sleep quality (child self-report) and sleep behaviour (parental survey), separately for boys and girls and learners attending different grades

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Child self-report														
I couldn`t fall asleep at night.	2.06	1.25	2.11	1.28	2.01	1.21	1.94	1.24	2.09	1.24	2.15	1.28	2.07	1.22
I woke up often during the night.	2.12	1.23	2.12	1.23	2.12	1.22	2.06	1.18	2.16	1.28	1.07	1.18	2.20	1.25
I felt tired during the day.	2.38	1.24	2.37	1.24	2.40	1.24	2.53	1.22	2.18	1.27	2.35	1.23	2.48	1.21
I had the feeling I didn't get enough sleep.	2.35	1.28	2.38	1.27	2.32	1.28	2.34	1.28	2.20	1.24	2.36	1.27	2.50	1.29
I felt very tired at bedtime.	2.60	1.29	2.58	1.30	2.64	1.29	3.02	1.22	2.37	1.31	2.60	1.30	2.42	1.25
I felt restored and fit in the morning.	3.03	1.23	3.05	1.22	3.00	1.25	3.24	1.10	3.06	1.23	3.02	1.26	2.80	1.30
Parental survey														
At what time does your child go to bed the night before a regular school-day?	20:23	0:46	20:25	0:47	20:21	0:44	20:22	0:53	20:17	0:38	20:25	0:46	20:28	0:43
At what time does your child wake up on school-mornings? (Monday to Friday)	6:17	0:29	6:18	0:29	6:16	0:28	6:20	0:30	6:17	0:29	6:19	0:27	6:12	0:29
Sleep duration on school-days (Monday to Friday)	9.90	0.86	9.88	0.88	9.92	0.84	9.99	0.87	9.97	0.81	9.92	0.81	0.74	0.93
At what time does your child go to bed the night before a weekend day?	20:55	0:51	20:56	0:51	20:54	0:51	20:46	0:53	20:51	0:49	20:58	0:51	21:05	0:49
At what time does your child wake up on a weekend day? (Saturday and Sunday)	7:43	1:09	7:39	1:08	7:46	1:10	7:43	1:08	7:36	0:59	7:48	1:16	7:42	1:12
Sleep duration on weekend days (Saturday and Sunday)	10.95	1.40	10.87	1.44	11.04	1.34	11.12	1.49	10.92	1.20	10.96	1.46	10.80	1.40

Academic performance and school perceptions

KaziAfya Project
2018 –2021

Background

Children's academic performance is influenced by a multitude of factors including socioeconomic status, health and nutritional status, family environment, social competence, cognitive skills and the ability to pay attention (Banerjee, 2016; Basch, 2011; Stevens & Bavelier, 2012). In socioeconomically deprived environments, essential services such as health care, sanitation, physical security, electricity, and high quality academic and physical education are often lacking (Bradley & Corwyn, 2002; Lu et al., 2016). Low socioeconomic status limits the parents' ability to offer a responsive, supportive and safe learning environment, and to enable access to cognitively stimulating materials such as books and toys (Ferguson et al., 2001; Riley et al., 2014). Poorer families often need to invest most of their resources into covering their household members' basic needs such as food and housing. Therefore, possibilities to invest in the future of their children is limited (Bradley & Corwyn, 2002; Linberg et al., 2019). Children from poorer families are also at increased risk for malnutrition (Voster, 2007), which can manifest in stunted growth. Stunting, in turn, has been associated with poor cognitive function and academic performance (Abebe et al., 2017). As shown by Liddell and Rea (2001), only 39% of all children in rural South Africa progressed through primary school without disruption, whereas 36% had left their original school, and 25% have been retained at least once. By contrast, prior investigations highlighted that physical activity has the potential to elicit both short- and long-term benefits with regard to children's executive function, attention and other academic outcomes (Han, 2018; Ludyga et al., 2020; Xue et al., 2019).

Poorer families often need to invest most of their resources into covering their household members' basic needs such as food and housing. Therefore, possibilities to invest in the future of their children is limited.

How did we measure school performance and school perceptions?

To measure academic performance, we collected the end-of-the-year results in school/home language, first additional language, mathematics and life orientation from each of the participating schools. We used the sum-score of the four subjects to estimate a child's overall academic achievement. The South African school system uses a 7-point grading scale from 1 to 7, with higher scores reflecting better academic achievement: 7=outstanding achievement (80-100%), 6=meritorious achievement (70-79%), 5=substantial achievement (60-69%), 4=adequate achievement (50-59%), 3=moderate achievement (40-49%), 2=elementary achievement (30-39%), 1=not achieved (0-29%). In addition, to measure satisfaction with school, perceived school-related pressure, and perceived academic competence compared to peers, we applied three items from the Health Behaviour of School-Aged Children (HBSC) survey. To assess school-related pressure, we asked the learners how pressured they feel by the schoolwork they must pursue. Possible answers were as follows: not at all, a little, some, and a lot. To measure school satisfaction, we asked the learners to respond to the question of how they feel about school at present. Possible answers were: I like it a lot, I like it a bit, I don't like it very much, and I don't like it at all (Figure 11.04, page 103). Finally, we asked learners what – in their opinion – their class teacher(s) think about their school performance as compared to their classmates. Possible answers were: much better than classmates, better than classmates, similar/same as classmates, and worse than classmates (Figure 11.03, page 103).

▲ "Health, hygiene, and nutrition" lessons were provided to all children during the intervention period, regardless of their group allocation

25%

of children in rural South Africa had to repeat a grade level at least once.

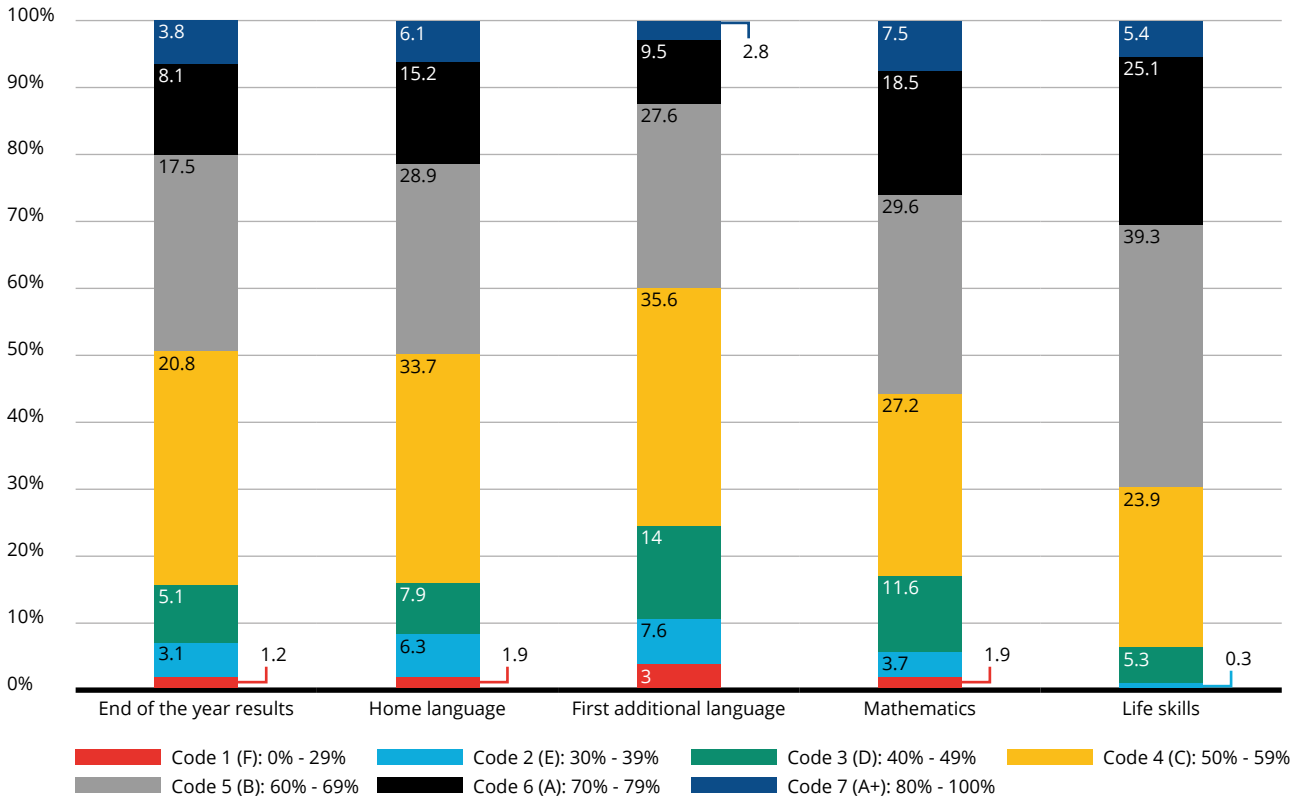
We used the sum-score of the four subjects to estimate a child's overall academic achievement.

Results

End-of-the-year results were available for 1057 learners, whereas 1272 to 1284 children answered questions about school satisfaction, pressure and perceived academic competence. As shown in Figure 11.01, only few children did not achieve with regard to overall end-of-the-year results (1.2%). Another 8.2% of learners had relatively low levels of achievement (elementary achievement: 3.1%, moderate achievement: 5.1%). Most of the learners showed adequate (20.8%) or substantial achievement levels (17.5%), whereas the percentage of learners with top grades was lower as foreseen by the grading system (meritorious: 8.1%; outstanding: 3.8%).

> ***Physical activity has the potential to elicit both short- and long-term benefits with regard to children's executive function, attention and other academic outcomes.***

Figure 11.01 Academic performance for different school subjects in the total sample (in %)



The percentage of learners with excellent achievement (meritorious and outstanding achievement) was highest in life skills (30.5%), followed by mathematics (26.0%), home language (21.3%), and first additional language.

The distribution of grades was similar across all four subjects (Figure 11.01). The percentage of students with relatively poor performances (not achieved to moderate achievement) was highest in the first additional language subject (24.6%), followed by mathematics (17.2%), home language (16.1%) and life skills (6.4%). By contrast, the percentage of learners with excellent achievement (meritorious and outstanding achievement) was highest in life skills (30.5%), followed by mathematics (26.0%), home language (21.3%), and first additional language (12.3%).

As shown in Table 11.01, girls had statistically significantly higher school grades than boys across all school subjects. Independent of the school subject, academic achievement was higher among students from more advanced school grades, with the most marked differences found in first additional language.

Figure 11.02 reveals that most of the learners (85.3%) liked school. No significant differences existed between boys and girls and learners from lower or higher grades. However, a substantial percentage of learners perceived pressure at school, with 18.1% reporting 'some pressure' and 21.2% 'a lot of pressure'. Perceived school pressure was statistically significantly higher among boys than girls (Table 11.01).

▲ Child learning in class

Figure 11.02 School perceptions in the total sample (in %)

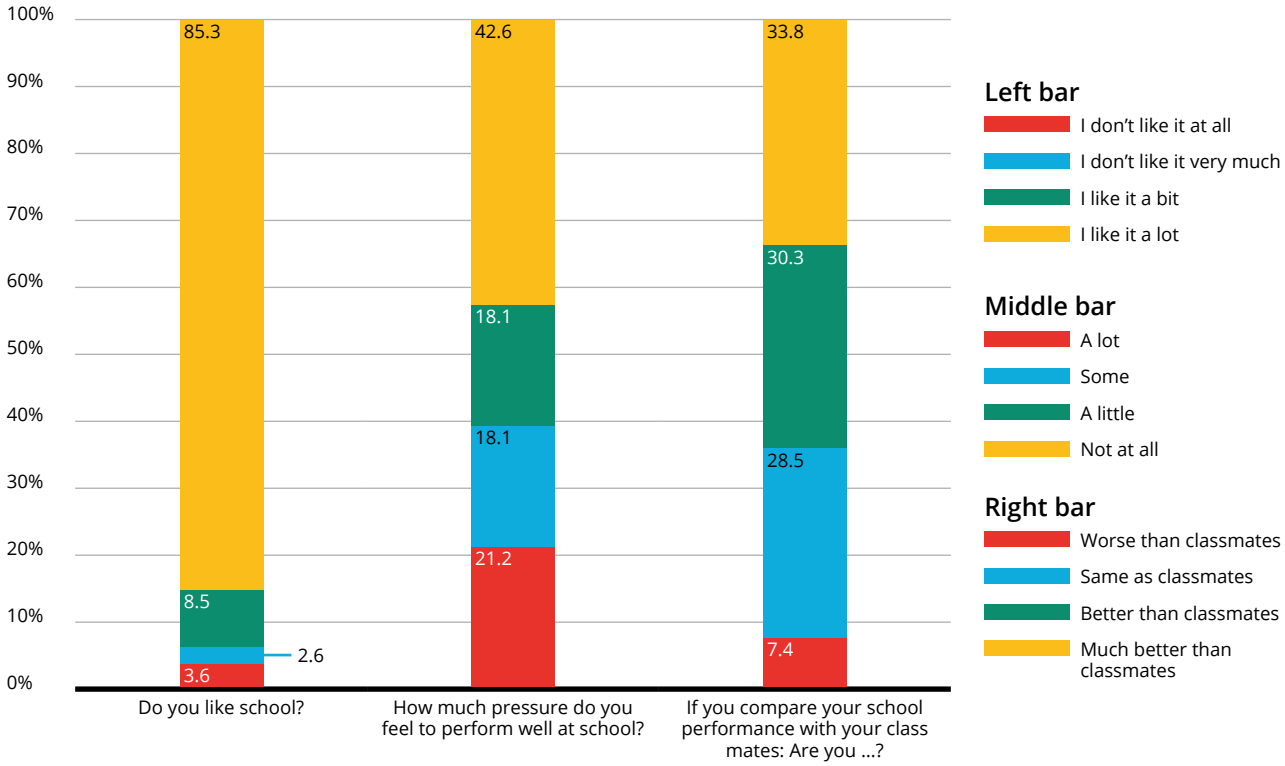
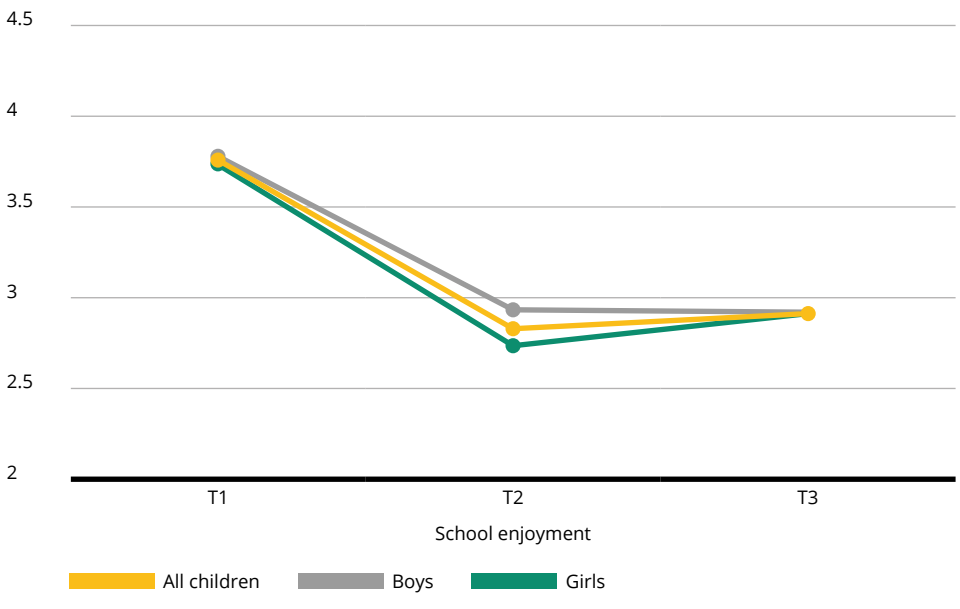


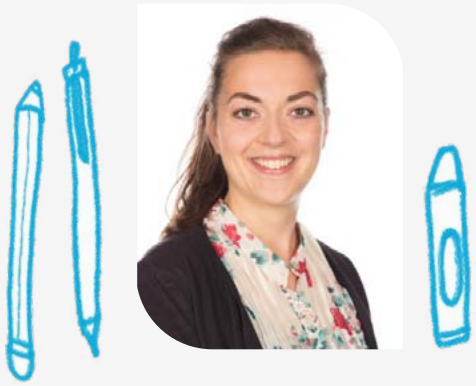
Figure 11.03 Development of school enjoyment across the study period, in the total sample and separately for boys and girls



As shown in Table 11.01, the level of perceived school pressure was significantly lower among grade 1 learners, compared to peers attending grades 2-4. Despite this, the learners rated their school performances quite positively, if compared to their classmates (see Figure 11.02), with more than 60% perceiving themselves as better or much better than their classmates (no differences found between boys

Learners rated their school performances quite positively, if compared to their classmates.

Children during a Moving-to-music lesson



"By joining the KaziAfya team, I was able to conduct my doctoral thesis within an international project, and as the project comes to an end, I recognize how significantly it has contributed to my personal growth. The genuine curiosity of the children allowed me to learn about their everyday lives, favorite games, and school habits. I greatly appreciated the meaningful exchanges with school teachers and children's caregivers, which provided many valuable learnings for the project. Finally, many thanks are owed to my former colleagues at our partner institutions, where I developed cherished friendships until today."

Ms. Johanna Beckmann
Doctoral student, University of Basel

Child learning in class

Some public primary schools in Gqeberha may have up to 60 learners per class.

and girls). Only 7.4% of the students felt that they were underachieving in comparison to their peers. Generally, more students from higher grades felt that they would perform better than their classmates (See Table 11.01). This accords well with the fact that on average school results became better from grade 1 to grade 4.

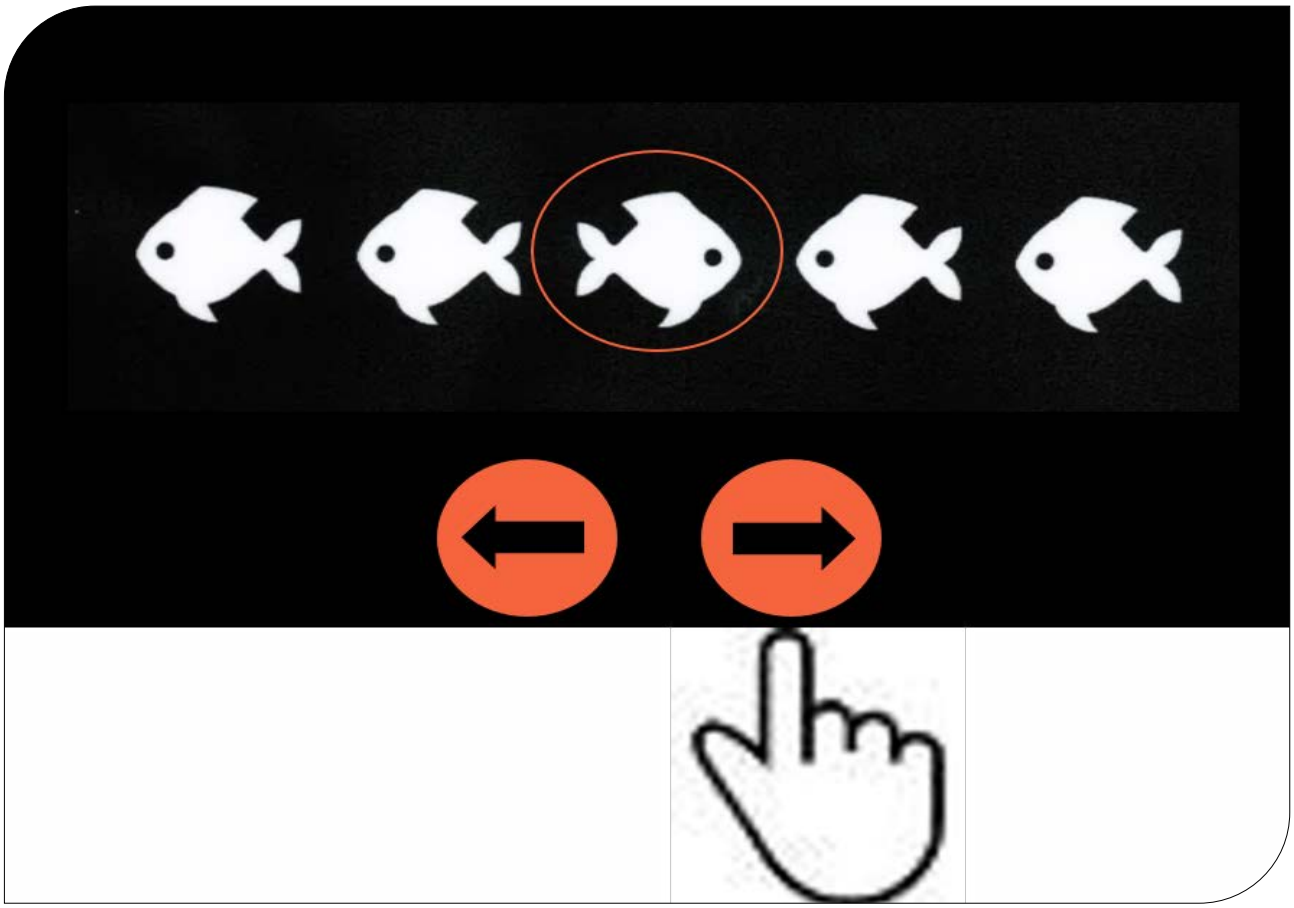
Overall, 807 children answered the questions three times and had valid school perception data across all measurement time points. As shown in Figure 11.03 (page 103), the children's school enjoyment decreased from T1 to T3. However, the overall decrement from T1 to T3 was similar among boys and girls. School pressure significantly increased during the study period (data not shown). However, while boys reported more pressure at T1, these baseline differences disappeared until follow-up (T3). The learners' ratings regarding their own academic competence compared to their classmates became more positive from T1 (M=2.95) to T2 (M=3.15), but a significant decrease was observed after the COVID-19 outbreak until T3 (M=2.65).

Note
In the present study, we also used computerized tests to assess children's selective attention and inhibitory control (two important components of executive function) via the Flanker task. The results of these tests are not inclued in this report, but have been reported in publications in specialized journals (see chapter 16).

▲ Children completing the Flanker task, a computerized cognitive performance task

Table 11.01 Academic performances and school perceptions, separately for boys and girls and learners attending different grades

	Total sample		*Boys*		*Girls*		*Grade 1*		*Grade 2*		*Grade 3*		*Grade 4*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Achievement levels														
End of year results	4.57	1.26	4.36	1.18	4.81	1.30	4.34	1.37	4.5	1.56	4.63	1.30	4.82	1.26
Home language	4.51	1.30	4.29	1.24	4.75	1.32	4.33	1.43	4.44	1.20	4.55	1.32	4.71	1.22
First additional language	4.17	1.26	3.94	1.21	4.40	1.27	2.11	0.93	4.20	0.96	4.33	1.33	4.33	1.18
Mathematics	4.65	1.32	4.44	1.24	4.87	1.36	4.34	1.41	4.57	1.19	4.71	1.37	4.64	1.32
Life skills	4.98	1.01	4.80	0.99	5.18	1.00	4.71	1.13	4.94	0.93	5.00	0.94	5.25	1.01
School perceptions														
School enjoyment	3.76	0.67	3.72	0.73	3.79	0.61	3.69	0.78	3.78	0.63	3.79	0.62	3.76	0.66
School pressure	2.82	1.19	2.92	1.16	2.72	1.22	2.49	1.16	2.92	1.12	2.94	1.21	2.94	1.22
Comparison with classmates	2.80	0.96	2.91	0.95	2.89	0.96	2.75	0.93	2.88	1.01	2.95	0.98	3.04	0.88



▲ Flanker test

Conclusion

Overall, it can be stated that children's school performance was satisfactory overall. Only few children seemed unable to keep up in the first four grades. However, fewer students fell into the top two performance levels than the grading system would suggest. Girls seemed to have an advantage over boys when it comes to academic performance. This may be the reason why boys perceived more pressure at school. In terms of school enjoyment, no differences were observed between the different grade levels at baseline, and the scores remained relatively stable across the study period.

Fewer students fell into the top two performance levels than the grading system would suggest.

Physical activity and physical fitness

KaziAfya Project
2018 –2021

12

Background

Due to the concerning rise in sedentary behaviour together with non-communicable diseases, the World Health Organization (WHO) published a Global Action Plan in 2018, which recommended physical activity promotion already at an early age (WHO, 2018). Children also become considerably less physically active as they go through primary school (Jago et al., 2020), making this a particular relevant target population for health programmes. Worldwide, a considerable shift in lifestyle factors is responsible for the fact that 81% of 11-17 year olds lack sufficient physical activity (WHO, 2018). A previous meta-analysis confirmed the important role of physical activity on various aspects of cognitive functioning in children, with the largest gains observed with longer interventions (22 weeks) and session duration of physical activity (30-60min) (Ludyga et al., 2020). However, most of the current evidence stems from pediatric populations in high-income countries. Physical activity interventions in schools in marginalized neighbourhoods show promising, yet inconsistent results (Gall et al., 2018; García-Hermoso et al., 2020; Takehara et al., 2021).

"Children in poor communities often bear the burden of communicable and non-communicable diseases. The KaziAfya study highlights many shortcomings affecting the health and well-being of children in Gqeberha, South Africa. The study broke down silos and brought together researchers, epidemiologists, academics, students, schoolteachers, school principals, parents, school governing bodies, public health officials, medical personnel, education department officials – all interested in improving the health and well-being of children."

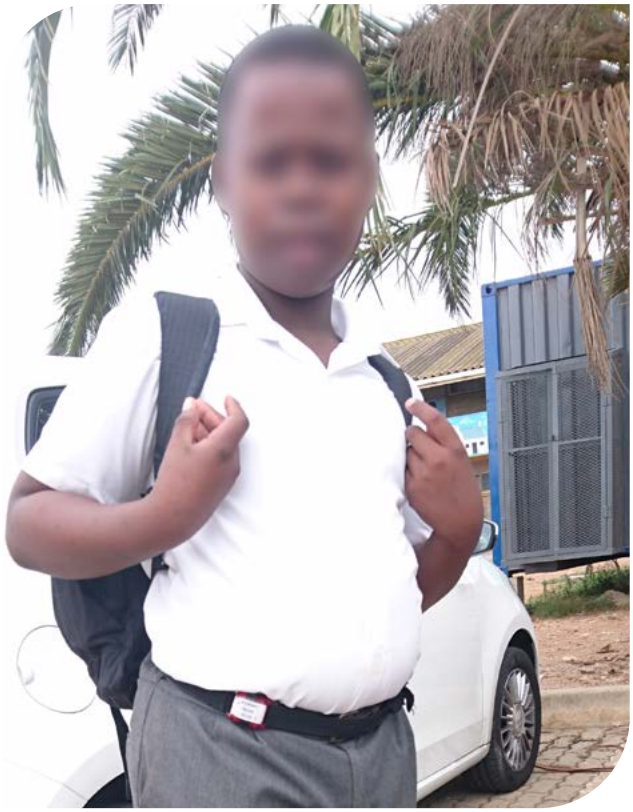
Prof. Dr. Cheryl Walter
South African principal investigator , Nelson Mandela University

How did we measure physical activity and fitness?

We applied two self-report instruments to collect information on children's self-reported physical activity (Bauman et al., 2010; Biddle et al., 2011). The first instrument was a single-item tool taken from the HBSC survey. The exact wording of this item was as follows: 'Physical activity is any activity that increases your heart rate and makes you get out of breath some of the time. Over the past 7 days, on how many days did you engage in such activity?' Children could answer the question on a scale from 1 to 7 days (Aït-Khaled et al., 2009). The second instrument was the Physical Activity Questionnaire for Children (PAQ-C), a 9-item instrument specifically designed for school-aged children (Crocker et al., 1997). Due to the limited age of our sample and time constraints, we decided to use only five items. The PAQ-C is a 7-day recall focussing on several domains. Responses are given on a 5-point Likert-scale (from 1 to 5). Items included in the present study refer to physical activity accumulated during physical education, recess, after school, in the evening and on weekends. Previous research has shown that the PAQ-C has acceptable reliability and convergent validity (Bervoets et al., 2014; Kowalski et al., 1997; Wang et al., 2016). To assess physical activity "objectively", we used hip-worn accelerometer devices (Actigraph wGT3x-BT; Shalimar, FL, USA). Children wore the device for 7 consecutive days to assess a full week, with a sampling epoch of 15 s (Rowlands, 2007). Time per day spent in moderate physical activity (MPA; ≥3 metabolic equivalents of task (MET))

Children also become considerably less physically active as they go through primary school.

▲ Children performing the 20m Shuttle Run Test, a multistage fitness test, under COVID-19 hygiene restrictions



▲ Child wearing an actigraph device around the hip

▲ Preparation of physical activity trackers (Actigraph wGT3X-BT) for drop-off at schools

and vigorous physical activity (VPA; ≥6 MET) were determined based on the raw accelerometry counts and the ActiLife® computer software (Actigraph; Shalimar, FL, USA), with cut-off values derived from Freedson et al. (1998). Evidence for the validity of ActiGraph accelerometers have been validated for children (Crouter et al., 2013; Hänggi et al., 2013). To measure children's cardiorespiratory fitness, we used the 20m shuttle run test (Leger et al., 1988). All children were instructed to report any body discomfort before the start of the test to avoid that students who felt unwell or uncomfortable participated in the test. Once children were familiar with the test procedures, they were asked to run back and forth on the 20m flat course (marked with colour-coded cones) in groups of 10–15 children, following the pace of a pre-recorded sound signal. The test started with a running speed of 8.5 km/h; we then increased the frequency of the signal every minute by 0.5 km/h. The test ended when a child failed to follow the pace in two consecutive intervals. The child's age and the speed at which the child terminated the test were used to estimate their VO2max. To assess upper body strength, we used the grip strength test (Saehan hydraulic hand dynamometer, MSD Europe BVBA; Tisselt, Belgium). We measured the hand span (distance from the tip of the thumb to the tip of the little finger) of the child's dominant hand (to the nearest 0.5 cm) before the start of the test. This allowed us to adjust the grip span on the dynamometer (Espana-Romero et al., 2008; Ruiz et al., 2008). The child gripped the dynamometer with the arm fully extended in an upright seating position. During this time, no other parts of the body touched the dynamometer, and the arm being tested was not squeezed against the body. Each child had six trials in total (three per hand), with a 30-s rest between trials, alternating between hands. Scores were noted to the nearest 1 kg.

Results

Data on self-reported physical activity were available for 1281 children at baseline. At baseline, more than two thirds of the children (67.4%) reported that they did not have physical education lessons (Figure 12.01A). Of those children who had physical education lessons, 13.0% reported that they hardly ever or only sometimes were very active (playing hard, running, jumping, throwing) during these lessons. Higher physical activity levels during physical education lessons were only reported by 20.6% of the learners (quite often: 9.1%, always: 10.5%). As shown in Figure 12.01B, many children were physically active during recess/breaks and lunch time. Almost half of the students ran and played at least a little bit during recess (44.6%) or lunch time (45.5%). Nevertheless, more than one third of the learners reported that they did not engage in physical activities during recess (39.3%) or lunch time (36.2%). With regard to leisure time physical activity (Figure 12.01C), 18.8% and 9.4% of the children reported that they did not engage in sports, dance or other (physically active) playful games during weekdays and weekend days, respectively, whereas more than one third of the students reported that they would participate in such activities almost every day (weekdays: 32.3%, weekend days: 39.1%). Overall, more than two thirds of the children engaged in sports, dance and other playful games at least two times per week (both during weekdays and weekend days). A similar (or even more) positive picture emerged when parents described the physical activity behaviour of their offspring (Figure 12.02). According to the parents' opinion, more than half (54.2%) of the children engaged in at least 60 minutes of physical activity per day on every day of the week, whereas only a small percentage of the parents felt that their child would engage in physical activity only on a few days of the week.

As shown in Table 12.02, participation in physical education was similar in boys and girls. In contrast, boys were significantly more active during recess, lunch time, after school, and during weekend days. Interestingly, this did not correspond with parents' and guardians' perspective who believed that boys and girls were similarly active.

Figure 12.01A Child-reported physical activity levels during physical education class

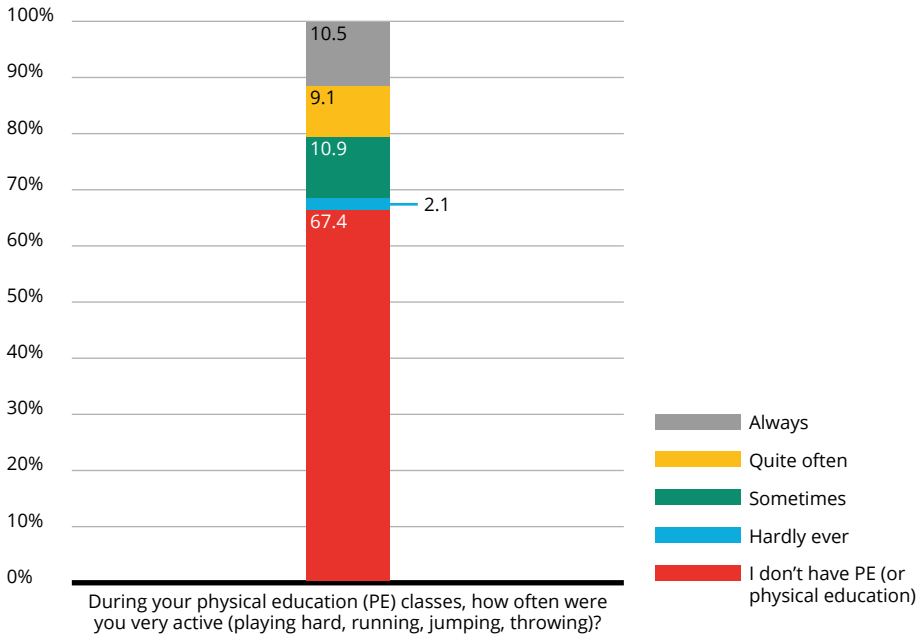


Figure 12.01B Child-reported physical activity levels during recess and lunch time

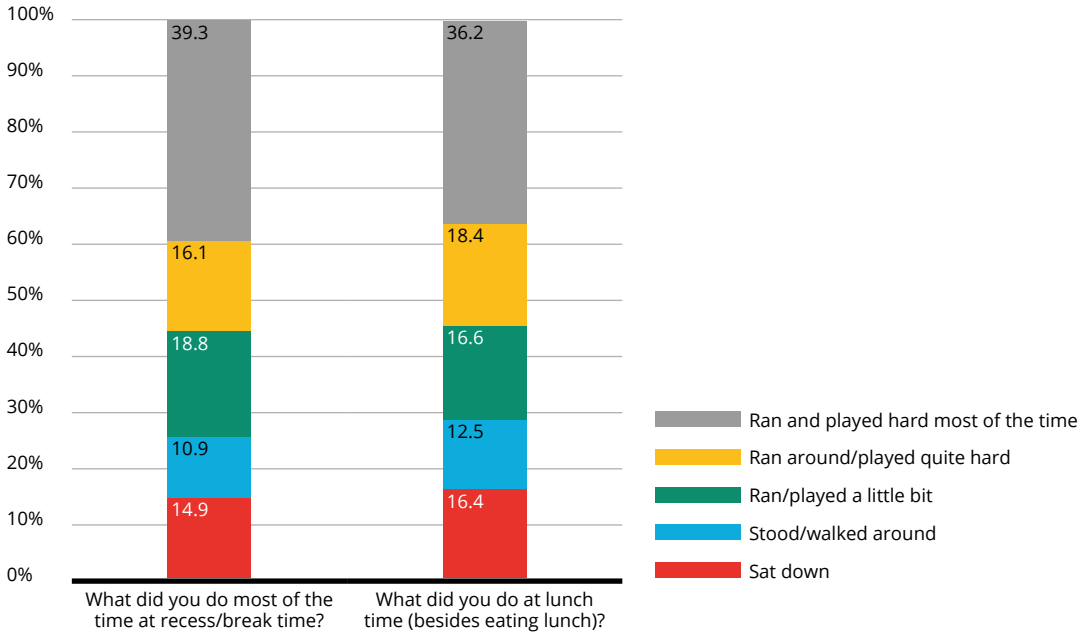


Figure 12.01C Child-reported physical activity levels during leisure time

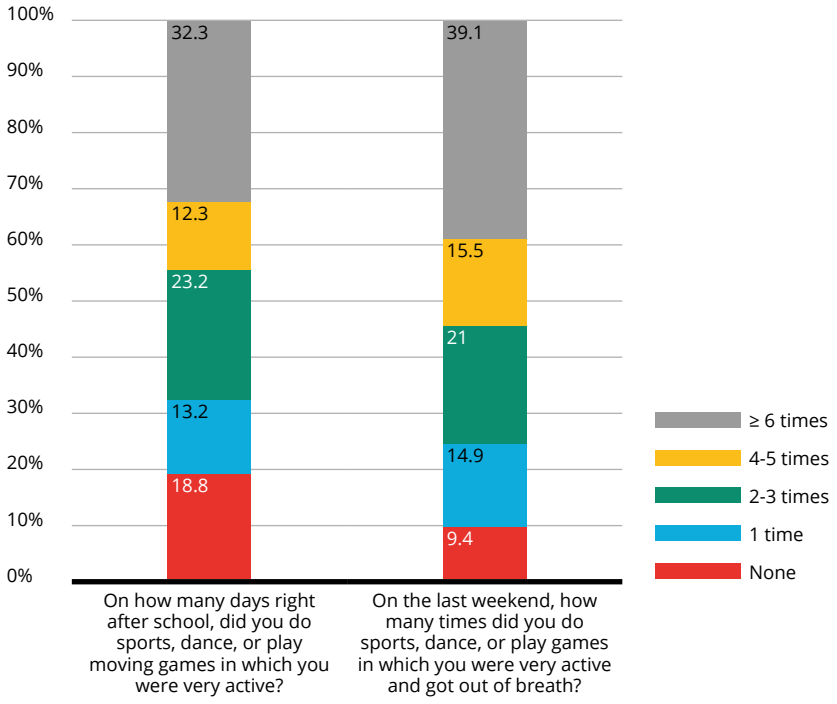
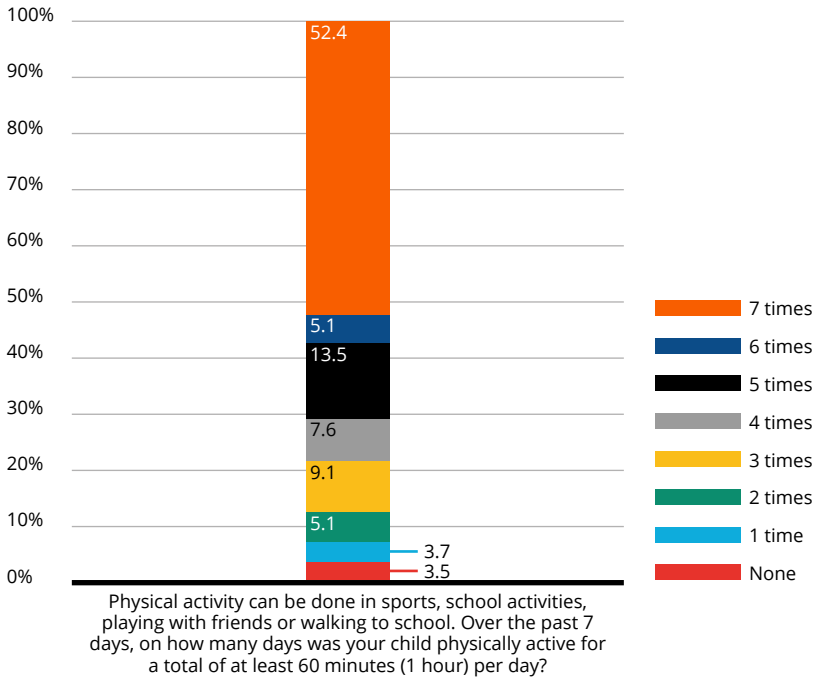


Figure 12.02 Parent-reported physical activity levels in the total sample (in %)



As shown in Table 12.02, with regard to grade level, the self-reported physical activity level during physical education lessons was highest in grade 1, whereas the lowest level was found in grade 2.

In grade 3 and 4, physical education-based physical activity increased again. With regard to physical activity during recess and lunch time, an opposite picture emerged, with grade 2 learners being most active. This might be seen as an effort of learners to compensate for the absence of physical education-based physical activity opportunities. With regard to after-school and weekend-based physical activities, the highest levels were found in grade 2 and 3 learners. With regard to parent/guardian reports, no differences were found between students from different grades.

Valid baseline actigraphy data was available for 1266 children. As shown in Figure 12.03, three of four children accumulated sufficient amounts of physical activity and thus met international physical activity guidelines (76.3%). However, there was a substantial difference between boys and girls, with boys being more likely to meet recommended levels of physical activity. As shown in Table 12.01, boys accumulated 93.14 min of MVPA per day, whereas girls engaged only for 69.69 min per day in at least moderately intensive physical activity. No differences were found between learners from different grades. Table 12.01 also highlights that children accumulated relatively high amounts of sedentary activity, with an average of 603.89 min per day. Sedentary time was significantly higher among girls (620.31 min) than boys (581.08 min). Moreover, time spent in sedentary activities gradually increased from grade 1 (586.66 min) to grade 4 (612.91 min).

Additionally, 779 children had valid actigraphy data across all measurement time points. Figure 12.04A reveals that in the total sample, physical activity levels increased from T1 to T2, and then dropped to the initial level at T3. Importantly, the decrease between T2 and T3 was significantly more marked in girls than boys. For sedentary activities, the levels were relatively stable between T1 and T2. After that, a substantial increase (by approximately 15 min per day) was observed (Figure 12.04B). Increases from T1 to T3 did not differ significantly between boys and girls.

Figure 12.03 Percentage of children meeting recommended levels of moderate-to-vigorous physical activity, based on accelerometer data, in the total sample and separately for boys and girls (in %)

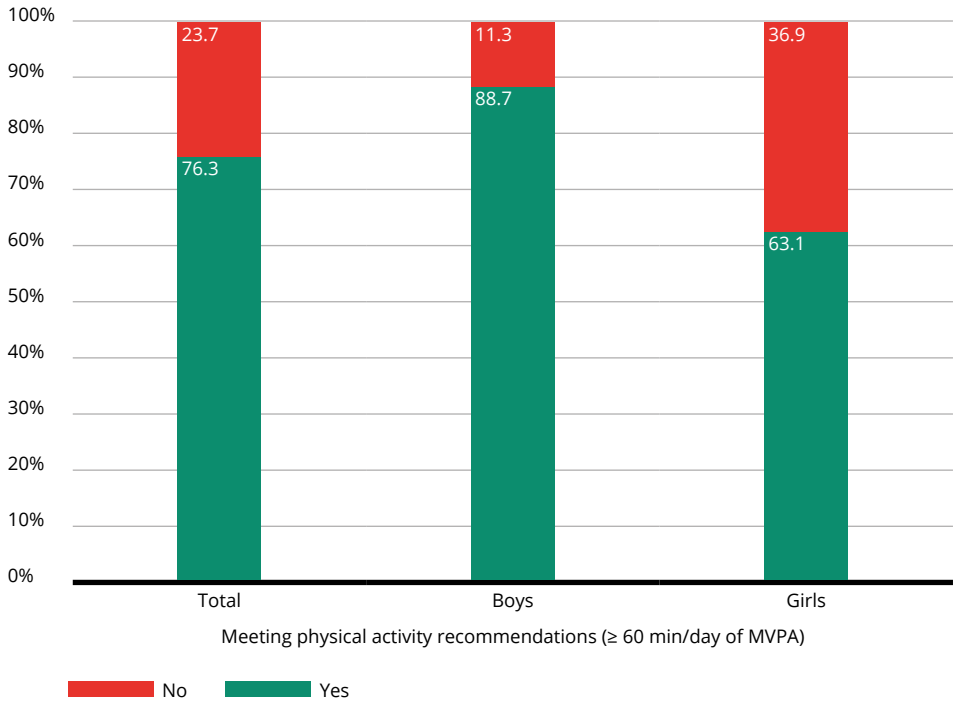


Figure 12.04A Development of moderate-to-vigorous physical activity across the study period, in the total sample and separately for boys and girls (in min/day)

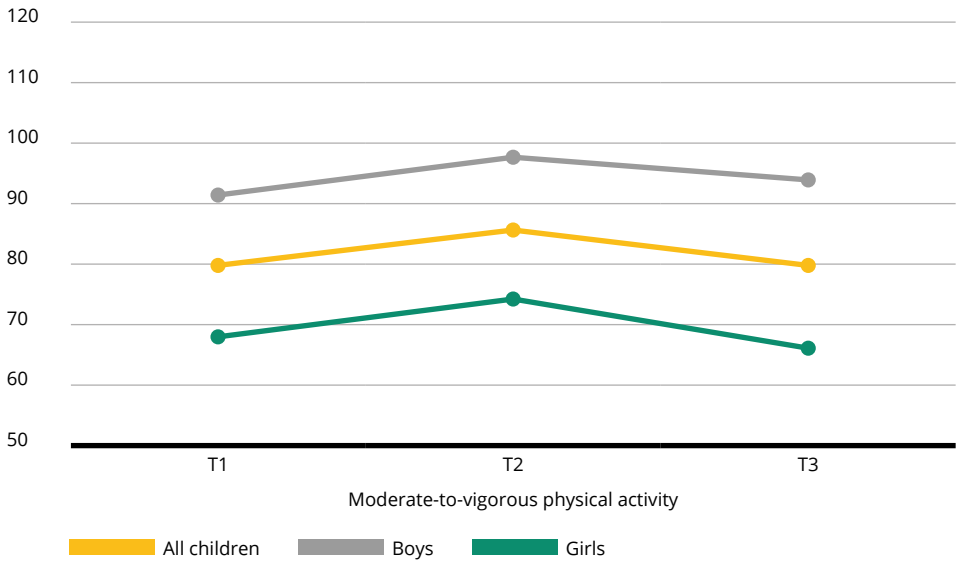
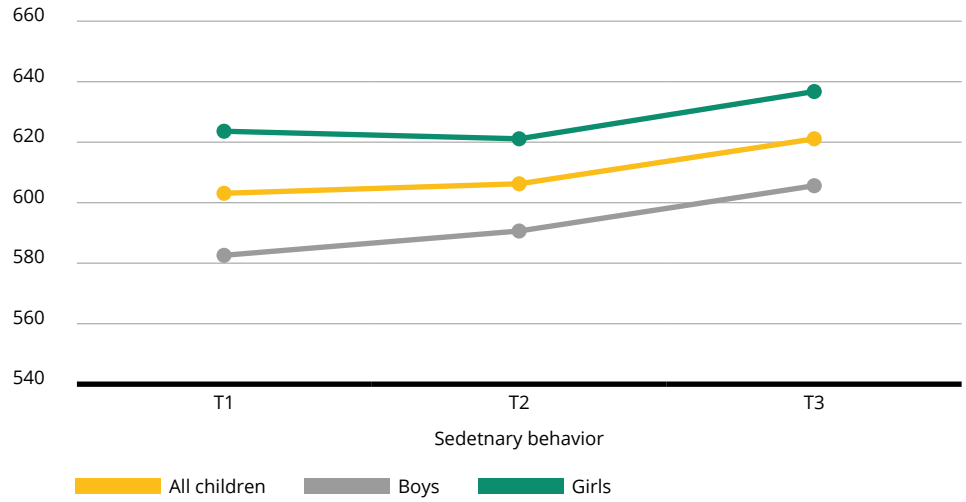


Figure 12.04B Development of sedentary behaviour across the study period, in the total sample and separately for boys and girls (in min/day)



▲ Children engaging in physical education lesson in one of the partner schools

Table 12.01 Accelerometer-based physical activity and physical fitness, separately for boys and girls and learners attending different grades

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Accelerometer-based data (Total)														
Sedentary behavior	600.04	78.02	581.08	78.02	620.31	69.28	586.66	71.66	596.71	71.46	603.56	80.74	612.91	79.47
Moderate physical activity	56.65	17.14	63.25	16.86	49.61	14.43	57.30	15.49	57.21	17.58	56.67	17.17	55.48	18.25
Vigorous physical activity	25.15	12.68	29.89	13.51	20.09	9.39	24.25	10.96	26.05	13.31	26.09	13.35	24.24	12.89
MVPA*	81.80	28.04	93.14	28.24	69.69	22.18	81.55	25.12	83.26	29.01	82.76	28.63	79.72	29.25
Accelerometer-based data (Weekdays)														
Sedentary behavior	603.89	77.58	585.57	78.84	623.47	71.23	590.67	75.46	602.84	72.84	607.03	81.31	614.59	79.00
Moderate physical activity	56.43	17.43	62.91	16.90	49.50	15.18	56.72	16.29	56.48	17.82	56.69	17.03	55.89	18.59
Vigorous physical activity	24.92	12.70	29.56	13.47	19.97	9.67	23.92	11.22	25.78	13.37	25.85	13.15	24.18	12.99
MVPA*	81.35	28.13	92.47	28.01	69.47	22.95	80.64	26.07	82.25	29.02	82.54	28.07	80.07	29.37
Accelerometer-based data (Weekend)														
Sedentary behavior	592.65	96.93	573.76	98.59	612.51	91.11	576.75	92.13	583.62	92.29	600.11	95.44	610.64	104.41
Moderate physical activity	57.67	21.73	65.30	22.27	49.64	17.96	59.27	18.75	59.82	22.17	56.87	22.41	54.66	23.10
Vigorous physical activity	25.85	15.95	31.20	17.60	20.23	11.61	25.08	13.38	26.76	16.06	26.94	17.63	24.55	16.39
MVPA*	83.52	35.67	96.50	37.34	69.87	27.96	84.35	20.41	86.58	36.32	83.81	37.73	79.21	37.54
Physical fitness														
Number of laps completed	21.85	13.46	23.40	15.16	20.17	11.11	16.88	8.24	19.53	11.19	26.39	15.77	24.41	14.98
Estimated VO_2max	47.46	3.89	47.63	4.10	47.29	3.65	49.11	2.39	48.04	3.15	47.62	4.50	45.11	4.01
Grip strength	11.41	4.67	12.18	4.55	10.58	4.66	7.83	3.73	10.95	4.68	12.72	4.50	14.03	3.10

*MVPA – Moderate-to-vigorous physical activity

Boys accumulated significantly more moderate-to-vigorous physical activity per day than girls.

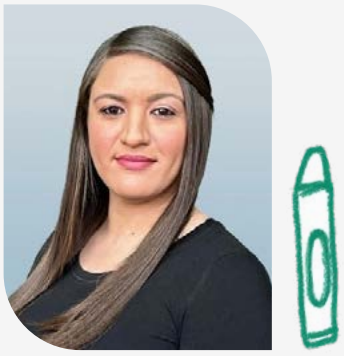
1294

children's grip strength was assessed.

Physical education

Descriptive data on children's physical fitness is shown in Table 12.01. 1280 children completed the 20m Shuttle run test, whereas grip strength was assessed in 1294 children. Average number of laps completed in the 20m Shuttle run test was 21.85 laps. Average VO_2max was 47.46, average grip strength 11.41 kg. Significant sex differences were found in two of three variables. While boys completed more laps in the Shuttle run test and achieved higher grip strength, no significant differences were found for estimated VO_2max. Whereas children from higher grades run more laps in the 20m Shuttle run test, estimated VO_2max decreased with increasing age. In contrast, a gradual increase was observed in grip strength from grade 1 to grade 4.

Hand grip strength test



"The comprehensive approach of the KaziAfya research project allows for a holistic understanding of health factors affecting children in different social-ecological contexts. It also provides valuable insights into the interconnectedness of different aspects of children's health. Understanding these associations can guide the development of targeted interventions and policies to improve health outcomes. Lastly, the evidence-based approach can inform future interventions and policies aimed at promoting active and healthy lifestyles among children. The engagement and collaboration with academics and researchers from other African countries contributed to an enriching, rewarding and stimulating research environment."

Ms. Larissa Adams
Research assistant

Conclusion

Overall, children of the present sample were relatively active, with more than 75% of the participants meeting international physical activity recommendations. However, boys accumulated significantly more MVPA per day than girls. According to the parents' reports, more than half of the children engaged in at least 60 minutes of physical activity per day on every day of the week, and more than two thirds of the children engaged in sports, dance and other playful games at least two times per week (both during weekdays and weekend days). Time spent in sedentary activities also gradually increased from grade 1 (586.66 min) to grade 4 (612.91 min). Finally, four out of ten learners reported very low levels of physical education during their physical education classes, while two thirds of the learners received no physical education lessons at all. Overall, children seem motivated to engage in physical activity during school time as almost half of the learners ran and played at least a little bit during recess or lunch time. With regard to their cardiorespiratory fitness levels, the performances of the present sample were comparable to those of previous child studies in South Africa (Lang et al., 2018). With approximately 22 laps completed, the perfomances were close to the 50 centile rank observed in a 50-country comparison and well below the performances achieved by children from other sub-Saharan African countries (Lang et al., 2018).

"The KaziAfya project has a significant impact, creating valuable opportunities in research and community/public health. Through comprehensive data collection, it expands knowledge on various health factors such as physical activity, diseases, nutrition, and food security. The project has also fostered research capacity development, allowing young researchers to utilize the collected data for their studies, contributing to the field of health and well-being."

Ms. Madeleine Nienaber
Research assistant

Table 12.02 Child- and parent-reported physical activity, separately for boys and girls and learners attending different grades

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Child-reported physical activity														
During physical education	1.93	1.44	1.96	1.46	1.90	1.43	2.20	1.65	1.68	1.22	1.79	1.33	2.07	1.50
During recess/break time	3.54	1.47	3.75	1.40	3.31	1.50	3.39	1.51	3.87	1.46	3.52	1.40	3.36	1.44
Right after school	2.26	1.50	2.43	1.44	2.08	1.54	1.92	1.38	2.40	1.54	2.53	1.43	2.17	1.57
On the last weekend	2.60	1.38	2.77	1.33	2.41	1.40	2.37	1.32	2.73	1.42	2.76	1.28	2.51	1.44
PAQC mean score	2.76	0.83	2.91	0.77	2.59	0.85	2.68	0.85	2.90	0.79	2.80	0.80	2.64	0.85
Parent-reported physical activity														
Number of days with ≥60 min of MVPA	5.48	1.83	5.51	1.73	5.45	1.93	5.48	1.75	5.65	1.73	5.41	1.86	5.37	1.97

Dietary behaviour and nutritional status

13

Background

Poor nutrition and infectious diseases can affect children's health and educational success (Hurlimann et al., 2017; Rytter et al., 2014). Over the past years, a majority of the South African population has undergone a lifestyle transition from a traditional to a more westernized lifestyle (Thathiah et al., 2013; Rousham et al., 2020; Vorster et al., 2011), including dietary consumption patterns and nutrient intake. The transition towards a high-energy and fat diet with poor nutritional value, however, is linked to a range of long-term consequences for child nourishment. At the moment, most countries in Sub-Saharan Africa are facing a double burden of under- and overnutrition. Undernourishment can be both a cause and a consequence of poverty (Local Burden of Disease Educational Attainment, 2020; UNICEF, 2019a). Insufficient nutrient and energy intake have been shown to impede children's curiosity, interest, and learning capabilities among stunted children (Mohammed Teni, 2017). Previous research has also shown that children from low- and middle-income countries (LMICs) have a specially high risk of food insecurity (Naicker et al., 2015; Shankar et al., 2017), multiple micronutrient deficiencies (Vorster, 2010), and malnutrition (including both overnutrition/obesity and undernutrition/stunting), which are all linked to poor academic and cognitive performance (Black et al., 2013a; Fiorentino et al., 2018). In South Africa, a relatively high percentage of children under the age of 5 years suffer from some kind of micronutrient deficiency (Ritchie; & Roser, 2017; Said-Mohamed et al., 2015; UNICEF, 2019b; Vorster et al., 2011) with iron, iodine, vitamin A and zinc being the most common micronutrient deficiencies (Bailey et al., 2015; Black et al., 2013b; Ritchie; & Roser, 2017). Accordingly, nutrition programmes, including micronutrient supplementation, may have the potential to enhance or compensate for deficits in cognitive performance (Best et al., 2011; Roberts et al., 2022).

The transition towards a high-energy and fat diet with poor nutritional value, however, is linked to a range of long-term consequences for child nourishment.

School tuck shop

How did we measure dietary behaviour and nutritional status?

Information on dietary intake was obtained from the parents/guardians to determine the adequacy of child's intake of macro- and micronutrients. Dietary intake of children was assessed with a culturally sensitive food item checklist for each country (Wentzel-Viljoen et al., 2011; Zack et al., 2018). The checklist was administered to the child's carer at baseline. In addition, USAID (www.usaid.gov) defines food security as a situation in which all people at all times have physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life. For the purpose of this study, we assessed food security with a questionnaire based on the Household Food Insecurity Access Scale (Salvador Castell et al., 2015), which has been validated in industrialized countries and LMICs. For example, the study by Knueppel et al. (2010) showed satisfactory validity and reliability among poor households in rural Tanzania. The micronutrient status of children was assessed using a finger prick technique. Five blood drops were collected on a filter card. We sent these dried blood spot samples to Neubergglobal Laboratory in Durban, South Africa. The eluted spots were screened for concentrations

of retinol binding protein (RBP), a vitamin A marker, vitamin D, zinc, and serum transferrin receptor (sTfR), an iron deficiency marker. The following age specific cut-offs were used to define micronutrient deficiencies: Vitamin A deficiency < 1.05 µmol/L, vitamin D deficiency <25 ng/ml, zinc deficiency <13.77 µmol/L, iron deficiency <8.3 mg/l.

Results

Data based on child self-reports of dietary behaviour was available for 1284 learners at baseline. More than 30.6% of the children reported that they went to bed hungry on the day before the data assessment (Figure 13.01). Approximately 25% of the children also reported that on the day before the data assessment, they only got one meal (or less). One third of the children (33.8%) got two meals, whereas 41.5% got three or more meals (Figure 13.02).

Parental reports were completed by 920 parents or guardians. Approximately one quarter of the parents/guardians (23.6%) had the feeling that their household members do not have access to enough food on every day (Figure 13.03). Approximately one of five parents/guardians (19.5%) reported that in the past 30 days, some members of the household went to sleep at night hungry because there was not enough food. Finally, 11.9% of the parents/guardians felt that during the past 30 days, some household members went a whole day and night without eating anything at all because there was not enough food.

Information with regard to food groups consumed is presented in Figure 13.04. The most frequently consumed food groups were cereals (95.3%), flesh meat (92.4), green vegetables (90.7%), milk (87.1%), sweets (85.1%), fruits (84.3%) and roots (81.2%). Least frequently reported were other vegetables (33.8%), fish (46.5%), and other meat (47.8%). Table 13.01 shows how many food items were consumed per food group (more detailed information about specific food items consumed is presented at the end of this chapter in Table 13.03). On average, children consumed 23.95 items from 6.23 different food groups. Differences between boys and girls with regard to consumed items per food group were found for none of the food groups.

Figure 13.01A Percentage of children who went to bed hungry last night in the total sample

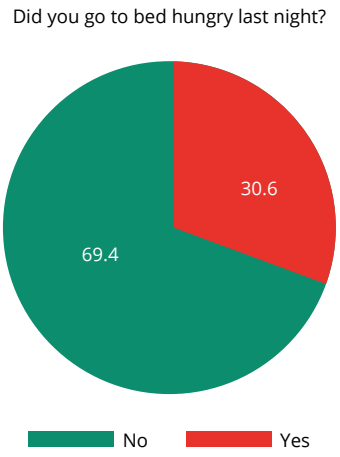
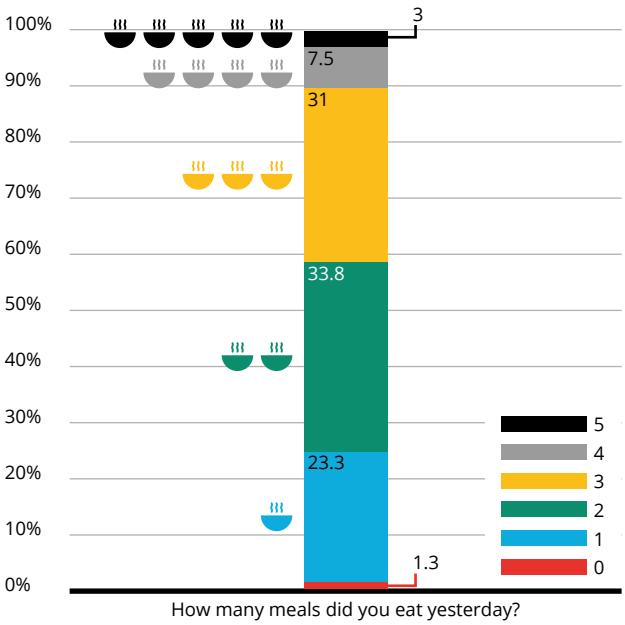
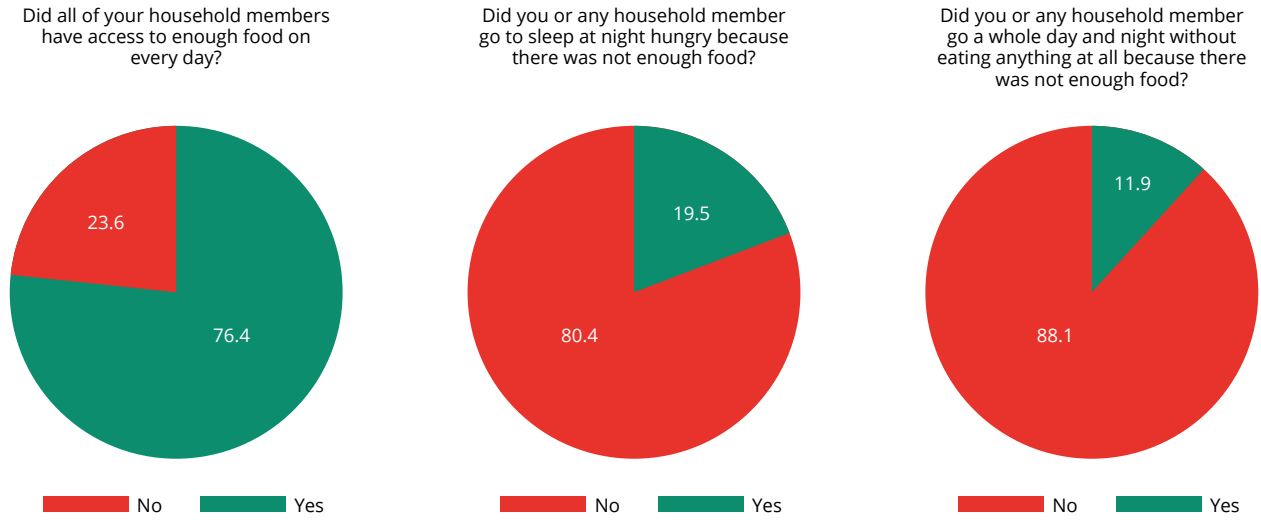


Figure 13.02 Number of meals consumed in the total sample (in %)



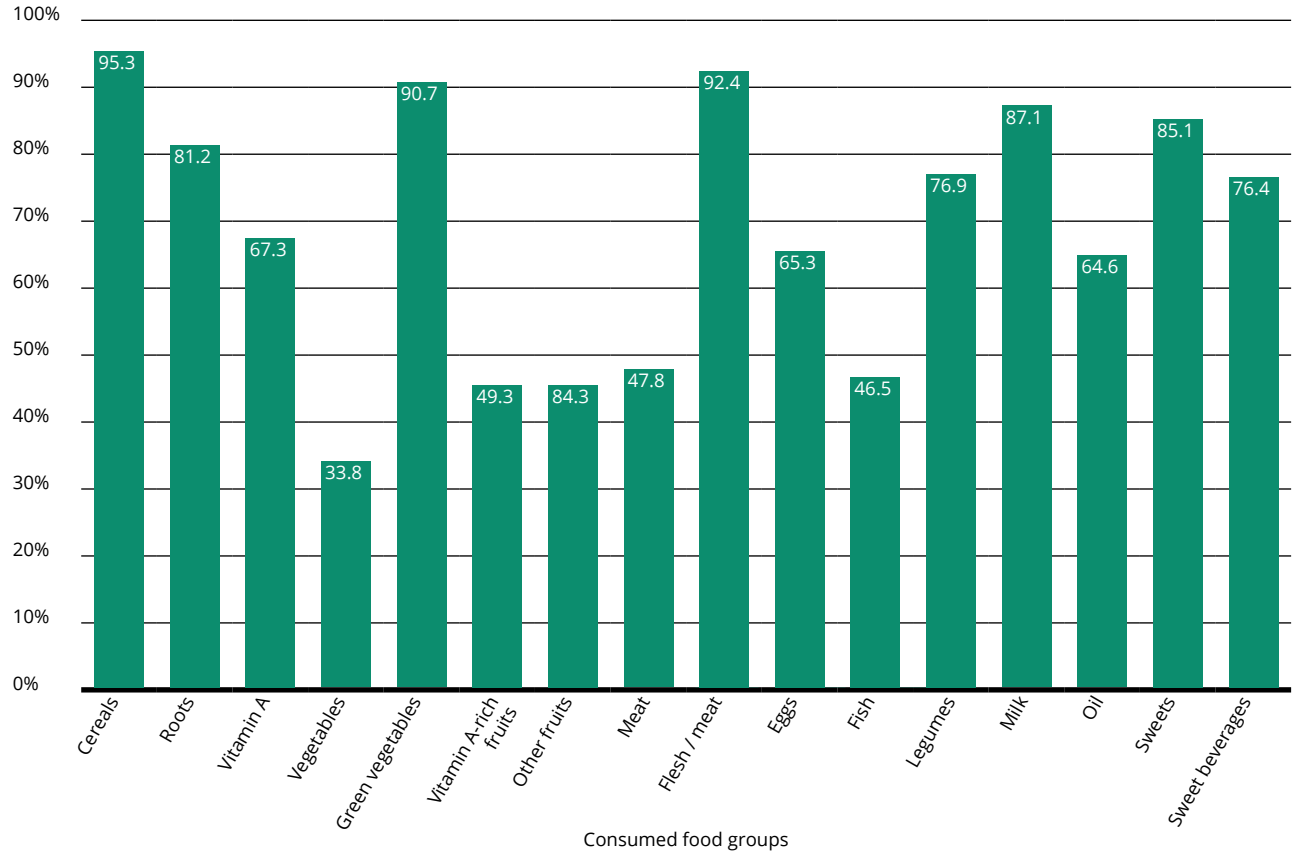
In South Africa, a relatively high percentage of children under the age of 5 years suffer from some kind of micronutrient deficiency.

Figure 13.03 Food security in the past 30 days (parent survey)



Micronutrient status was assessed in 998 children. As shown in Figure 13.05A, most of the children presented with a vitamin A deficiency. Given the low variation in the present sample, it was no surprise that no significant difference was observed between boys and girls. Similarly, a large percentage of children (69.4%) was found to have a vitamin D deficiency (Figure 13.05B). Again, no significant differences were seen between boys and girls. A different (and somewhat unexpected) picture emerged for zinc (Figure 13.05C). While a deficiency was observed in 10.7% of the children, most of the participants (67.9%) had abnormally high zinc levels. While boys (12.7%) were more likely to have a zinc deficiency than girls (8.6%), high zinc levels were more often observed in girls (71.7%) than in boys (64.3%). Finally, with regard to iron (Figure 13.05D), a deficiency emerged in 43.3% of the children, with boys and girls being similarly represented in the deficient group. Descriptive statistics for micronutrients are shown in Table 13.02 (page 128). No significant differences were found between boys and girls in any of the micronutrients. While transferrin was highest in grade 4 learners (M=10.03), a gradual increase was observed in zinc from grade 1 (M=17.10) to grade 4 (M=18.43). Such an increase was also found for vitamin A, with initial levels at grade 1 being significantly lower (M=7.14) than at grade 4 (M=8.17). A detailed overview of all consumed food items is provided in Table 13.03 (page 129).

Figure 13.04 Consumed food groups in the total sample (in %)



▲ Umvubo

▲ Pap and a meat dish

Figure 13.05.A Vitamin A status

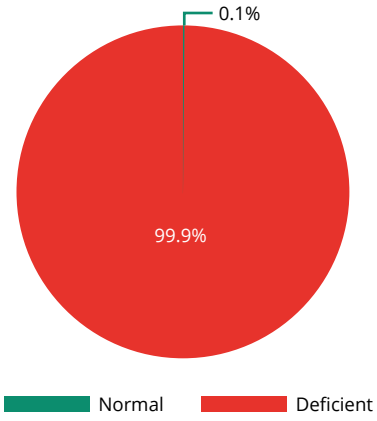


Figure 13.05.B Vitamin D status

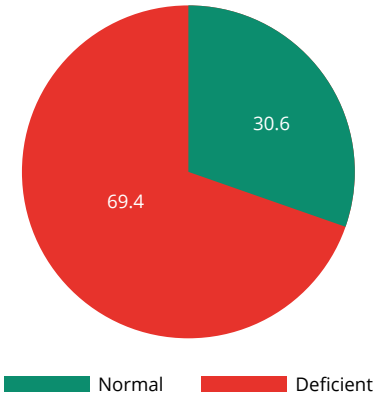


Figure 13.05.C Zinc status

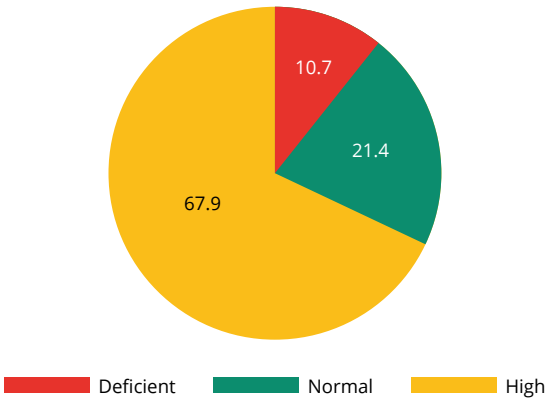
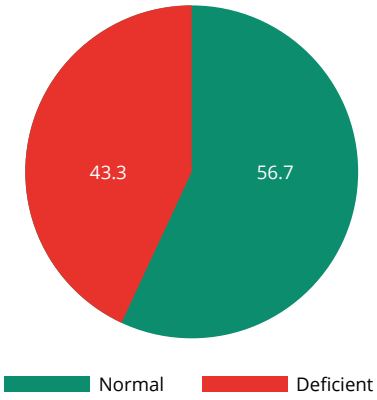


Figure 13.05.D Iron status



More than 30% of the children reported that they went to bed hungry on the day before the data assessment and approximately 25% of the children only got one meal (or less) the day before the data assessment.

Conclusion

With regard to food security, more than 30% of the children reported that they went to bed hungry on the day before the data assessment and approximately 25% of the children only got one meal (or less) the day before the data assessment. This corresponds well with the fact that approximately one quarter of the parents/guardians felt that their household members would not have access to enough food on every day. The most frequently consumed food groups were cereals, flesh meat, green vegetables, milk, sweets, fruits and roots. On average, children consumed approximately 24 items from 6 different food groups per day. With regard to micronutrient status, many children presented with vitamin A (97%), vitamin D (69%) and iron (43%) deficiencies. With regard to zinc, a deficiency was observed in 11% of the children, whereas most participants had abnormally high zinc levels (68%). Please add this sentence: These findings contradict those of other studies conducted among children in South Africa. We also analyzed soil and water samples from these areas, but the higher zinc levels could not be explained.

Kota

Biltong

A rice-based meal

Table 13.01 Consumed food groups and number of food items, separately for boys and girls and learners attending different grade levels

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Cereals	4.16	3.21	4.22	3.21	4.09	3.01	3.95	3.23	4.43	3.02	4.00	3.10	4.28	3.09
Roots	0.87	0.48	0.90	0.48	0.85	0.48	0.91	0.47	0.88	0.43	0.83	0.51	0.87	0.49
Vitamin A	1.23	1.16	1.21	1.16	1.24	1.15	1.26	1.19	1.37	1.14	0.98	1.07	1.31	1.20
Vegetables	0.53	0.89	0.55	0.88	0.52	0.90	0.56	0.92	0.57	0.91	0.38	0.72	0.63	0.97
Green vegetables	3.97	3.28	4.10	3.35	3.83	3.20	4.06	3.29	4.28	3.43	3.32	2.92	4.26	3.40
Vitamin A-rich fruits	0.93	1.19	0.91	1.18	0.95	1.19	0.88	1.15	1.03	1.25	0.81	1.12	1.00	1.22
Other fruits	3.85	3.60	3.83	3.54	3.88	3.66	3.85	3.47	4.06	3.58	3.42	3.44	4.13	3.83
Meat	0.67	0.83	0.68	0.84	0.65	0.83	0.70	0.83	0.66	0.82	0.58	0.79	0.73	0.89
Flesh meat	4.79	4.61	4.76	4.57	4.83	4.66	4.84	4.67	4.92	4.54	4.12	3.92	5.26	5.08
Eggs	0.65	0.48	0.68	0.47	0.63	0.48	0.65	0.48	0.70	0.46	0.60	0.49	0.68	0.47
Fish	0.79	1.08	0.78	1.07	0.80	1.09	0.79	1.07	0.81	1.07	0.66	0.93	0.90	1.21
Legumes	1.79	1.85	1.78	1.88	1.80	1.82	1.69	1.80	1.81	1.92	1.72	1.72	1.90	1.90
Milk	2.73	2.01	2.76	2.03	2.69	1.99	2.69	1.93	2.81	2.04	2.46	1.90	2.94	2.11
Oil	1.60	1.67	1.61	1.66	1.58	1.68	1.61	1.65	1.69	1.68	1.35	1.52	1.73	1.77
Sweets	3.39	2.75	3.42	2.78	3.35	2.71	3.32	2.78	3.29	2.69	3.26	2.60	3.68	2.90
Sweet beverages	1.88	1.81	1.92	1.86	1.84	1.76	1.85	1.72	1.86	1.78	1.71	1.72	2.09	1.99
Total number of healthy food items	23.95	17.35	24.16	17.45	23.74	17.27	23.84	17.43	25.14	17.58	21.27	15.18	25.61	18.65
Total number of healthy food groups	6.23	1.72	6.24	1.73	6.21	1.72	6.17	1.91	6.43	1.59	6.01	1.77	6.33	1.59

Table 13.02 Micronutrients, separately for boys and girls and learners attending different grade levels

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Transferrin	8.35	9.69	7.74	5.72	8.98	12.49	7.15	6.79	8.46	10.66	7.87	11.01	10.03	9.75
Vitamin D	20.98	9.84	20.81	10.00	21.14	9.69	21.20	10.73	20.79	9.40	20.65	9.57	21.40	9.66
Zinc	17.72	3.81	17.51	4.04	17.93	3.55	17.10	4.11	17.35	3.47	17.99	3.82	18.43	3.70
Vitamin A	7.66	3.48	7.60	3.63	7.73	3.33	7.14	3.23	7.70	3.77	7.64	3.31	8.17	3.56

Table 13.03 Consumed food items, separately for boys and girls and learners attending different grade levels

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Cereals. white roots and tubers														
Amaranth	9	0.9	5	1.0	4	0.8	3	1.3	3	1.3	2	0.8	1	0.4
Baby/infant cereal	24	2.5	13	2.7	11	2.3	6	2.5	3	1.3	9	3.6	4	1.7
Brown, whole wheat bread	330	34.2	174	35.7	156	47.3	72	30.5	94	40.2	76	30.2	85	35.6
Cake flour	196	20.3	102	20.9	94	19.7	56	23.7	55	23.5	35	13.9	50	20.9
Couscous	10	1.0	5	1.0	5	1.0	3	1.3	2	0.9	2	0.8	3	1.3
Maize	200	20.7	113	23.2	87	18.2	47	19.9	51	21.8	45	17.9	56	23.4
Maize porridge	480	49.7	248	50.9	232	48.5	116	49.2	116	49.6	126	50.0	119	49.8
Mealie rice & samp	220	22.8	112	23.0	108	22.6	46	19.5	58	24.8	54	21.4	62	25.9
Millet	13	1.3	7	1.4	6	1.3	4	1.7	1	0.4	6	2.4	2	0.8
Noodles, instant 2-min	403	41.8	201	41.3	202	42.3	97	41.1	102	43.6	100	39.7	103	43.1
Noodles, other	223	23.1	107	22.0	116	24.3	45	19.1	66	28.2	58	23.0	53	22.2
Nshima	7	0.7	4	0.8	3	0.6	2	0.8	1	0.4	2	0.8	2	0.8
Oats, flakes, breakfast cereals	420	43.5	222	45.6	198	41.4	97	41.1	112	47.9	104	41.3	106	44.4
Potato	780	80.8	403	82.8	377	78.9	197	83.5	196	83.8	194	77.0	190	79.5
Rice	596	61.8	295	60.6	301	63.0	137	58.1	152	65.0	154	61.1	153	64.0
Sorghum porridge	32	3.3	30	4.1	12	2.5	5	2.1	6	2.6	10	4.0	11	4.6
Sorghum, whole grain	22	2.3	11	2.3	11	2.3	8	3.4	2	0.9	4	1.6	8	3.3
Ugali, based on corn meal	19	2.0	8	1.6	11	2.3	5	2.1	3	1.3	6	2.4	5	2.1
Wheat	109	11.3	54	11.1	55	11.5	22	9.3	34	14.5	24	9.5	29	12.1
White bread/bread rolls	480	49.7	237	48.7	243	50.8	110	46.6	127	54.3	133	52.8	109	45.6
Other bread	120	12.4	67	13.8	53	11.1	28	11.9	26	11.1	34	13.5	31	13.0
Other cereal products	82	8.5	41	8.4	41	8.6	18	7.6	20	8.5	19	7.5	24	10.0
Vegetables														
Amadumbe	9	0.9	5	1.0	4	0.8	3	1.3	2	0.9	1	0.4	3	1.3
Baby vegetable purees	35	3.6	17	3.5	18	3.8	6	2.5	10	4.3	7	2.8	11	4.6
Beetroot	317	32.8	161	33.1	156	32.6	73	30.9	89	38.0	65	25.8	88	36.8
Broccoli	100	10.4	44	9.0	56	11.7	29	12.3	23	9.8	16	6.3	32	13.4
Butternut	276	28.6	145	29.8	131	27.4	79	33.5	72	30.8	53	21.0	71	29.7
Cabbage	431	44.7	227	46.6	204	42.7	104	44.1	121	51.7	89	35.3	116	48.5
Carrot	531	55.0	266	54.6	265	55.4	128	54.2	141	60.3	123	48.8	136	56.9
Cauliflower	134	13.9	62	12.7	72	15.1	31	13.1	28	12.0	28	11.1	47	19.7
Celery	17	1.8	10	2.1	7	1.5	5	2.1	7	3.0	3	1.2	2	0.8

Continued overleaf

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Chilli	46	4.8	25	5.1	21	4.4	7	3.0	11	4.7	13	5.2	15	6.3
Green mealies	78	8.1	37	7.6	41	8.6	19	8.1	19	8.1	14	5.6	26	10.9
Imifino	104	10.8	60	12.3	44	9.2	24	10.2	33	14.1	21	8.3	25	10.5
Kale	14	1.5	6	1.2	8	1.7	4	1.7	4	1.7	0	0.0	6	2.5
Lettuce	157	16.3	84	17.2	73	15.3	36	15.3	39	16.7	39	15.5	42	17.6
Morogo	20	2.1	9	1.8	11	2.3	4	1.7	7	3.0	4	1.6	5	2.1
Onion	514	53.3	265	54.5	249	52.1	131	55.7	136	58.1	111	44.0	134	56.1
Pepper, red	158	16.4	87	17.9	71	14.9	47	19.9	40	17.1	26	10.3	44	18.4
Pepper, others	85	8.8	53	10.9	32	6.7	18	7.6	23	9.8	22	8.7	22	9.2
Pumpkin	371	38.4	181	37.2	190	39.7	91	38.6	105	44.9	72	28.6	102	42.7
Spinach	243	25.2	133	27.3	110	23.0	63	26.7	67	28.6	42	16.7	70	29.3
Squash	125	13.0	57	11.7	68	14.2	32	13.6	34	14.5	27	10.7	32	13.4
Sweet potato, leaves	221	22.9	125	25.7	96	43.4	46	19.5	61	26.1	48	19.0	65	27.2
Tomato	474	49.1	246	50.5	228	47.7	120	50.8	117	50.0	111	44.0	125	52.3
Other fresh vegies	129	13.4	59	12.1	70	14.6	44	18.6	30	12.8	26	10.3	28	11.7
Fruits														
Apple	658	68.2	332	68.2	326	68.2	159	67.4	164	70.1	156	61.9	178	74.5
Apricot	229	23.7	118	24.2	11	23.2	49	20.8	54	23.1	56	22.2	69	28.9
Baby fruit purees	29	3.0	14	2.9	15	3.1	6	2.5	8	3.4	8	3.2	7	2.9
Banana	588	60.9	301	61.8	287	60.0	149	63.1	152	65.0	138	54.8	148	61.9
Cantaloupe	41	4.2	19	3.9	22	4.6	5	2.1	13	5.6	8	3.2	14	5.9
Cherries	50	5.2	24	4.9	26	5.4	11	4.7	13	5.6	10	4.0	16	6.7
Dried fruit	65	6.7	33	6.8	32	6.7	14	5.9	16	6.8	14	5.6	21	8.8
Grapes	435	45.1	221	45.4	214	44.8	107	45.3	112	47.9	105	41.7	110	46.0
Lemon	115	11.9	52	10.7	63	13.2	27	11.4	28	12.0	27	10.7	32	13.4
Mango	212	22.0	104	21.4	108	22.6	54	22.9	57	24.4	45	17.9	55	23.0
Naartjie	291	30.2	152	31.2	139	29.1	72	30.5	77	32.9	68	27.0	73	30.5
Orange	396	41.0	202	41.5	194	40.6	97	41.1	105	44.9	88	34.9	105	43.9
Papaya	33	3.4	15	3.1	18	3.8	6	2.5	12	5.1	8	3.2	7	2.9
Peach	381	39.5	185	38.0	196	41.0	93	39.4	104	44.4	88	34.9	95	39.7
Pear	567	58.8	286	58.7	281	58.8	101	42.8	104	44.4	91	36.1	101	42.3
Strawberries	182	18.9	80	16.4	102	21.3	41	17.4	47	20.1	38	15.1	55	23.0
Sweet melon	100	10.4	47	9.7	53	11.1	24	10.2	23	9.8	18	7.1	34	14.2
Water melon	234	24.2	116	23.8	118	24.7	57	24.2	53	22.6	62	24.6	61	25.5
Wild fruits	37	3.8	18	3.7	19	4.0	7	3.0	9	3.8	7	2.8	14	5.9
Other citrus fruit	57	5.9	28	5.7	29	6.1	12	5.1	12	5.1	17	6.7	15	6.3

Continued next page

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Other fruit	83	8.6	42	8.6	41	8.6	24	10.2	26	11.1	15	6.0	17	7.1
Milk, milk products and eggs														
Buttermilk	143	14.8	70	14.4	73	15.3	32	13.6	44	18.8	24	9.5	42	17.6
Eggs	632	65.5	331	68.0	301	63.0	153	64.8	163	69.7	152	60.3	162	67.8
Milk, cow	431	44.7	234	48.0	197	41.2	107	45.3	97	41.5	110	43.7	117	49.0
Milk, other	293	30.4	148	30.4	145	30.3	66	28.0	83	35.5	65	25.8	77	32.2
Sourmilk	151	15.6	73	15.0	78	16.3	35	14.8	40	17.1	26	10.3	48	20.1
Soymilk	31	3.2	13	2.7	18	3.8	7	3.0	10	4.3	4	1.6	9	3.8
Yogurt	585	60.6	303	62.2	282	59.0	149	63.1	143	61.1	142	56.3	149	62.3
Other milk products	105	10.9	55	11.3	50	10.5	24	10.2	23	9.8	29	11.5	27	11.3
Legumes, nuts and their products														
Cashew	42	4.4	22	4.5	20	4.2	8	3.4	10	4.3	9	3.6	13	5.4
Coconut	113	11.7	56	11.5	57	11.9	25	10.6	19	8.1	32	12.7	35	14.6
Groundnut	75	7.8	39	8.0	36	7.5	14	5.9	23	9.8	18	7.1	19	7.9
Hummus	15	1.6	8	1.6	7	1.5	4	1.7	4	1.7	5	2.0	2	0.8
Lentils	255	26.4	119	24.4	136	28.5	62	26.3	55	23.5	72	28.6	64	26.8
Melon seeds	31	3.2	13	2.7	18	3.8	6	2.5	8	3.4	8	3.2	9	3.8
Palm nuts	38	3.9	15	3.1	23	4.8	9	3.8	9	3.8	11	4.4	8	3.3
Peanut, peanut butter	548	56.8	279	57.3	269	56.3	140	59.3	137	58.5	138	54.8	132	55.2
Peas, split/dried	256	26.5	128	26.3	128	26.8	60	25.4	61	26.1	55	21.8	79	33.1
Sesame seeds	26	2.7	12	2.5	14	2.9	3	1.3	10	4.3	5	2.0	6	2.5
Shea nut	27	2.8	14	2.9	13	2.7	4	1.7	7	3.0	6	2.4	9	3.8
Flesh meat, organ meat, fish														
Baby beef or chicken puree	106	11.0	53	10.9	53	11.1	24	10.2	28	12.0	17	6.7	35	14.6
Bacon	301	31.2	153	31.4	148	31.0	77	32.6	72	30.8	70	27.8	80	33.5
Beef and veal	217	22.5	114	23.4	103	21.5	55	23.3	45	19.2	46	18.3	70	29.3
Biltong, dried sausages	196	20.3	96	19.7	100	20.9	49	20.8	43	18.4	46	18.3	56	23.4
Chicken	774	80.2	381	78.2	393	82.2	190	80.5	197	84.2	190	75.4	195	81.6
Cold meets, Vienna, Russian sausage	433	44.9	224	46.0	209	43.7	106	44.9	111	47.4	97	38.5	116	48.5
Cured meat	49	5.1	20	4.1	29	6.1	11	4.7	8	3.4	11	4.4	17	7.1
Dried fish	82	8.5	41	8.4	41	8.6	21	8.9	19	8.1	18	7.1	22	9.2
Duck	23	2.4	8	1.6	15	3.1	7	3.0	6	2.6	3	1.2	6	2.5
Fresh fish (Salmon, Tuna)	241	25.0	117	24.0	124	25.9	60	25.4	61	26.1	53	21.0	66	27.6
Goat	85	8.8	44	9.0	41	8.6	16	6.8	23	9.8	14	5.6	31	13.0

Continued overleaf

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Heart or other organ meats	76	7.9	38	7.8	38	7.9	22	9.3	14	6.0	16	6.3	23	9.6
Insects	11	1.1	3	0.6	8	1.7	3	1.3	3	1.3	1	0.4	3	1.3
Kidney	121	12.5	66	13.6	55	11.5	28	11.9	29	12.4	26	10.3	36	15.1
Lamb	269	27.9	137	28.1	132	27.6	67	28.4	71	30.3	62	24.6	68	28.5
Liver/ chicken liver	447	46.3	229	47	218	45.6	115	48.7	112	47.9	104	41.3	115	48.1
Meat pastes	70	7.3	39	8.0	31	6.5	15	6.4	16	6.8	15	6.0	23	7.2
Mutton	317	32.8	159	32.6	158	33.1	85	36.0	81	34.6	69	27.4	80	33.5
Pork	384	39.8	187	38.4	197	41.2	94	39.8	104	44.4	87	34.5	97	40.6
Poultry, other	42	4.4	22	4.5	20	4.2	13	5.5	13	5.6	6	2.4	8	3.3
Rabbit	12	1.2	6	1.2	6	1.3	6	2.5	3	1.3	1	0.4	1	0.4
Sausages, boerewors	395	40.9	199	40.9	196	41.0	99	41.9	93	39.7	98	38.9	104	43.5
Shelfish	23	2.4	10	2.1	13	2.7	5	2.1	6	2.6	2	0.8	9	3.8
Tinned fish, pilchard	320	33.2	162	33.3	158	33.1	77	32.6	78	33.3	73	29.0	91	38.1
Other birds	13	1.3	5	1.0	8	1.7	4	1.7	2	0.9	0	0.0	6	2.5
Other fish	98	10.2	51	10.5	47	9.8	24	10.2	25	10.7	21	8.3	27	11.3
Other meats	78	8.1	41	8.4	37	7.7	16	6.8	18	7.7	20	7.9	23	9.6
Other sausages	85	8.8	44	9.0	41	8.6	19	8.1	25	10.7	17	6.7	23	9.6
Beverages, sweets, oil														
Cake, doughnuts, tarts	345	35.8	169	34.7	176	36.8	82	34.7	76	32.5	87	34.5	98	41.0
Candies, lollipops	463	48.0	219	45.0	244	51.0	100	42.4	109	46.6	126	50.0	127	53.1
Chocolates	476	49.3	244	50.1	232	48.5	110	46.6	113	48.3	122	48.4	130	54.4
Cookies, biscuits	439	45.5	224	46.0	215	45.0	109	46.2	107	45.7	112	44.4	110	46.0
Crisps/packet of chips	389	40.3	200	41.1	189	39.5	95	40.3	88	37.6	106	42.1	99	41.4
Ice crème	374	38.8	185	38.0	189	39.5	85	36.0	91	38.9	92	36.5	105	43.9
Honey	127	13.2	66	13.6	61	12.8	34	14.4	29	12.4	23	9.1	39	16.3
Jam, syrup	274	28.4	143	29.4	131	27.4	74	31.4	66	28.2	63	25.0	69	28.9
Pies	332	34.4	169	34.7	163	34.1	76	32.2	78	33.3	83	32.9	93	38.9
Sugar	424	43.9	232	47.6	192	40.2	104	44.1	104	44.4	100	39.7	114	47.7
100% fruit juice	338	35.0	170	34.9	168	35.1	79	33.5	87	37.2	75	29.8	95	39.7
Soft drinks	387	40.1	191	39.2	196	41.0	98	41.5	101	43.2	87	34.5	99	41.4
Sweetened ice tea	50	5.2	27	5.5	23	4.8	13	5.5	9	3.8	11	4.4	16	6.7
Sweetened, flavored milk beverages	116	12.0	62	12.7	54	11.3	22	9.3	25	10.7	26	10.3	42	17.6
Sweetened juice drinks, concentrated	332	33.4	170	34.9	152	31.8	81	34.3	78	33.3	84	33.3	76	31.8
Tea	487	50.5	253	52.0	234	49.0	122	51.7	111	47.4	122	48.4	129	54.0
Water	652	67.6	334	68.6	318	66.5	158	66.9	159	67.9	161	63.9	172	72.0

Continued next page

	Total sample		Boys		Girls		Grade 1		Grade 2		Grade 3		Grade 4	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Butter	404	41.9	203	41.7	201	42.1	94	39.8	100	42.7	99	39.3	109	45.6
Coconut oil	42	4.4	22	4.5	20	4.2	8	3.4	11	4.7	6	2.4	16	6.7
Ghee	13	1.3	6	1.2	7	1.5	2	0.8	4	1.7	1	0.4	5	2.1
Margarine	304	31.5	164	33.7	140	29.3	82	34.7	75	32.1	66	26.2	79	33.1
Mayonnaise	369	38.2	179	36.8	190	39.7	96	40.7	100	42.7	80	31.7	91	38.1
Shea butter	28	2.9	15	3.1	13	2.7	5	2.1	8	3.4	5	2.0	9	3.8
Sunflower and vegetable oil	332	34.4	174	35.7	158	33.1	81	34.3	89	38.0	69	27.4	91	38.1
Other oils	48	5.0	20	4.1	28	5.9	11	4.7	8	3.4	13	5.2	14	5.9

"The KaziAfya project created valuable opportunities such as to collect data from young schoolchildren from vulnerable communities, use the findings to alert policy makers on recommendations that, if implemented, could improve not only the involved participants' short- and long-term health status, but also that of other communities in similar circumstances with direct positive spinoff for the country's economy. Appreciation is extended to all who made this project possible: sponsors, co-researchers, relevant gatekeepers and research participants."

Prof. Dr. Rosa Du Randt
Co-researcher

▲ Vetkoek with mince and vegetables

Intervention

KaziAfya Project
2018 –2021

14

Feasibility

At all schools the teachers and principals accepted and welcomed the KaziAfya project. Schools particularly appreciated the physical education training, food preparer training, as well as the provision of physical education coaches. The teachers saw the physical education coaches as good role models for the teachers. There was also overall support from parents, school governing body (SGB) members and the children who participated in the project activities.

As far as project sustainability is concerned, we believe that it will not be feasible for the schools to continue with the multi-micronutrient supplementation once external financial support for the project ends. This is due to the financial resources required to provide the supplement and we know the Department of Education does not have a budget for this. The only budget given to quintile 3 schools is for the National School Nutrition Programme that offers children one meal a day. To assist in the nutrition programme, school food preparers benefited from basic training in nutrition knowledge and food preparation, cooking and hygiene. Even though this training was beneficial, schools change food preparers after one year to give other parents an opportunity as a way of employment and poverty alleviation in the community. The change in food preparers does not allow for sustainability, however, there are possibilities for limited support and training for the SGB members, who have a long-term commitment at the school and can train in-coming food preparers.

In terms of preparing food for the children, we conducted an analysis of the portions and nutritional content of the food and we found that some of the schools do not use standardized recipes. After the analysis and training, we recommended the use of standardized recipes that will be beneficial in ensuring each child receives the correct portion size of each food group, as well as preventing waste or under-catering.

Regarding the implementation of physical education, having physical education coaches at the schools is not feasible due to financial reasons. However, there is potential for training parents and volunteers to assist with the physical education lessons. This was the only feasible idea that was discussed between the researchers and school stakeholders. According to the teachers and principals, the Department of Education provides little to no clear guidelines as to what they must do in terms of physical education. As such, the project was deemed as an attractive source of support and information in terms of meeting their Life Orientation responsibilities. In light of the ambiguity about what teachers are expected to do, the physical education training and provision of the KaziKidz toolkit was highly valued.

The ultimate goal is to have the schools take over responsibility for their students' physical education, nutrition, and health practices.

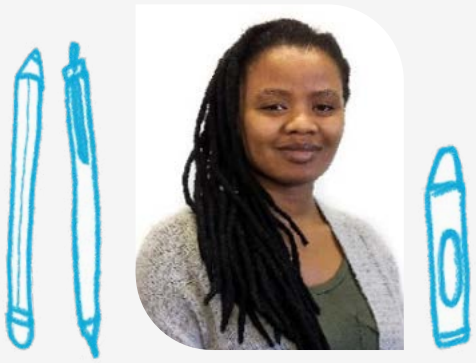
Distribution of multi-micronutrient supplementation tablets

Challenges

Working with schools in marginalised communities came with a number of challenges. Some of the main social and economic problems in these areas are unemployment, gangsterism, poor infrastructure, lack of parental involvement and overcrowded homes. These situations mean that the parents struggle to meet the basic needs of their children, and there are many 'absent parents', which means that many children are raised by their grandparents on social grants. In many cases, the biological parents are often deceased or not living with their children. Food is an issue for some children due to the high level of poverty, with some children going to school hungry and the one meal they get at school is sometimes the only meal they have in a day. As a result, at all the four schools, children are encouraged to bring a 'snack' box to school. The food preparers fill these boxes with leftover food for these children to take home after school. Sadly, the children attending these schools are faced with many challenges that are beyond their control. The principal at Greenville explained that there are nine-year olds who have to face "adult problems on a daily basis – they face the life problems of a 21-year-old".

There are nine-year olds who have to face "adult problems on a daily basis – they face the life problems of a 21-year-old".

Teachers at these schools face challenges such as high work workload due to overcrowded classrooms (up to 65 children per class) and a lack of resources (books, sports equipment, sports facilities). All these challenges lead to them not dedicating or having enough time to implement physical education lessons, despite it being part of the curriculum. According to the teachers, the Department of Education provides little to no training or clear guidelines as to what they must do in terms of physical education, which leads to it being marginalised. Initially, we faced a challenge of teachers not engaging in the physical education lessons during the intervention. Our goal was to have the physical education coach work closely with the teacher in implementing the lessons, but some teachers showed no interest or motivation in the lessons. Having the physical education training and the coaches was for capacity building and to ensure that teachers can continue implementing physical education after the project had stopped. With buy-in from a few enthusiastic teachers, we saw the importance of increasing pedagogical content knowledge, competence and value placed on physical education and the confidence to implement it. Hence, the KaziBantu team has developed short learning programmes (SLPs), including more involved workshops to help develop content knowledge in physical education teachers (www.kazibantu.org).



"KaziAfya is the first study of its kind involving schoolchildren from the Eastern Cape that combined physical activity and multi-micronutrient intervention. It provides important insight into the dual disease burden of both communicable and non-communicable diseases in schoolchildren from marginalised communities in Gqeberha."

Dr. Siphesihle Nqweniso
South African project coordinator

Micronutrients prepared for schools

Moving to music lessons

Distribution of orange-flavoured chewable micronutrient tablets

Physical education running

During data assessment, we had challenges of lack of cooperation from some teachers and high absenteeism (especially in post-COVID-19 assessment). Some schools reported the project had interfered with the smooth running of the school in a minor way due to children leaving the classroom for testing. A major disturbance was caused by the researchers using the school staffroom for testing because of limited space in the school. At other schools, the project had not interfered with the smooth running of the school as all stakeholders drew up the schedule for activities and the schools had planned for the project to fit in with the school programme.

We experienced major challenges with the implementation of the second intervention during COVID-19. The second part of the intervention was launched in January 2020, however, it was abruptly halted in March as a result of COVID-19 pandemic regulations, which resulted in nationwide school closure. Although schools re-opened in August 2020, children were only attending school on a rotational basis (allowing 50% capacity at the school and in each class) and no physical education or sport was allowed. Luckily, the provision of the supplementation continued, allowing children to receive their tablets 2-3 days a week (instead of 5). This delay in project activities due to the national lockdown also resulted in the third and final data assessment, planned for 2020, to be postponed until August 2021. Overall, the first-intervention year was implemented as planned, while the second-intervention year only included the micronutrient supplement intervention but not the physical education intervention.

Opportunities

Through the KaziAfya project, school staff and parents were able to better understand the health status of their children and identify barriers to their learning. One principal noted that the project had influenced the mentality of the children and the school in a very positive way. He had observed that the teachers had changed their views from just giving the children academic assignments to viewing them

The KaziAfya project helped the school staff and parents know the state of their children's health and helped identify barriers to learning.

"The fact that nutrition was included in the KaziAfya study made this a particularly valuable study as nutrition information in this specific group is scarce and interventions were not implemented before. Value is added by the interdisciplinary approach as all aspects seen together give more insight and understanding of the problems that these children and teachers face."

Prof. Dr. Annelie Gresse
Coordinator for nutrition intervention programmes

"in their totality". The principal from the school that had the highest prevalence of worm infections said the project was an "eye-opener" to her due to what the results exposed in terms of learners' health. She also mentioned the deworming of children, which she saw as a matter of major concern in her school.

After the project had ended, one principal saw an opportunity to propose a policy document for intervening in Life Skills and bringing in physical education to structure Life Orientation and Life Skills in the school. He complained that the core subjects get attention, but not Life Orientation and Life Skills and he believed that there is so much trauma in the community that Life Skills are critical as the socio-economic challenges in the area result in child neglect. In line with developing a school policy about structuring Life Orientation and Life Skills, some schools have planned to attract volunteers that can assist in physical education lessons and sport. These volunteers would include past learners from the school, unemployed youth in the community and interested parents, but these volunteers would need training. One principal noted that "in time, they would become mentors for others."

We believe that the physical education SLPs as well as the freely available KaziKidz toolkit can be used to train these school volunteers. After completing the SLP, participants get a certificate, and it was mentioned that providing a certificate for trained teachers and volunteers would be a good incentive. At least two of the school principals are looking for sponsors to provide a physical education teacher (SGB post) and additional sports equipment to accommodate the large classroom sizes.

Effects on physical activity, fitness, body composition, and nutrients

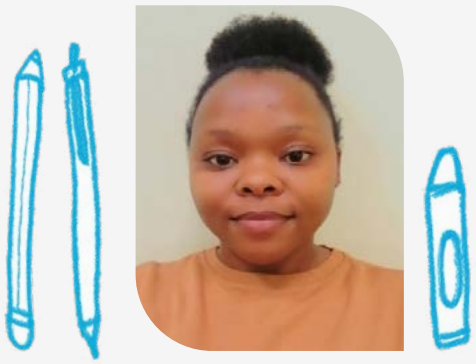
With regard to the effects of the intervention, the results seem more complicated than expected. For instance, whereas the findings of our study showed no direct impact of the intervention arms on MVPA, the PA+MMNS arm was effective in reducing HbA1c, while the MMNS arm significantly increased

cardiorespiratory fitness and reduced systolic and diastolic blood pressure. Additionally, the PA+MMNS arm was associated with increased percentage body fat and decreased HDL, while the PA+Placebo was associated with increased LDL and the MMNS arm resulted in increased triglycerides (Nqweniso et al., submitted). Moreover, among girls, promotion of physical activity was associated with reduced overall fat mass and truncal fat mass at T2, whereas MMNS was associated with increased fat-free mass. Children with reduced height velocity in the PA arm had reduced fat mass, while children in the MMNS arm with lower height velocity had increased fat mass compared to children in the control arm. Similarly, children with lower height velocity in the MMNS and PA groups had reduced truncal fat mass compared to children in the control arm (Long et al., 2022). Moreover, the trajectory for fat-free mass was found to be positive among children in the MMNS arm in the first period of the study, whereas the PA+MMNS arms both had positive indirect effects on the fat-free mass trajectory for the first period of the study and even greater positive effects for the second period when mediated by zinc. PA + MMNS, in contrast, had an inverse indirect effect through serum transferrin receptor for the first period. Promotion of PA was associated with a reduced fat mass trajectory in the first period, but was associated with an increased trajectory for the second period after the onset of the COVID-19 pandemic. The physical activity arm was inversely associated with the fat mass trajectory for the first period of the study when mediated by zinc.

In summary, these findings suggest that the promotion of PA+MMNS in school-based interventions may be an effective strategy in reducing childhood overweight and obesity and increasing fat-free mass in LMICs partly through the effects on micronutrient status (Long et al., in preparation).

Areas in which further action is needed, claims to political stakeholders

From the researchers and stakeholders, there is a shared belief that there is a need for the ongoing training of teachers, as well as training for new teachers and those who did not participate in the project in 2019. Some SGB members indicated that they would be prepared to help as volunteers.



"The conclusions and recommendations made from the project will fuel future research and projects to engage similar communities. The project is eye-opening to governing bodies to show what more needs to be done for these communities. The best part is the knowledge and encouragement that was instilled in the participants, including the teachers and parents. It is with great hope that even though the project is concluded, these communities, especially the schools, will use the small blocks of information to make a change in the lives of the children."

Ms Sesethu Ncanywa
Research assistant

The KaziKidz SLP can assist in training and developing skills in physical education teachers, which will ensure sustainability in the implementation of physical education in these schools and communities. There was also a clear need for annual training of the food preparers who are replaced each year on completion of their one-year contract from the Department of Education. The most urgent areas of training required for the food preparers is the issue of nutrients and prescribed daily amounts. In order to make this possible, the Department of Human Nutrition and Dietetics at Nelson Mandela University is developing training manuals and menus that can be used to train school food preparers and these resources will be made available for all schools. The training will also benefit the school staff members in charge of ordering the food, they will gain nutritional knowledge to make economical and appropriate food choices. The goal is to help schools position themselves to take responsibility for the physical education and nutrition aspects of the project.

A representative from the Department of Education felt that the project has contributed noticeably to the overall aims of the Department of Education, adding that "as an Employee Health and Wellness Coordinator it assisted me on addressing some of my key areas in my role. In community/public health, the KaziAfya project's findings will inform policymakers for the Eastern Cape Department of Education and Health about potential recommendations to enhance children's' health status. These insights will guide the development of targeted interventions, programmes, and policies for improving community well-being." In addition to using the findings to alert policy makers, the recommendations, if implemented, could improve not only the involved participants' short- and long-term health status, but also that of other communities in similar circumstances with direct positive spinoff for the country's economy.

The long-term impact of the project is to encourage schools and the Department of Education to adopt strategies similar to those used in the KaziAfya project in order to promote physical activity levels and literacy among primary schoolchildren.

The goal is to help schools position themselves to take responsibility for the physical education and nutrition aspects of the project.

Concluding remarks and acknowledgments

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The KaziAfya project was the first study of its kind involving children from the Eastern Cape, involving two marginalised communities in Gqeberha, the Township and Northern areas. The project was well received by the children, and it ran as expected in terms of the physical activity intervention, provision of micronutrients and assessment until interrupted by the COVID-19 pandemic. It further contributed to the awareness of physical education and its benefits, not just to school teachers, but also to all stakeholders. Teachers believed that children take what they learned to their parents and that it 'rubs off' at home.

In conclusion, the KaziAfya research project significantly contributed to understanding health issues among schoolchildren in low- and middle-income countries. By investigating the effectiveness of school-based interventions and exploring the associations between different health parameters, the project informs evidence-based strategies to promote children's health and well-being. Ultimately, this research has the potential to alleviate the burden of infectious and non-communicable diseases within these communities.

We would like to extend a warm thanks to Mr Gorgonzola, the Director of the Eastern Cape District Department of Education for granting us access to the four primary schools. The four school principals, Mr Memese (Isaac Booi primary), Dr Hendricks (Alpha primary), Mr Josephs (Greenville primary) and Mr Koliti (David Vuku) for allowing us to conduct our research at their schools. The school teachers and SGB members for working closely with the researchers in ensuring the smooth running of data collection and delivery of the study intervention. Most importantly, to the parents and children for granting us consent and assent to conduct the study for the duration of three years.

Additionally, for the support, a heartfelt thank you goes to the Biokinetics and Sport Science Unit that provided Biokineticists who assisted in all the clinical assessments. To the Human Nutrition and Dietetics department for providing Dietitians who assisted with the nutrition data collection and analysis and the Medical Laboratory Sciences for their big role in the preparation and analysis of the parasitological data. Furthermore, huge thanks also go to the many undergraduate student research assistants from Human Movement Science, Nursing, Sport Management, Psychology and Faculty of Education. These research assistants played a vital role in data collection and capturing, which ensured the smooth running of all three testing time points.

Publications, theses and presentations

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Publications in peer-reviewed journals

Nqweniso, S., Walter, C., du Randt, R., Adams, L., Beckmann, J., Coulibaly, J.T., Degen, J., Dolley, D., Gall, S., Joubert, N., Long, K.Z., Müller, I., Nienaber, N., Pühse, P., Seelig, H., Steinmann, P., Utzinger, J., Gerber, M., & Lang, C. (2023). Associations between soil-transmitted helminth infections and physical activity, physical fitness, and cardiovascular disease risk in primary schoolchildren from Gqeberha, South Africa. *PLOS Neglected Tropical Diseases*, 17(10): e0011664. https://doi.org/10.1371/journal.pntd.0011664

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PhD theses

Dr. Siphesihle Nqweniso: Physical activity, fitness and health of schoolchildren from marginalized communities in Gqeberha: Impact of a school-based intervention, status: completed (graduation date: 21 April 2023)

Ms. Johanna Beckmann: Risk factors and the potential of a school health program that targets executive function and academic achievement among South African school-aged children, status: ongoing (graduation date: planned for 2025)

Ms. Madeleine Nienaber: A toolkit to determine household food security, dietary diversity of children in low-income households in a selected area of Nelson Mandela Bay, Eastern Cape, status: ongoing (graduation date: planned for 2025)

Presentations and posters at national and international conferences

Long, K., Beckmann, J., Lang, C., Müller I., Nqweniso, S., Probst-Hensch, N., Pühse, U., Seelig, H., Steinmann, P., Utzinger, J., Walter, C., & Gerber M. (2022). Symposium: International participatory and data-based approaches to empower children, adolescent, and adult health behaviour change. 13th Annual Conference of the Swiss Association of Sport Sciences (SGS), University of Lausanne, Lausanne, Switzerland, February 10th 2022. Presenting author (talk): BECKMANN & LONG.

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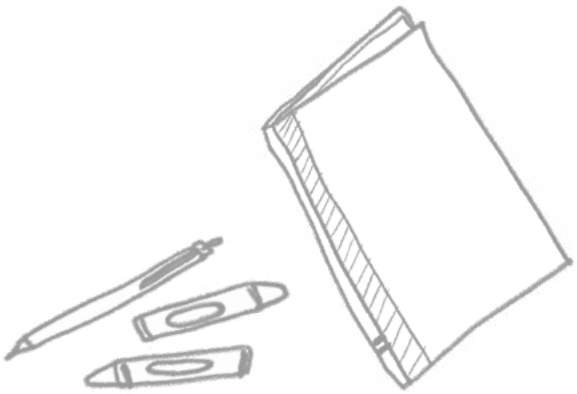
▲ BRICCSESS conference, Cape Town, 2019



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