

Adolescent health in rural South Africa: building an evidence-base to inform a health promotion intervention supporting healthier lifestyles

By

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Declaration

I, **Tshegofatso M Seabi**, declare this thesis is my original, unaided work. It is being submitted for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg, South Africa. It has not been submitted previously for any degree or examination at any university or institution.

Signed  on the **17 May 2017**

Dedication

This PhD is dedicated to all the adolescents and their parents/caregivers who made it possible to conduct the research. To adolescents who allowed us to get their insights on health in the context. To community leaders and school principals and teachers who dedicate themselves to helping the adolescents in the community and allowing us space to use their facilities.

To the adolescents, thank you for inspiring me through the process and I hope that you will continue to be imaginative and positively defiant enough to accomplish the seemingly impossible. To the field team, thank you for the great insights and reality check of working with adolescents through the successes and challenges in the context.

To adolescents, you have reminded me of the importance of understanding context and it has been a privilege to learn from you. I want you to know that I hear you, I see you and hope that what I have learnt improves health promotion interventions within the rural context and contributes to continued efforts to improve health in the life cycle.

Abstract

Background

Low- and middle-income countries (LMICs), including South Africa, face the persisting double burden of malnutrition, with undernutrition and overnutrition coexisting within the population. This issue is particularly pronounced among rural adolescents, who experience limited access to healthcare services, inadequate infrastructure, poverty, and a scarcity of nutritious foods. Addressing this double burden of malnutrition is essential for improving the health outcomes of rural adolescents and breaking the intergenerational cycle of malnutrition. Community health worker-led interventions have shown promise in promoting healthier lifestyles in this population, making it crucial to understand the feasibility and acceptability of such interventions.

Aim

This thesis aims to provide context-specific information on the changing distribution of Body Mass Index (BMI) and views on obesity among rural South African adolescents to inform the development of a targeted behaviour change intervention. Furthermore, it seeks to determine the feasibility, acceptability, and overall experience of implementing a complex intervention aimed at promoting healthier lifestyles in this population.

Methods

Using a mixed methods approach focusing on adolescents 12-20 years of age living in rural South Africa. This work is nested within the MRC/Wits rural public health and health transitions research unit (Agincourt) Health and Demographic Surveillance System, which is where the sample was drawn and provided explanatory variables such as SES. This work includes data from two studies with comparable measures, conducted in 2007 (n= 1309) and in 2018 (n=518), this study analysed comprehensive data on the prevalence and trends of BMI, including both undernutrition and overweight/obesity, among rural adolescents in 2007 and 2018. This was done through weight and height measures. Growth z-scores were used to determine stunting, underweight and overweight and overweight/obesity was generated using the 2007 WHO growth standards for adolescents aged up to 17 years and adult cut-offs of BMI of ≤ 18.5 for underweight and ≥ 30 kg/m² for overweight and obese respectively for adolescents 18 to 20 years. Qualitative data was collected in the form of focus group

discussions and in-depth interviews. Pre-intervention, three focus group discussions were held with male (n = 16) and female adolescents (n = 15) focusing on obesity to capture views, attitudes and perceptions surrounding obesity. Post-interventions, six focus group discussions were held with male and female adolescents. In-depth interviews were conducted with adolescents (n=20), parents (n=5) and CHWs (n=3), focusing on the feasibility and acceptability of the health promotion intervention. All qualitative data were analysed using inductive thematic analysis.

Results

This study found that there is a persistent double burden of malnutrition amongst rural adolescents. The pattern of underweight and overweight/obesity remains similar between 2007 and 2018, with an increase in overweight and obesity, and a decrease in underweight observed across different age and gender groups throughout this period. The prevalence of stunting and underweight, particularly in males in both 2007 and 2018 was substantial although lower in the later year. Adolescents expressed conflicting views of obesity, highlighting their knowledge of the cause and long-term consequences of obesity. In regard to the intervention, participants expressed support for the CHWs and the community-based intervention guided by them. The findings demonstrated the feasibility of providing the intervention to adolescents in a rural context, with modifications needed to ensure participant uptake, such as changes to the time and location. Responses from participants show how the intervention, which included dietary and quantity modifications, was acceptable to adolescents. The gathered information in this study serves as a foundation for developing a health promotion intervention tailored to the specific needs and circumstances of rural adolescents, considering both undernutrition and overweight and obesity.

Conclusion

This research provides valuable context-specific insights into the burden of malnutrition and perceptions of obesity among rural South African adolescents, considering the complexities of the double burden of malnutrition. The findings contribute to the development of tailored health promotion interventions that address both undernutrition and overweight/obesity in this population. Understanding the feasibility and acceptability of such interventions is vital for successful implementation and sustainability in rural communities.

Keywords: Nutrition transition, double burden of malnutrition, stunting, underweight, overweight, obesity, community health workers, health promotion, rural, South Africa, low-to-middle income countries.

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I want to express my sincere gratitude to the young people who participated in the study, the Mpumalanga Health District for allowing me to carry it out, and my supervisors, without whom my PhD would not have been possible.

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Overall, I want to thank the study participants. Without the study participants who were willing to share their time and experiences, none of this would have been possible. This type of study would be impossible without adolescents who are willing to let an outsider explore the promotion of healthy lifestyles through their views. The study participants' kindness, willingness and engagement have been the highlight of the PhD. May their views and experiences which are contributions to the body of knowledge, be honoured through this work.

I owe it all to you! Ndza khensa! Ke a leboga!

Thesis materials

Original publications

1. Tshegofatso M. Seabi, Ryan G. Wagner, Shane A. Norris, Stephen M. Tollman, Rhian Twine, David B. Dunger & Kathleen Kahn (2021) Adolescents' understanding of obesity: a qualitative study from rural South Africa, *Global Health Action*, 14:1, DOI: 10.1080/16549716.2021.1968598.

Student's contributions to the publication

Student managed data collection in the field, was responsible for the literature search, conceptualised the paper, conducted the data analysis, and drafted and revised the manuscript.

2. Tshegofatso M. Seabi, Ryan G. Wagner, Shane A. Norris, Stephen M. Tollman, & Kathleen Kahn. Trends in body mass index, blood pressure and associated determinants among rural adolescents, 2007 to 2018. *BMC Public Health* (under review)

Student's contributions to the publication

The student conceptualised the paper, undertook the literature survey, analysed the data, and wrote and revised the manuscript.

3. Tshegofatso M. Seabi, Ryan G. Wagner, Shane A. Norris, Stephen M. Tollman, Kathleen Kahn & Carolyn Audet. Assessing the feasibility of a community health worker-led, community-based health promotion intervention for rural South African adolescents (under review)

Student's contributions to the publication

The student's contributions included conceptualisation, literature survey and management of the data, coding the data, and drafting and wrote the manuscript.

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Presentation and awards/recognition

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Acronyms

AFHS	Adolescent-friendly health services
BMI	Body Mass Index
DBM	Double burden of Malnutrition
NAFCI	National Adolescent-Friendly Clinic Initiative
YFS	Youth Friendly Services
CHWs	Community health workers
DoH	Department of Health
PHC	Primary health care
HIV	Human immunodeficiency virus
AIDS	Acquired immunodeficiency syndrome
LMICs	Low- and middle-income countries
SSA	Sub-Saharan Africa
WHO	World Health Organization
NCDs	Noncommunicable diseases
SA	South Africa
CVD	Cardiovascular diseases
MDGs	Millennium development goals
SANHE-S	South African National Health and Nutrition Examination Survey
UN	United Nations
SDGs	Sustainable development goals
WAZ	Weight-for-age
BMIZ	BMI-for-age
WHZ	Weight-for-height
HAZ	Height-for-age z-score
SD	Standard deviation
SES	Socioeconomic status
NGOs	Non-governmental organizations
HDSS	Health and socio-Demographic Surveillance System

Preface

*“Africa is facing a growing problem of obesity and overweight, and the trends are rising. This is a ticking time bomb. If unchecked, millions of people, including children, risk living shorter lives under the burden of poor health,” said **Dr Matshidiso Moeti, WHO Regional Director for Africa**. “But we can resolve the crisis because many of the causes of obesity and overweight are preventable and reversible.”*

“NCDs are driven primarily by behaviours that often start during childhood and adolescence including physical inactivity, unhealthy diet, tobacco use and harmful use of alcohol, they have the potential to impact child and adolescent health and bring about negative health outcomes in adulthood” UNICEF Data: Monitoring the situation of children and women_ noncommunicable diseases April 2021

When I first thought of doing a PhD, I was working on a project called ‘blood sugars’ which focused on the facilitators and barriers to care for diabetic patients from the perspective of the patients, families and healthcare professionals. The study was based in an urban area out of a tertiary hospital’s endocrinology department. The study began with an ethnographic view of the interactions between the patients and health professionals. Then moved to interviews on diabetes touching on knowledge, diet, treatment barriers and facilitators. What stood out from those interviews and focus groups was the difficulty in changing diets and adopting a healthier lifestyle in order to control their diabetes. Most older patients (who are mostly diagnosed with type 2) mentioned jobs, lack of time and finances as well as the difficulty in changing long-standing diets from childhood. The adolescents and young adults mentioned the difficulty in fitting in with friends and having no decision-making power on food choices from home. Both patients, families and healthcare professionals acknowledged the limited psychosocial support offered to patients and families after diagnosis, only management bimonthly or more. The healthcare professionals emphasized the need to intervene before being diagnosed as that’s only too late, often intervention must start from the younger years, which they did not have the resources to do.

In attending a group session with adolescent diabetic patients, I was made aware of all the unique challenges that adolescents felt they had to deal with differently from older people. Some of them were around diet, alcohol, and physical activity. While they knew they needed to live a healthy lifestyle, it was difficult because of social changes happening and not being decision-makers in the household. Both male and female adolescents worried about the long-term effects of unmanaged diabetes such as erectile dysfunction from the males and pregnancy complications for females. They admittedly with the long-term worries also

emphasised the difficulty in living a healthy lifestyle. They mentioned the lack of awareness of diabetes which for some in the group led to making decisions that were not good and no support. The story that one adolescent told was that he went to a dance club, while he didn't intend to drink alcohol that night, friends encouraged him to drink and ate food sold at the place. He then needed to use his insulin injection, he was seen and mistakenly thought he was injecting drugs as such was assaulted and removed. He ended up in the hospital, and with this horrific experience, the adolescent mentioned he still frequently goes dancing clubs as that's how he specialises with friends but without his insulin.

While the participants in my previous work already were diabetic, the findings got me interested not only in prevention interventions but also interventions with adolescents. When I met with Ryan and Kathy, to discuss my PhD I was introduced to the Ntshembo project. When I began to review literature guided by my supervisors, it dawned on me that the problem of obesity intervention amongst adolescents is complex and involves the double burden of malnutrition. First I was surprised at the rate of documented undernutrition that had persisted in South Africa and the rising rates of overweight and obesity among adolescents. Surprised at how little is known about community-based interventions in a rural setting. I needed to understand what is currently happening with the double burden of malnutrition and how it has changed over time in order to better understand aspects of the intervention. The literature showed the implications of the double burden of malnutrition on individuals in later life highlighting NCD risk and even intergenerational transfer of risk to offspring.

This encounter with literature, coupled with constant guidance from my supervisors and broader scientific leadership, broadened my mind with regard to what I was going to explore in my PhD. I wondered, "How would the double burden of malnutrition have changed over the years and the determinants among adolescents in a rural setting, what are the views of obesity amongst adolescents and how feasible and acceptable is a community-based obesity prevention intervention? In conducting the study, I felt it important to be in the research area to further develop my understanding of the context and learn from the adolescents from being present.

This thesis presents a clear insight into a disturbing trend in rural South Africa of the persisting existence of the double burden of malnutrition. The presence of underweight, particularly male adolescents and rising overweight and obesity particularly female

adolescents. Presents views and understanding of obesity from rural adolescents and the feasibility and acceptability of community health worker-led interventions.

This thesis adopts a modern style of thesis writing; the “thesis with divided block”. Sections of the thesis are described in the thesis structure.

Structure of the thesis

This PhD thesis is presented with publications and contains three manuscripts

Following the abstract, acknowledgement and preface, the thesis is structured as follows:

Chapter 1: Introduction – includes the conceptual framework on which this thesis was based

Chapter 2: Literature review

Chapter 3: Methods – Provides information about the study site; a brief description of the data collection procedures; the survey instruments used, methods to ensure data quality and ethical approval and consent documents.

Chapter 4: Paper 1 – provides on trends of BMI and determinants by sex between 2007 and 2018

Chapter 5: Paper 2 – provides insights on adolescents views of obesity

Chapter 6: Paper 3 – provides results of the feasibility and acceptability of a CHW-led community based health promotion intervention

Chapter 7: Discussion – includes strengths and limitations

Chapter 8: Conclusions – includes future research

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Chapter 1: Introduction

Sub-Saharan Africa (SSA) has a growing population of adolescents [1] and will have the highest population growth and youngest population globally throughout the 21st century [1,2], together with the worst adolescent health profile [3]. Increased behavioural risks for non-communicable diseases (NCDs), such as heavy alcohol and tobacco use, low levels of physical activity [4], poor diet and increasing rates of overweight and obesity [5], are combined with persistently high maternal and infectious disease mortality (including HIV [6]). In South Africa, 33% of women over the age of 15 years have been found to be overweight or obese compared to 11% of males [7]. In studies from rural Mpumalanga, South Africa and other parts of sub-Saharan Africa (SSA) [8], undernutrition - especially stunting in the early years of life - and rising rates of overweight and obesity in adolescent girls and young women, have been described as a double burden of malnutrition [8]. The World Health Organization (WHO) has recommended more research on the frequency and levels of risk factors to health in LMICs, including South Africa.

As many risk factors for obesity are behaviourally acquired, obesity is a potentially preventable condition that nevertheless remains a major contributor to NCDs. In South Africa, obesity is ranked among the leading causes of premature death [7]. Obesity can lead to premature mortality through a number of pathways and is associated with increased risk for adverse events, including stroke [9,10] and myocardial infarctions [11]. Thus, early development of obesity increases risk of vascular events or developing diabetes [10]. There are other traditional NCD risk factors, such as hypertension and smoking, as well as emerging risk factors, such as one's inflammatory profile and ethnicity that also should be considered in a setting like South Africa [12]. For females, early development of obesity increases the possibility of intergenerational transfer of risk to their offspring [13]. Currently, 5% of deaths worldwide are estimated to be due to obesity. This has significant health and socio-economic consequences in South Africa and globally [11].

In light of the significant consequences of malnutrition, the United Nations (UN) and World Health Organization (WHO) encouraged national governments to collaborate with other sectors including civil society, academia, and the private sector [14] in an effort to mitigate the burden of malnutrition. Adolescence is a stage between childhood and adulthood that is marked by significant psychological, physical, environmental, and social changes [15,16]. Often defined as

those aged 10-19 years, adolescence is marked by increased susceptibility and exposure to unhealthy diets, which may play a significant role in the development of obesity and other chronic diseases later in life [15–18]. Addressing NCD risk in adolescence can prevent or delay their onset, reducing the burden of disease in later life. As adolescents transition from being under the care of their parents and teachers at home and school to being exposed to various sources of information, such as social media and television advertisements, targeted health promotion interventions become crucial in addressing non-communicable diseases. There are several interventions that have been proposed to address adolescent obesity. These interventions range from nutrition education, family and school-based interventions, as well as physical activity promotion all aiming to promote healthy eating habits, increase physical activity, and prevent or treat obesity-related health problems. A combination of approaches may be needed to address the complex causes of adolescent obesity and improve long-term health outcomes. One such way could be the use of community health workers to provide education, promote physical activity, monitor health, offer peer support, and engage the community. In this way, CHWs could contribute to the prevention and management of obesity among rural adolescents.

Understanding the burden of overweight and obesity, including trends in BMI over time, and appreciating the views of adolescents themselves are key to developing targeted and effective interventions. Presently, there is a paucity of this information from rural South Africa – something that this PhD aims to fill. Furthermore, this work goes on to undertake a health promotion intervention targeting behaviour change in adolescents. Understanding the perspectives of the adolescents, their family members and the individuals who deliver the intervention are essential to developing an approach that is feasible and acceptable [14–18].

Statement of the problem

There is a nutrition transition underway, accompanied by reported decreases in physical activity levels in low- and middle-income countries (LMICs), where there are also rapid economic transitions and urbanisation underway [17,18]. The nutrition transition is particularly evident in rural settings where traditional diets, mostly derived from plant-based food sources requiring high labour intensity to produce, are being replaced with less expensive, more easily accessible, high-energy-dense processed foods. This transition is, in part, fuelled by increasing access to disposable income and to shops selling high-density foods in many rural areas. These dietary changes, together with a more sedentary lifestyle, result in obesity-related problems and non-

communicable diseases (NCDs), despite undernutrition persisting in many of these countries [18–23]. The increasing sedentary lifestyles are due to increased time sitting in schools, increased screen time (on cellphones due to social media and television), and in some instances, lack of access to facilities and adolescent reported laziness for physical activity [16,24,25].

Obesity has been increasing in LMICs, and South Africa is no exception [26,27], becoming a major public health concern and contributing substantially to the burden of disease in these countries [17,22,28]. Research has shown that obesity developed during adolescence may persist to adulthood [29,30], resulting in longer-term consequences including heightened morbidity and premature mortality from cardiovascular diseases (CVD) and type II diabetes, as well as impaired social, educational and economic productivity [29,31,32]. Despite the rising levels of obesity in LMICs, undernutrition in children continues to be a great public health concern, particularly in sub-Saharan Africa [33]. Stunting is the most prevalent form of child undernutrition in these countries, with underweight following. Africa and Asia are the most affected and have a similar prevalence. Within Africa, the prevalence of underweight is higher in the sub-Saharan African region [34–37]. This leads to a phenomenon termed “the double burden of malnutrition”; that is, the co-occurrence of both undernutrition and obesity in the same population [18–23].

As mentioned, there have been rapid economic and social transitions with urbanisation in South Africa. There have been positive economic growth from 2007 to 2018 and as of current [38] as well as increased rural-urban migration [38,39]. In South Africa, there has been a reported marked shift towards an energy-dense diet as lifestyles, norms and food practices change with availability and access to foods, and economic means; studies in South Africa have reported decreased intake of staple foods including maize meal and increased intake of energy-dense foods including added fats and oils and animal-derived foods occurring alongside urbanisation [40–42] with rural areas rapidly following these dietary practices as access increases. High levels of physical inactivity and sedentary lifestyles together with the nutrition transition contribute to the increase in obesity [40,42]. As a consequence, South Africa has a high prevalence of overweight and obesity among adults, particularly women (55%) [43,44], and a high burden of diet-related non-communicable diseases [28,30,45]. While evidence of obesity among adolescents is emerging, in-depth insights on nutritional changes in this age group within the rural context are limited [34,46–49].

The World Health Organization (WHO) recognised the public health implications of the double burden of malnutrition and there are relevant millennium development goals (MDGs) and sustainable development goals (SDGs) focusing on zero hunger as well as health and wellbeing. To mitigate the growing epidemic of obesity, understanding adolescents' knowledge and views of obesity is needed to tailor interventions aimed at changing behaviour to reduce levels of obesity. Few studies from either rural or urban South Africa have explored adolescents' views and understanding of obesity. Previous studies have examined body image mainly amongst adolescent females [50–53]. They concluded that South African female adolescents struggle with body image and desire 'unhealthy', mostly bigger body shapes, with most participants having a distorted view of body image, that bigger means happy [54–56]. While these studies examined body image, they fell short of exploring reasons for adolescents' understanding of the causes of obesity and did not discuss possible interventions to change BMI levels.

While lifestyle risk factors are largely well known, there is presently not enough data to support context-specific interventions that could alter behaviours to promote health. This is one of the top priorities for SA's national youth and adolescent health policy [57]. Thus, in an effort to mitigate the growing levels of obesity and consequent NCDs, behaviour change interventions for adolescents are needed.

Justification for the study

LMICs face a double burden of malnutrition: the rising burden of overweight and obesity and the unfinished agenda of undernutrition as evidenced by persistent stunting. This problem among adolescents, particularly within a rural context, is not well understood [46,58]. Given that the pace and nature of transitions vary across geo-cultural settings, context-specific data are increasingly seen as essential in the development of local programming and policy. There is limited literature on trends in BMI and the double burden of malnutrition, particularly in rural areas in South Africa [34,35,59]. Of particular interest is context-specific evidence on the age and sex patterns of co-existing underweight and obesity and associated risk factors – recommended by WHO [60,61] – as such evidence can inform targeted adolescent health policies and interventions aimed at curbing the problem. In so-doing, an important pathway to later non-communicable conditions can be interrupted.

Recognising the extended health system as an important vehicle for potentially delivering an adolescent-focused health intervention, this study investigates ways in which primary health care services might effectively address particular health requirements of adolescents and prevent future negative outcomes [62]. Adolescent-targeted initiatives call for evidence-based policies and programmes to enhance adolescent health. The risks of developing future health problems can be reduced by promoting healthier behaviours in adolescents [63,64]. Studies like this, which focus on implementation, are crucial to informing policy and sustainable interventions. Engaging adolescents in programmes to reduce threats to their health and well-being may have far-reaching effects on their adult lives and potentially their offspring.

There is little evidence to-date of context-specific programmes that effectively influence health behaviours, particularly among adolescents, even with the current awareness of the various risk factors associated with lifestyle choices. The National Adolescent and Youth Health Policy for 2017 includes this as one of its goals [65,66]. To enhance adolescent and youth health, there are growing requests globally, including in South Africa, for the creation and implementation of age-appropriate programmes that address both access and quality issues [67,68]. The introduction of Community Health Workers has been envisioned to bridge the gap between the community (in this case adolescents) and the health services. This is important because CHWs, working closely with communities and building trust with adolescents and their families, can help create a more supportive and welcoming environment for adolescents seeking health services.

Investing in adolescent health and well-being now will have a number of positive effects that can improve long-term health for the current generation and future generations [68]. The introduction of CHWs can potentially bridge the gap between the community and health services and improve adolescent health outcomes by increasing access to context-specific, age-appropriate health education, promoting and improving healthier behaviours, and providing essential basic health services. This study contributes to the understanding of the burden of malnutrition and the views of adolescents on obesity, and makes the case for well-designed, context-specific interventions aimed at promoting healthy behaviours of adolescents in rural South Africa by looking at the feasibility and acceptability of an intervention. The study also highlights facilitators and barriers to an intervention from the perceptions and experiences of adolescents and health professionals, thus informing a potential intervention targeting health promotion amongst adolescents.

Research Questions

This thesis answers three questions:

1. How has the prevalence and determinants of overweight and obesity in rural adolescents changed over a ten-year period (2007-2018)?
2. How do rural adolescents view overweight and obesity?
3. What is the feasibility, acceptability, and experience of a complex intervention to promote healthier lifestyles in rural South African adolescents?

Aim and Objectives

Aim

The aim of this thesis is to provide context-specific information on the changing distribution of Body Mass Index (BMI) and views on obesity to inform a rural adolescent-focused health promotion intervention. It goes on to determine the feasibility, acceptability and experience of a complex intervention by Community Health Workers (CHWs) to promote healthier lifestyles in rural South African adolescents.

Objectives

The objectives of this research are sequential and four-fold. They are to:

1. Measure changes in BMI in 12–20-year-old rural South Africans over a 10-year period (2007–2018)
2. Evaluate the association of determinants with BMI changes in rural South African adolescents, 12-20 years (2007-2018)
3. Explore rural adolescents' aged 14-20 years understanding of obesity, its burden, and its consequences through focus group discussions (2018).
4. Assess the feasibility, acceptability, and experiences of delivering a community-based intervention by Community Health workers (CHWs) to promote healthier lifestyles in rural South African adolescents.

Conceptual framework

To prevent or promote certain behaviours, there needs to be an understanding of the factors influencing the behaviours [69]. Figure 1.0.1 provides a conceptual framework to describe the key elements affecting behaviour and considers the complex interplay between an individual, their social relationships, and their community and societal factors [70–72]. The conceptual framework has been adapted using the socio-ecological model to illustrate the guiding principles followed in this thesis (Figure 1.0.1). Firstly, it recognises the multiple influences on health behaviours and outcomes, including factors that operate at the individual, household and community levels. The model assumes that various factors at the different levels interact and have influences that impact the outcome, in this case, health behaviours [73,74]. It indicates that there is a requirement to focus on specific health behaviours and outcomes, identifying those factors most likely to influence the specific behaviour or outcome at each level of the framework. Lastly, the framework suggests that for interventions that address factors at an individual level, there are interactions of factors at multiple levels that affect each other and this behaviour. This interactions should be acknowledged and can potentially be harnessed to reinforce and strengthen the promotion – or prevention – of the intervention.

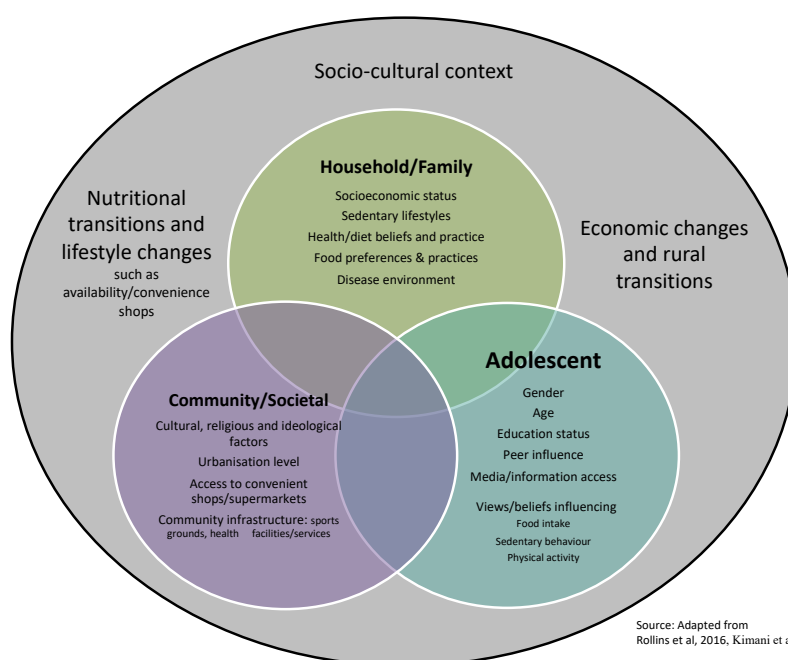


Figure 1.0.1: Conceptual framework adapted from the socio-ecological model

The intervention in this study sought to increase knowledge at the level of adolescents and their peers, thereby improving healthy lifestyle choices including better diet, increased physical activity and decreased sedentary behaviour, in order to decrease BMI (addressed in Chapter 6) (Figure 1.0.2). The framework articulates health as multi-factorial and recognises that health and illness are defined by a person interacting within an environment [75], making it necessary to understand the epidemiology (chapter 4) but also the individual's knowledge and attitudes toward the condition, including an understanding of their behaviour (chapter 5).

The model highlights the importance of the sociocultural context, which is the societal factors such economic changes and nutritional which contributes to the interplay at the different levels of the framework that affect the individual (adolescent)'s health behaviour [71,72]. The model highlights the intervention, the outputs and potential impact of the intervention. The advantages of this model are that it recognises the multifaceted nature of the relationships between person, household, and community [76]. The model illustrates how people understand their own health conditions. The framework reflects on the importance of the sociocultural context and interviewing people within their own cultural framework is more likely to be acceptable to them and allows for building rapport [74].

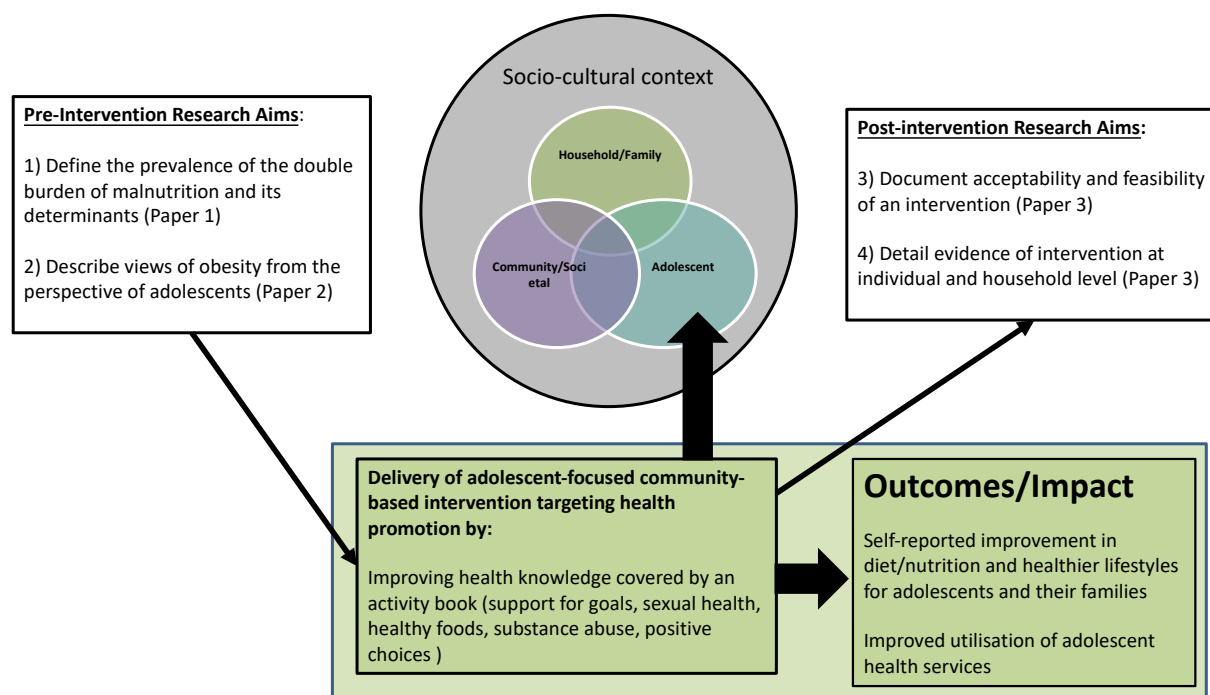


Figure 1.0.2: Showing the conceptual framework extended to include the intervention

In conclusion, adolescents are an important target group due to the large adolescent population globally of which a significant number are in Africa, and their transitioning developmental stage. There are established risk factors in adolescence that can have a long-term impact on health, and an opportunity for interventions, therefore, to promote healthier lifestyle behaviours into the future. Several interventions have been proposed to promote health, including healthy eating habits, increasing physical activity, and preventing or treating obesity-related health problems. To effectively address the complex causes of adolescent behaviour change and its implications for long-term health outcomes, a combination of approaches is often required for health promotion. The conceptual framework emphasizes the various levels of interaction that influence adolescents in determining their behaviour, underscoring the need for a comprehensive approach. Community-based programs can be effective in promoting healthy behaviours in among rural-dwelling adolescents. Community health workers can play a critical role in interventions in rural Africa by providing education, promoting physical activity, monitoring health, offering support. By engaging the community, CHWs can help link adolescents to health services. This is documented through the literature review in Chapter 2.

Chapter 2: Literature Review

Adolescence: an important stage of development

Adolescence is described as a vital stage of development between childhood and adulthood [6,77]. Originally defined as occurring from the age of 10 to 19 years [3], the 2016 Lancet Commission on adolescent health and wellbeing recommended extending the definition of adolescence to 24 years, based on recent research indicating that brain development continues until this age [78–80]. Globally [4] there has been a dramatic rise in the number of adolescents [81]. In 2019, almost one quarter of the world's population (over 1.2 billion individuals) was comprised of adolescents [82–84] with 90% of adolescents residing in LMICs [85]. It is estimated that the proportion of the world's adolescent population, particularly in Africa, will continue to rise - from 18% in 2012 to 28% in 2040; a trend not seen in other regions of the world [85].

During adolescence, individuals undergo brain changes resulting in the development of physical, cognitive, emotional, social and economic resources that form the basis for later life health and well-being practices. Furthermore, it is during this period of transition that individuals interaction with the social environment (referring to surroundings that adolescents experience within community) shapes their knowledge and abilities that are taken into adulthood [6]. It can also be a period when major negative health and health-related behaviours such as smoking and substance abuse, unsafe sexual practices, poor eating, and lack of exercise often emerge. These behaviours can substantially- and detrimentally- impact health outcomes in later life [74].

A snapshot of adolescent health

Adolescents face several potential health challenges related to changing behaviour and experimentation. The challenges can include sexually transmitted infections (including HIV), early pregnancy, poor mental health, substance use disorders and malnutrition. In LMICs, these challenges are often a result- or exacerbated by- a lower socio-economic status, violence, poorer infrastructure and access to resources. In rural South Africa, where high levels of teenage pregnancy and HIV infection have been documented [86], malnutrition has also been found to be a challenge [46]. Many male and female adolescents in rural South Africa enter adolescence undernourished, making them more vulnerable to disease and premature death [87]. Those at the

other end of the malnutrition spectrum, marked by overweight and obesity, are at increased cardiometabolic risk later in life [88]. This co-existence of undernutrition and overnutrition in the same population is known as the double burden of malnutrition. The phenomenon of the double burden of malnutrition, experienced in many low- and middle-income countries (LMICs) with diverse cultural and nutritional backgrounds, primarily arises from the ongoing nutrition transition fuelled by economic and social development. This economic and social development brings about significant changes in dietary patterns and lifestyles of some whilst other remain less developed, leading to the coexistence of under- and overnutrition within the same population [17,89–91]. The nutrition transition has been shown to be driven by several factors, including urbanization, and shifts in social and cultural norms marked by increased daily intake of starchy, carbohydrate-laden foods. As countries become more urbanized, people tend to have less access to traditional diets of whole foods including fruits, vegetables, whole grains, legumes, nuts, seeds, and unprocessed animal products historically grown or farmed in rural contexts which are nutrient-dense and provide a wide range of essential vitamins, minerals, and fibre. These foods are replaced with greater access to processed foods that are high in calories and low in nutrients [92,93]. This, coupled with the rise of supermarkets and fast-food chains, has led to an increase in the consumption of unhealthy foods and a decrease in the consumption of fruits, vegetables, and other nutrient-dense foods [94]. Evidence suggests that in nations with high rates of undernutrition, improvements in economic conditions likely results in increased incidences of non-communicable diseases linked to diet and obesity [17].

Dietary and nutritional changes are clearly evident in adolescents. The prevalence of overweight and obesity among 5-19 years old children and adolescents, has risen extensively from just 4% in 1975 to around 18% in 2016, equating to 340 million overweight and obese children and adolescents globally. The proportion of overweight and obese children and adolescents is estimated to reach over 25% by 2050. Likely contributing to the experienced and expected rise, research suggests that globally fewer than 25% of adolescents meet the recommended guidelines for physical activity [61]. The combination of poor diet and low physical activity in adolescence produces a high risk for cardiometabolic diseases later in life, with potentially negative intergenerational effects. There are other factors, such as views of obesity and defining that contribute to the prevalence. According to SANHE-S, the ideal body is ‘fat’ [95] for South Africans, particularly females, and this may also contribute to the rising prevalence

While the levels of overweight and obesity continue to rise, undernutrition amongst adolescents also remains. According to the South African National Health and Nutrition Examination Survey (SANHE-S), approximately 27% of children and adolescents < 15 years are stunted, with the greatest proportion found in those < 5 years), indicating substantial levels of chronic undernutrition [95]. One of the main drivers of this continued undernutrition in South Africa is poverty, which limits access to healthy food and safe water. Notably, South Africa is one of the most unequal societies globally [39]. Coupled with this gross inequality, weak public health systems and limited progress in improving water and sanitation contribute to this continuing prevalence of undernutrition [96].

The consequence of this observed double burden of malnutrition can be intergenerational. In much of sub-Saharan Africa, including South Africa, where females often give birth to their first child in their late teens, the skills and behaviours learned during adolescence can influence the health and behaviours of their offspring [97–99]. According to the World Health Organization, an estimated 21 million girls aged 15 to 19 years [29], and 2 million girls aged under 15 years become pregnant annually in LMICs [100]. Globally, around 16 million babies are born to adolescents between the ages of 15 and 19 years [101]. This trend has implications for the health of the adolescent mother as well as their offspring. Undernutrition in adolescent mothers can lead to low birth weight, premature birth, and other complications during pregnancy and delivery [32]. In addition, adolescent mothers who are undernourished are more likely to have stunted growth and impaired cognitive development, while obesity in adolescent mothers increases the risk of complications during pregnancy, such as gestational diabetes, and hypertension.

Considering the increasing levels of overweight and obesity, the persisting levels of undernutrition and the documented risks of these conditions to both mother, in terms of future risk of NCDs, and child, in terms of pregnancy and delivery related adverse events [102], decisions and behaviours that adolescents, and particularly female adolescents, develop during adolescence, become particularly important [6,99]. In many contexts, including South Africa, adolescents' situations are further complicated by a number of factors including lack of health education, restricted access to care, weak health systems, and the absence of autonomy or support in their social arrangements- with these factors often due to, or exacerbated by poverty. Understanding adolescent views and behaviour along with the changing burden of overweight

and obesity as well as undernutrition may assist in developing health promotion interventions targeted at this crucial period of development [78].

Malnutrition: Stunted and underweight

The World Health Organization (WHO) defines underweight as a body mass index (BMI) less than 18.5 for adolescents over the age of 18 years. For adolescents under 18 years, the WHO 2007 child growth standards were used to develop height-for-age (HAZ), weight-for-age (WAZ), BMI-for-age (BMIZ) and weight-for-height (WHZ) Z-scores [103,104]. On the other hand, stunting is defined as a height-for-age z-score (HAZ) of less than -2 for adolescents under 18 years [103–105]. WHO's classification of BMI categories range from moderate and severe underweight to obesity, defined based on global symmetric thresholds of standard deviations (SDs) from the reference population median [106].

The Epidemiology of Stunting and underweight

The percentage of underweight adolescents globally has decreased from 25% in 1990 to 15% in 2015 [107,108]. However, this drop was not witnessed equally across the globe, with South East Asia and sub-Saharan Africa experiencing less of a reduction in underweight and currently home to roughly 90% of all underweight adolescents [108,109]. Childhood undernutrition is the second most common kind of malnutrition, after micronutrient deficiencies in LMICs [110,111]. In sub-Saharan Africa, the prevalence of undernutrition is especially high among male adolescents. According to the Millennium Development Goals (MDG) report from 2015, in sub-Saharan Africa, 39% of children under five are stunted, ten percent are wasted, and 25% are underweight [87]. These findings imply that, notwithstanding the advancements made globally, the undernutrition problem in sub-Saharan Africa is still grave and far from being resolved [112]. The prevalence of undernutrition among adolescents in sub-Saharan Africa through this highlights the critical importance of focused work on undernutrition.

South Africa, the most affluent, multicultural, and ethnically diverse nation in southern Africa, continues to struggle with child and adolescent malnutrition [113,114]. Approximately 25% of children aged 1 to 9 years were stunted, with Mpumalanga province (where the current research is based) having the highest rate of stunting [112,115–119]. The most recent data from the South African National Health and Nutrition Survey (SANHANES-1) in 2013, revealed that over 15%

of South Africans aged 0 to 14 years were stunted, 5.8% were underweight, and 3.8% were severely stunted [43,46–50].

Determinants of stunting and underweight

The causes of child undernutrition have been described in various models [124–126]. In UNICEF's 1990 framework of the its causes [120], undernutrition is thought to occur as a result of a group of factors operating at several levels, including individual, family/household, and the wider societal/community level. These are spelt out in some detail in the following sections [12,48,55].

Individual level determinants of stunting and underweight

Individual-level determinants, such as sex and age, have been found to be inversely correlated in several studies conducted in LMICs. Various studies have examined the relationship between gender and nutritional outcomes, with mixed findings. Some studies have found that male children are more susceptible to undernutrition [121,122]; others, particularly those conducted in Asia, have found that females are more vulnerable [123]; and still, others have suggested that gender has no bearing on nutritional status [124]. In South Africa, studies have consistently highlighted the gender-specific nature of undernutrition, revealing that males are disproportionately affected, with higher levels of stunting and underweight, compared to females. Among the various forms of undernutrition, wasting and stunting have emerged as particularly prevalent among younger children [46,125,126]. Other individual-level determinants, such as insufficient dietary intake, are influenced by familial/household and societal-level variables.

Social, family and household level determinants of stunting and underweight

Household levels of food security, the formal education level of the household head and socioeconomic status and are among the determinants related to adolescent stunting and underweight. Children from food-insecure households exhibit poorer nutritional outcomes than children from food-secure households [123]. A child's nutritional status has been favourably correlated with the education level of the household head or the father, which may be related to socioeconomic status and food security [127]. This positive correlation is also seen with the mother's education level [121,128]. Socioeconomic position, knowledge of healthcare, and

current attitudes toward healthcare are some of the factors that link maternal education to nutritional status [129]. According to at least one study, children who live with their mothers have higher nutritional conditions than children who do not [130]. Additionally, several studies have found that children of working mothers have worse nutritional status, especially younger children [131,132], particularly if the mother works in the informal sector. On the other hand, a higher nutritional status have been linked to mother's employment in the formal sector and income [133,134]. It has also been shown that maternal health-seeking behaviour is favourably related to the nutritional results of their offspring [135]. Children of younger mothers, especially teenage mothers, are reportedly more likely to be underweight [136].

The relationship between nutritional health and household size [93,123,137] and the number of children in the household is unclear with some research suggesting a larger household size is related to undernutrition [133,138] with other research suggesting the opposite - that having a larger family protects against malnutrition [133]. The nutritional health of children is positively correlated with improved household water and sanitation [117,135,138]. Additionally, undernutrition is inversely correlated with household socioeconomic status [121,138].

Community & Societal determinants of stunting and underweight

At the community level, environmental factors such as the proportion of households with improved water and sanitation at a societal level, are positively associated with better nutritional outcomes [138], although some studies have found no association [121]. The presence of non-governmental organizations (NGOs) and governmental policy as well as health services in the area has also been positively linked to better nutritional outcomes in children [136,139].

Research has also shown that children in rural settings are more likely than those in urban areas to be undernourished [117,121]. Different studies confirm the influence of child, household and community-level factors on a child's nutritional status.

Consequences of stunting and underweight

Undernutrition is a serious risk factor for ill health [110,140–142]. It is one of the top ten most important risks to health [61,143] leading to increased mortality, contributing a significant portion of child deaths [140,144,145]. A study examining data from eight low-income countries (Ghana, Guinea Bissau, Senegal, the Philippines, Nepal, Pakistan, India, and Bangladesh) to determine disease risks associated with childhood undernutrition found that undernutrition was

associated with high risk of all-cause mortality as well as pneumonia, diarrhoea, malaria and measles specifically [110,142].

In addition to childhood and adolescent health, undernutrition can have longer-term impacts [145], including impaired mental and cognitive [144,146]. This is partly explained by the fact that undernutrition dulls motivation and curiosity, hence reducing play and involvement in exploratory activities [144] in children and adolescents. Underweight adolescents risk decreased physical and intellectual ability and thus lower productivity as adults. This has an impact on social and economic levels [147]. Additionally, underweight adolescents are also at greater risk for obesity in adulthood with concomitant increased risk of chronic diseases and disability [148] and subsequent increased healthcare costs. All these lead to lowered human capital and potentially lower socio-economic status [147,149].

Whilst the prevalence of undernutrition have come down globally, undernutrition - marked by stunting and underweight, persists in many LMICs. In these settings, with a documented nutrition transition underway, a new type of malnutrition is emerging; one marked by overweight and obesity.

Malnutrition: Overweight and Obesity

Overweight and obesity are determined by measuring one's body mass index (BMI), which is a ratio of weight divided by the square of their height. Using the WHO classification, a BMI between 25 and 30 is defined as being overweight and a BMI greater than or equal to 30 is considered obese [150]. For adolescents under the age of 18 years, the WHO uses BMI-for-age to assess for overweight and obesity, with overweight defined as greater than +1 standard deviation (SD) and obesity as greater than +2 SD [103–105].

The Epidemiology of Overweight and Obesity

Overweight and obesity in adolescents are a growing public health concern globally [150]. Figures from 2022 show the prevalence of overweight and obesity was 16.5% in adolescents, with this figure rising, especially amongst LMICs [151]. According to a comprehensive evaluation of surveys conducted between 1950 and 2007. The prevalence of

overweight among adolescents in South Africa was found to be around 22% in 2016, up from 11.0% in 2008 [30,152].

In South Africa, there is a concerning trend of increasing overweight and obesity rates, with notable gender disparities. Studies have consistently reported a higher prevalence of overweight and obesity among females compared to males, across all ages from adolescents to adulthood, with this disparity continuing to increase [36,37,95,125,151]. Furthermore, it is important to consider the differences between rural and urban settings in South Africa. With initially higher levels of overweight and obesity found in urban areas, recent studies have shown increasing overweight and obesity in rural areas; now matching levels seen in urban areas [152–154]. While both settings face the challenge of rising overweight and obesity rates, there are overlapping and differing factors at play in each context.

Determinants of obesity

Obesity is a complex, multifactorial and preventable condition which is likely to be caused by a combination of individual, social, community and societal level determinants, similar to that seen in undernutrition described above [155]. Differing from undernutrition, though, many of the determinants found to be associated with overweight and obesity arise from behaviour choices, influenced by individual and social factors and affected by attitudes. Understanding these determinants- at the individual, social, community and societal levels- and their interplay, may lead to the development of more informed interventions targeted at improving healthy behaviour and reducing obesity.

Individual determinants of Overweight and Obesity

At an individual level, sex, education, dietary factors, mental well-being and lack of physical activity have all been shown to influence obesity [156,157]. In several studies, including those from rural South Africa, adolescent females were found to have higher (in some studies, four times higher) levels of overweight/obesity than adolescent males [8]. Levels continue to rise in females approach late adolescence, with this gender disparity likely highlighting the complex interactions of social, cultural and biological factors [7]. This means that a person's health and well-being are influenced not only by their biological makeup but also by the social and cultural contexts in which they live. These factors can shape behaviours, attitudes, access to resources, and healthcare practices, ultimately impacting health outcomes.

One's level of education is also associated with BMI, although the relationship is not linear [158]. In previous studies, females with no education and females with tertiary education had lower BMI values while those with some education were found to have higher BMI values [27]. Education may be a proxy measure for socioeconomic status (SES), with SES discussed further in the next section. In such cases, females with no education may also be of lower SES, thereby limiting access to calorie-dense foods; whereas females with tertiary education may have a higher SES and greater access to healthier foods or be more knowledgeable of the importance of a healthy diet and exercise, thereby making healthier behaviour choices.

An individual's diet has been shown to be associated with overweight and obesity globally and in sub-Saharan Africa. The consumption of calorie-dense foods and low intake of fruits and vegetables have been related to obesity [27]. In South Africa, the total energy consumed from calorie-dense foods increased by more than half in five decades leading up to 2012, with the increase being attributed to greater availability, accessibility and consumption of 'luxury foods', marked by higher calories. These foods include meat, fried foods, soft drinks, butter, mayonnaise, sugar, bottled beer, tinned food and cheese [159]. The consumption of these calorie-rich foods, combined with decreased physical activity and sedentary lifestyles perhaps contribute the most to the rising levels of obesity seen in South Africa [160].

Decreased physical activity and sedentary behaviour have increased substantially worldwide and are in part due to increased access to television and computers, the so-called 'screen time', which have replaced more active leisure activities. This is especially true in settings where outdoor activities have become unsafe. This phenomenon is more prominent in, but not relegated to, urban areas (discussed further below). However, as new technologies penetrate rural sub-Saharan Africa, jobs will continue to become less physically demanding and leisure activities will become more sedentary [159,161], resulting in a further decline in physical activity.

Mental well-being has been found to be another important determinant of obesity, especially in adolescents. Global estimates suggest 10-20% of children and adolescents are affected by poor mental health, including depression, anxiety and substance use disorders [162]. The WHO defines mental health as a state of an individual's social, emotional, and psychological well-being [102–104]. Global studies looking at the effects of depression and anxiety on obesity in

adolescents found a bidirectional relationship: depression and anxiety were risk factors for obesity and obesity was a risk factor for depression and anxiety [163]. In South Africa, particularly rural South Africa, studies that look at the relationship between depression and anxiety and obesity are lacking [164].

Genetics also play a crucial role in how the body obtains, stores and expends energy, which has direct implications on overweight and obesity. Studies have identified genes that influence both behaviour and physiological processes including an uncontrollable urge to eat, an inclination for physical inactivity, an increased capacity to store fat, and a minimal ability to expend dietary fat [159]. The most quoted theories attribute the current worldwide surge of obesity in both children and adults to the interaction between a genetics and a permissive environment of readily available food and sedentary behaviours [156,161].

Social, family and household determinants of overweight and obesity

At the social level, studies from developed countries have shown an inverse relationship between SES and obesity; however, in South Africa and other sub-Saharan African countries, a positive relationship between obesity and socioeconomic status has been found [158,165,166].

Community and societal level determinants of overweight and obesity

Physical activity in adolescents has recently decreased for various reasons, with urban adolescents' levels declining more rapidly compared to rural adolescents. One suggested reason for this decline is the increasingly unsafe environments now seen in many South African communities. This prevents adolescents from walking or cycling to schools and requires them to now take communal taxis, which are currently the most used method of transportation to school [167].

In addition to community safety, community or societal views on weight can also be important contributors to the changes in BMI being witnessed. South Africa, where HIV levels remain high, [167–169] being overweight or obese is seen as a sign of good health, beauty and affluence [27]. This societal view is likely to impact adolescents' views of body weight and influence their preferences and what they choose to buy. Adolescents buy food from tuck shops and informal markets outside of schools [168]. What is sold in these places is often high in calories, sugar and preservatives. The ability to purchase these items is often seen as socially desirable and associated with higher SES.

Consequences of Overweight and Obesity

Overweight and obesity have significant consequences on individuals' health and well-being, as well as broader societal implications. Overweight and obesity are serious risk factors for ill health [110,140–142] and leads to significantly increased risk for a wide range of medical conditions [61,143]. Perhaps most pronounced is the increased risk of chronic diseases including cardiovascular disease, type 2 diabetes, hypertension, and certain types of cancers that are found to be significantly associated with increased BMI [169,170]. These conditions can have severe health consequences, affecting the quality of life and ultimately increased mortality [171,172].

The economic burden related to overweight and obesity is also substantial. This relates to healthcare costs for the individuals and increased burden to the health system. Additionally, productivity losses due to decreased work capacity and absenteeism can have an economic impact on families and communities. The health effects of obesity have been documented in several countries [173,174].

There is also intergenerational impacts, with obesity during pregnancy linked to increased risk of adverse birth outcomes, including large birth weight, gestational diabetes, pre-eclampsia and can predispose offspring to obesity and associated health problems later in life [116,175–177]. This perpetuates a cycle of overweight and obesity within families and communities [178,179].

With the persisting levels of stunting and underweight and rising levels of overweight and obesity and clear health, social and intergenerational impacts from this malnutrition developing an intervention that targets behaviour in adolescents, a crucial development period in one's life is both timely and necessary. The next section discusses work that has been previously undertaken and limitations experienced.

Developing an intervention to address the double burden of malnutrition

According to UNICEF's conceptual framework for child nutrition, the factors outlined above at the individual, social and community levels are associated with malnutrition [180]. The framework suggests that these levels are interconnected and have a combined effect on nutrition. Therefore, they recommend that interventions be targeted at several of these levels and the interactions between levels. The 2013 *Lancet Maternal and Child Nutrition series* recommended

that interventions should be context-specific and aim to improve health through health education, access to safe environments for physical activity, and access to health services in order to address these multiple levels [181]. By targeting individual behaviours, such as dietary choices, physical activity, and health-seeking behaviours, interventions can promote positive changes that contribute to improved nutrition outcomes. Social and community-level factors, such as social norms, cultural practices, and community support, also influence behaviour change and should be considered in intervention design. It is through recognizing the role of these various levels- and the importance of context, that a multi-level health promotion intervention targeting behaviour change should be developed.

Behaviour change in adolescents

The behaviour change approach promotes health through individual lifestyle changes that are appropriate to one's unique setting [182]. The assumption of the approach is that, before people can change their lifestyle, they must first understand basic facts about a particular health issue, adopt key attitudes, learn a set of skills and be given access to appropriate services [183]. The effectiveness of the behaviour change approach still remains unclear [182]. However, fundamentally it is believed that people do not resist change, but resist being changed. This suggests that an intervention for behaviour change in adolescents must be collaborative and empower the participant to change by providing them with the information necessary to change.

In applying the behaviour change approach to adolescents, the focus is no longer just on individuals' attitudes, behaviours and choices, but also on how different individual, social and societal aspects are likely to influence decisions. Thus, the focus is on how behaviours form, how they are reproduced, maintained, stabilized, challenged and ultimately rejected or firmly accepted [183]. In making recommendations for behaviour-changing interventions for obesity, targeting interventions at adolescents may contribute to the adaptation of healthy behaviour lifestyles from a young age which can then be taken into adulthood. There is limited research on adolescent behaviour change interventions in the rural context related to obesity or diet-related interventions; a paucity that this current research seeks to fill [184]. Using the behaviour-change approach recognizes that behaviour-change interventions are likely to be most successful when they are multifactorial and context-specific [185].

Evidence from Previous Interventions

In the South African context, adolescent behaviour change interventions have largely focused on behaviours focused on reducing the risk of acquiring HIV/AIDS. These interventions have taken various forms, including Lovelife, which promoted healthy sexual behaviour and HIV/AIDS awareness through diverse activities such as sports games and peer educators in communities and schools [186,187]. Research found that Lovelife improved levels of HIV testing, and interpersonal communication about HIV and decreased HIV infection rates among South African adolescents [186]. Other interventions that facilitated environments of learning in a peer group manner, were also found to be effective, though challenges and barriers, such as sustainability of the programs, were also noted [186–188].

Behaviour change interventions targeted at promoting healthy lifestyles through physical activity in different communities have also been undertaken. One particular study undertaken in Cape Town called ‘Healthkick’, provides an example of an intervention that seeks to promote healthy eating habits and increase physical activity to reduce and/or prevent obesity and thus risk for chronic diseases [189]. Research showed that interventions like this one could provide value in achieving positive outcomes and should include parents/caregivers and schools [189,190]. This includes creating an enabling environment for interventions, including nutrition-specific interventions, that specifically address the immediate causes of child undernutrition, such as factors relating to inadequate dietary intake and poor health status [59,191].

Looking further afield, an intervention undertaken in a rural part of the United States of America attempted to evaluate BMI changes achieved when adolescents, aged 10 to 16, participated in a structured physical activity regimen with dietary education classes that involved adolescents and parents preparing meals. Findings from this research highlight the need for information regarding appropriate physical activity and diet practices. Participants expressed a desire to learn about the correct and incorrect approaches to engaging in physical activity and maintaining a healthy diet. The evaluation of the intervention showed some success as well as highlighted areas needing more understanding. The researchers concluded that overall, obesity management programs for adolescents in rural primary care clinics need to be tailored to specific populations in order to provide the maximum benefit to the individuals, families, and their communities [192].

An intervention undertaken in Switzerland with children and adolescents involving multidisciplinary group therapies were family based and showed significant changes in children and adolescents' BMIs towards healthier weights [193]. The intervention involved training adolescents and their caregivers on obesity care, food portions and exercise, Information sessions were facilitated by a paediatrician and sessions with a nurse on behavioural change techniques were conducted over multiple visits. This intervention highlights the importance of several 'contact points' where information and understanding can be reviewed and key messages can be reinforced.

Even with positive experiences being reported by participants in health promotion and behaviour change interventions, very few studies have documented long-term behaviour change [187]. This is likely due to the multiple, complex factors, including the role of SES in sustaining the intervention. Furthermore, it may be that the environment is not conducive for the continuation of the intervention and the intervention lacks the context-specificity, they may not always be context specific to the needs of the community that they serve.

Beyond just providing information to inform health behaviour change, studies have looked at empowering and providing motivation to individuals working towards solutions for health issues through dialogue [194,195]. Work in Southampton with patients and clients of health and social care services has introduced healthy conversation skills to assist with facilitating communication. The approach is promising in its ability to produce sustained changes in the way health and social care staff support behaviour change, and its impact on the lifestyles of different population groups is being tested [196]. This is through empowering participants to understand their health and providing consistent support through interactive engagement on health [197,198]

In conclusion, behaviour change interventions in adolescents that are multifactorial in their approach (involving the individual, their family, community and policy) have been reported to produce better results for behaviour change, but have largely not been found to be sustainable [199–204]. Interventions providing information as well as fostering dialogue may be more likely to achieve sustainability. The final section of this chapter focuses on a cadre of health worker who may be able to deliver adolescent-focused behaviour changes interventions that both provide information and allow for a continued dialogue.

Community health workers

Community health workers (CHWs) are lay personnel employed to serve as a link between professional healthcare staff and the community. They are trained to deliver an intervention and have no formal professional or paraprofessional certification or degree [205]. CHWs are often members of the communities where they work, should be selected by the community, should be answerable to the community for their activities, should be supported by the health system but not necessarily a part of its organisation, and have shorter training than professional workers [206,207]. CHWs, when used effectively, can make major improvements in health priorities in the areas where they work. In areas experiencing shortages of doctors and nurses, including many LMICs, CHWs have been introduced to fill some of that shortage [150].

CHWs can be found in almost every primary healthcare system across the world and carry out a range of tasks including palliative care, counselling, health promotion, treatment support, and breastfeeding support [205,208]. In South Africa, CHWs have often been employed by non-government organisations (NGOs) to focus on specific diseases in rural communities, (mainly HIV and TB) and mostly working with women. CHWs have been found to reduce under-5 mortality, improve women's health, and assist in reducing the spread and management of HIV, malaria, and TB, as well as diabetes in different communities [209–212]. CHWs have also been used in cancer screening in some communities [212], in reducing undernutrition, and in increasing access to healthcare facilities by 79% in one study [78,205,206,208,210–215].

CHWs can act as an extension by delivering community health services, and some have argued that CHWs who specialise in adolescent health [69] may be able to increase health coverage of adolescents by specifically targeting households with adolescents, and complementing already available, primary health care services [78]. CHWs who focus on adolescent health are defined as 'specialist' CHWs, as they have acquired and deployed with a narrowly defined set of skills focused on a specific population group or disease [78]. CHWs working with adolescents could help to increase awareness of adolescent-friendly health services, focus on key messages to enhance behaviour change in adolescents, and develop a high level of expertise in adolescent health [214]. More evidence is required, however, to compare the effectiveness of generalist versus specialist CHWs [78].

As part of a policy effort to address adolescent health issues in South Africa, adolescent-friendly health services (AFHS) were introduced into the South African public sector health care system to address the unique health needs of adolescents [216]. While primary healthcare facilities were previously dedicated to youth-friendly areas, attendance by local adolescents at these facilities was lacking. When asked, adolescents responded that this was due to feeling the stigma of attending a clinic and the inability to discuss certain topics with staff (lack of dialogue, an important aspect of sustainability as noted above). Other barriers cited were lack of confidentiality, the stigma of HIV, the lack of professional neutrality, failure to understand adolescents, poor service delivery, long queues and administrative problems [217], suggesting that structural and systemic constraints prevented the successful provision and programming of AFHS, despite the country's extensive legal and policy framework and commitment to improving the health of young people [67,68]. Hence, whilst the commitment to adolescent health is present, the current use of the primary health care system by adolescents seems to be lacking. This may be overcome through the work of CHWs and may result in some integration with existing health services and improved health profiles of adolescents.

This chapter has provided a thorough discussion of the double burden of malnutrition, providing evidence of the persisting levels of undernutrition and the increasing levels of overweight and obesity. In presenting both the determinants and consequences – both proximal and distal- this chapter provides strong justification for the need to address this burden, something echoed by recently launched *Lancet* Commission on Adolescent Health and Well-being. While previous interventions have been attempted with mixed results, as noted in this chapter, these studies suggest that successful interventions must address the interplay between several levels of determinants and must be contextually relevant. Globally, there has been an increased focus on adolescent health in the post-2015 developmental agenda. While this PhD work does not address the policy aspects of adolescent health, it does provide insights into the continuing burden of malnutrition in rural South African adolescents. It goes further to understand adolescent's views on obesity, and examines the feasibility and acceptability of a community-based, adolescent behaviour change intervention, delivered by CHWs. In doing so, this work seeks to contribute to the continuing discussion of adolescent health and the development of feasible, effective and contextually appropriate interventions that will mitigate this growing burden of malnutrition at a critical period in one's life. The next chapter provides details on the Methods employed to address these important questions .

Chapter 3: Methodology

3.1. Introduction

To achieve the objectives outlined in Chapter 1, this PhD employed both qualitative and quantitative methods, with three data collection components listed in order below and represented in Figure 3.1.

- Quantitative data from surveys in 2007 and 2018 was used to document the changing trends in BMI of adolescents and associated determinants, and were used to achieve Objectives 1 and 2 of the thesis (Component 1). This is reflected in paper 1 (chapter 4) exploring trends of BMI from secondary data (2007) (n=1309) and data collected in 2018 (n=518) included in the study.
- Qualitative data from focus group discussions was used to explore rural adolescents' views and perceptions of overweight/ obesity, and were used to achieve Objective 3 (Component 2). This qualitative approach is reflected in Paper 2 (chapter 5), the participants were randomly selected from participants who participated in the survey data collection in 2018 and invited to participate in the focus group discussions (three focus groups, total n=31), this data feed into the approach of the intervention.
- Quantitative and Qualitative data – attendance and attrition data, focus group discussions and interviews respectively – were used to investigate the feasibility and acceptability of the pilot intervention, and to achieve Objective 4 (Component 3). This approach evaluating the intervention is reported in Paper 3 (chapter 6). Participants eligible to participants were those 14-20 years of age and were recruited and invited from the survey data collected in 2018 to participate in the intervention. Participants who participated in the focus group discussion and interviews were recruited from adolescents who participated in the intervention (6 focus groups, interviews *adolescents* (n=20), *caregivers* (n=5) and *CHWs* (n=3))

This illustrates how the quantitative data collected in 2018 flows in to the qualitative approach and intervention throughout the lifecycle of the study.

Figure 3.0.1 highlights the sequence of the components of the study. The intervention will be discussed in further detail below.

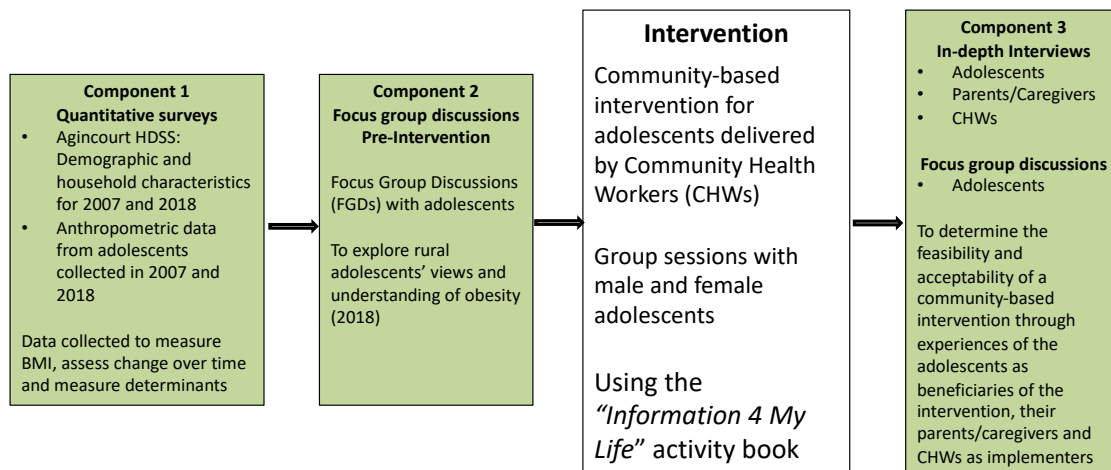


Figure 3.0.1: Data collection and intervention activities

The data collection components have been shaded in green.

3.2. Study Site Description - Agincourt

3.2.1. Study setting: MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt) study area

This research was nested within the MRC/Wits-Agincourt Research Unit, located in the Bushbuckridge sub-district, Ehlanzeni district of Mpumalanga Province, rural northeast South Africa, close to the southern Mozambique border. The Agincourt Health and socio-Demographic Surveillance System (HDSS) is run by the MRC/Wits-Agincourt Unit and spans 450 square kilometres [218]. Given its proximity to the Mozambican border, about one-third of the population is of Mozambican origin [218] (Figure 3.0.2). The Agincourt HDSS is one of the rural nodes of the South African Population Research Infrastructure Network (SAPRIN) [219].

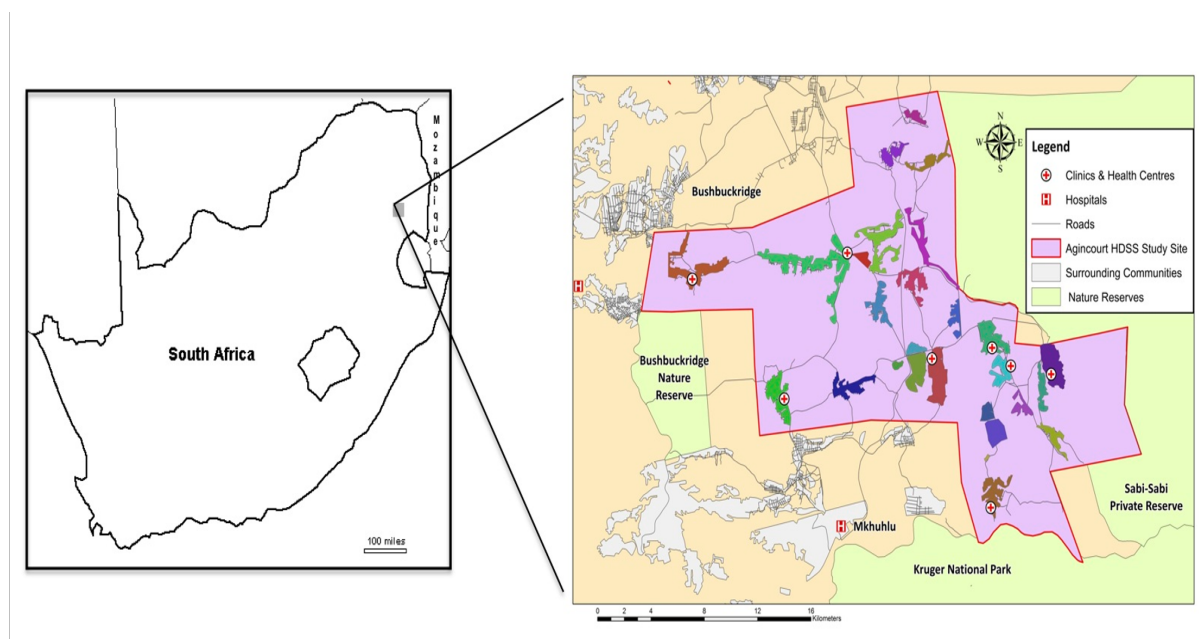


Figure 3.0.2: Map showing the Agincourt HDSS study area [218]

The Agincourt study area is rural, defined on the basis of a number of indicators, including lack of provision of amenities and infrastructure, falling under a traditional authority, and located outside of a city [220]. Notably, there have been some government infrastructure development initiatives, including electrification, provision of piped water at community level and improved road networks, though many of these initiatives remain limited and still remain a problem in the area [220–222]. Housing material varies from traditional mud dwellings to brick houses. Limited government housing is provided through the rural development programme. There are frequent water shortages in most villages, with generally poor sanitation marked by pit latrines - varying from traditional pit latrines to ventilated improved pit latrines - as dominant means of sewage disposal [47,223]. Main roads leading to shopping complexes have been tarred; however, the roads are largely in extremely poor condition. Public transport is limited to taxis and buses, with the dominant means of transport being privately owned taxis.



Figure 3.0.3: Showing pit latrines used in the community

3.2.2. Demographics

The Agincourt health and socio-demographic surveillance system (HDSS) was established in 1992 and has accumulated 30 years of comprehensive population-based surveillance data. There were 57,000 people living in 11,700 households in 21 contiguous villages at baseline in 1992, and the surveillance platform has expanded to now encompass some 117,000 people in 20,000 households living in 31 villages [47,218]. In 2018 the resident adolescent population aged 14-19 years was 14,154, of which 50.7 % were female and 49.3% male [47]. The population is mainly comprised of the xiTsonga-speaking ethnic group.

[44,198][44]

3.2.2.1.Socio-economic status

The area is characterised by high levels of poverty, with Bushbuckridge where the study area is located having one of the highest poverty rates in South Africa (85% of the population living below the poverty line) [224]. There are high levels of unemployment, with only 14% of the population between 15 and 65 years being economically active [93,224,225]. Circular labour migration, defined here as working outside of the study area for at least half the year, is widespread and involves up to 70% of working-age males and a growing proportion of females [224]. For those formally employed, particularly men, work is primarily in the mining sector, in security and construction firms of larger towns, and in the nearby plantations and game reserves. Women are mainly employed in domestic work and on farms. The public sector is another source of local employment, including health, education and police. Due to low levels of formal employment and high levels of unemployment, government support grants, particularly the child support grant and old-age pensions, are important sources of income for many families. Because of limited income, households struggle to afford electricity [93].

3.2.2.2.Education

Access to education has improved greatly in recent years. There are five education districts within the Agincourt study area. Each village contains at least one primary school and there are 23 secondary schools in the study site. Within the study area, adolescents between 14-20 years that are eligible and have access to school [224], over 88% are in school. It is estimated that over 70% of schools have no access to water or electricity [93,224].

3.2.2.3. Health and Social Services

Health care services are limited: there are seven primary care clinics staffed by nurses that provide free services such as chronic disease monitoring and medication collection, a child health clinic, antenatal services amongst others. The clinics refer to bigger community health centres or to three district hospitals 25 to 60 kilometres from the research site. Faith and traditional healers are commonly used and are consulted for a wide range of conditions. Prevention-of-mother-to-child-transmission (PMTCT) and anti-retroviral therapy (ART) has been available in district hospitals since late 2005, and since 2007 a public-private community health centre, previously located in one of the villages, also provided ART [47,224]. PMTCT and ART are now freely available at all government facilities within the site.

As part of the health services implementation, the DoH has a youth-friendly health services programme that was adopted into primary healthcare facilities in 2006. It initially focused on improving sexual and reproductive health of young males and females, including providing HIV counselling and testing and family planning. Research conducted on the use of these services in the study area found various barriers to their implementation within the primary care facilities, such as space and training of healthcare workers [226,227]. In Mpumalanga, in an effort to strengthen primary health care, CHW programmes were rolled out in 2011. While some CHWs were employed by NGOs, they received a stipend from the DoH and CHW teams were overseen by senior professional nurses based in the local primary health care (PHC) facilities. Their role is described as a combination of health promotion and preventive roles in the surrounding rural communities [228,229].

3.2.3. Quantitative Data Collection

The section focuses on the data used in the analysis for this study – some existing data and some primary data collection during the course of the PhD.

- 2007 data (collected April to July 2007) as part of the growth study: obtained from a survey of children and adolescents aged 1-20 years randomly sampled from the Agincourt HDSS database. Data collected included height, weight, and blood pressure [46].

- 2018/19 data (collected September 2018 – July 2019) as part of the Ntshembo: obtained from a survey of adolescents aged 12-20 years from two villages within the Agincourt HDSS. Data collected included height, weight, and blood pressure [230]
- Household-level variables from the Agincourt HDSS collected in 2007 and 2018 used to supplement data collected in both 2007 and 2018 studies. The data were linked to household of the study participants through the individual HDSS study identification number.

3.2.4. Study sample

Age

For the purpose of this PhD, adolescence is defined as ages 12-20 years, as it is at these ages that rapidly increasing levels of BMI in females have observed been in the Agincourt study area [8].

Data collected in 2007: Growth Study

The Growth Study was conducted between April and July 2007 to investigate the prevalence and patterns of stunting, overweight, and obesity among children and adolescents [46]. The study randomly sampled 4658 individuals aged 1-20 years from the Agincourt HDSS [46]. Both male and females were invited to participate in the study if they had resided in the study area at least 80% of the time since birth or since the baseline Agincourt HDSS census in 1992. To allow for comparison with the 2018 Ntshembo study, only individuals aged 12-20 years (i.e., adolescents; n=1309) at the time of recruitment for the 2007 Growth Study were included in the analysis. A secondary analysis of the data was conducted for the PhD study.

Data collected in 2018: Ntshembo Study

As part of the Ntshembo Study, BMI measurements were collected between September and November 2018. The study sample included 518 male and female adolescents aged 12-20 years who resided in two villages within the Agincourt HDSS area. Only adolescents attending high school were included in the study. Similar to the 2007 Growth Study, individuals were invited to participate in the study if they had resided in the study area at least 80% of the time during the 2017 household census [47,231] and their residence status was verified during recruitment into the study. The Ntshembo study involved primary data collection. The PhD

candidate contributed to the study protocol including the study's objectives, methods, and procedures; submitted the ethics applications; and developed the Standard Operating Procedures (SOPs) for the study. She was involved in the recruitment and training of all the field staff; data collection, management and quality control; field logistics and coordination; as well as managing all timelines and budgets for the study.

3.2.5. Data collection and instruments

3.2.5.1. Quantitative Data

The quantitative survey (Component 1) included collecting measurements from the adolescent using standardised tools designed and validated for adolescents.

2007 Data

Data collected in 2007 as part of the growth study used in the study for secondary analysis was through STATA files and household-level data was extracted from the HDSS matched through the participant's study ID (table 3.1).

2018 Data

Data collected in 2018 as part of the Ntshembo study which was primary data collection was all were entered into RedCap in 2018 (Appendix 3) and survey variables described in table 3.1. Adolescents were sampled through the HDSS database using the following inclusion criteria: adolescents aged 12-20 years of age, and resident in two villages. The villages were selected in the study as they are on periphery of the study area. Identified individuals were invited to participate in the survey at their homes, and were informed of the study and what was required through the consenting process. Consent was obtained from adolescents over 18 years of age, while and assent was obtained from adolescents younger than 18 years together with their guardian/parent consent. All quantitative data was captured on RedCap. Any identifying information captured on the RedCap system was automatically omitted from data exports, with only unique study IDs exported. Study IDs were used to ensure that no identifying information was available. All consent forms were stored safely in a locked room.

Table 3.1: Quantitative data: list of survey variables used for the study from 2007 and 2018

Data	Measures	Description of Data Collected	Years collected
Demographic and household characteristics	From adolescents and data extracted from the HDSS	Individual - age, sex, level of education Household - socio-economic status	2007 & 2018
Adolescent anthropometric & blood pressure data	Using weight scale, stadiometer, sphygmomanometer, tape measure	Individual - height, weight, waist circumference, blood pressure	2007 & 2018

3.2.5.2. Qualitative data: In-depth interviews (IDIs) and Focus group discussions (FGDs)

After the completion of the quantitative data collection (see Figure 1), three focus group discussions (FGDs) with adolescents were conducted prior to the intervention. Adolescents participating in the focus groups were purposively and randomly sampled from adolescents who participated in the quantitative survey. They were randomly assigned to one of three groups for the discussions. These discussions sought to understand rural adolescents' views and perspectives on obesity, physical activity, desirable body shape and nutrition to begin to unpack knowledge and behaviour. The focus group guide is attached (Appendix 5) and the results are presented in Chapter 5, addressing second objective of the PhD. To address the practicality of the intervention and investigate its acceptability, there were post intervention in-depth interviews and focus group discussions (Component 3) (see Table 2) with adolescents, care/givers/guardians and CHWs (appendix 6) as well as focus group discussions (appendix 6) with adolescents who participated on the intervention. The results presented in Chapter 6.

IDIs were all conducted in the participant's home for the adolescents and caregivers/guardians, the Agincourt research office was used for the IDIs with the CHWs. The interviews averaged 30 minutes. The FGDs for both pre- and -post intervention were conducted at a community venue. There was mixture in the FGDs, facilitating multiple viewpoints; each focus group had 8-10 participants. The FGDs averaged 50 minutes, conducted with a facilitator and refreshments provided at the end of the discussion. All interviewed and focus group discussions were recorded and then transcribed and translated into English for analysis.

3.2.5.3. Intervention design

This PhD formed part of a community-based pilot intervention study (described below) to inform and promote healthier lifestyles amongst adolescents in a rural context. The intervention was designed as a community-based intervention with adolescents as recipients and community health workers (CHWs) as implementers of the intervention.

The Intervention

The objective of the intervention was to encourage rural adolescents to adopt healthy lifestyle choices and behaviours. This was achieved through face-to-face interactions in a group setting, where participants were guided in identifying suitable methods to implement these choices and behaviours within their specific contexts.

An activity book called *Information 4 My Life* provided participants with health promotion information. The activity book was created through formative work with local adolescents and stakeholders. It was based on findings from research on adolescents in the Agincourt study area that was therefore directly relevant to the adolescents targeted for the intervention. The final activity book was created through collaboration between MRC/Wits-Agincourt researchers, educators, nutritionists, and adolescents from the study villages.

Each adolescent received a copy of the book to keep, enabling participants to interact with the subject matter both during and after group meetings. The workbook addressed a number of subjects, including 1) the power of information, 2) making the right decisions, 3) selecting healthy foods, 4) selecting an active lifestyle, 5) choosing healthy sexual behaviour, and 6) finding support for my goals. Adolescents were led through the six subjects in a group setting by CHWs, completed the exercises in the activity book, and were encouraged to put the activity book's proposed learned behaviour modifications into practice. The activity book was made to encourage interaction and engagement, as opposed to the more formal didactic method usually employed in schools. Through the CHW-facilitated conversations, adolescents were able to interact with the materials both alone and with their peers. Further description of the intervention and material is found in chapter 6.

Intervention implementers and delivery

CHWs were employed to carry out the intervention as “implementers”. All CHWs involved in the study had completed secondary school [232], had prior experience working with adolescents and HIV counselling at the MRC/Wits-Agincourt Research Unit or local NGOs. They also lived in the HDSS area (though not in the study's target villages), spoke xiTsonga, (the same language as the adolescents), and were trained to administer the consenting process. The project manager (PhD candidate) led the CHW training with assistance from the MRC/Wits-Agincourt public engagement staff. The two-week-long training included both theory and practice, as well as role-playing exercises to prepare the CHWs to deliver the intervention. One male and two female CHWs, both older than 30 years, were employed.

Initially, two consecutive Saturdays at a central community meeting hall were planned for the delivery of the intervention to the adolescent groups targeting about 60 adolescents in each Saturday. Each session was scheduled to run for four hours, cover three topics, and conclude with a light snack. It was expected that participants would attend both Saturday sessions.



Figure 3.0.4: images showing the CHWs training, setup of the sessions (community-based) and intervention session (school-based)

Table 3.2: Qualitative Research Post-Intervention

Participants	Qualitative Data Collection	
	IDIs	FGDs
Adolescents	20	Six (6) with a mix of male and female adolescents
Parents and other caregivers	5	
Community Health Workers	3	

3.2.6. Data quality

Data quality was assessed and assured at several points during the study using the following approaches: high quality training, development of standardised protocols, review of data collected, and timeous translation/transcription. These methods are described more fully below.

3.2.6.1. Training

Training topics for fieldworkers conducting interviews and CHWs included the purpose of the research, ethics and confidentiality, interviewing and communication skills, the survey instrument, qualitative interview guides, data capture on a tablet, and standardised anthropometric and blood pressure measurements according to SOPs. The training included measuring interobserver/intraobserver variability to ensure quality data collection. The quality of data collected was further enhanced through regular monitoring and re-training where required. Regular monitoring through the RedCap system allowed for built-in prompts to ensure all data was collected before completion of survey, improved quality of data captured, and continuous monitoring of data collected in real time.

3.2.6.2. Procedures for feedback and support

A Standard Operating Procedure (SOP) for dealing with psychological distress arising from any study in the MRC/Wits-Agincourt Research Unit was adapted for use in this study. During the intervention, debriefing discussions after each session were held with the CHWs to address concerns they had and share issues that may have arisen during the sessions. These feedback discussions also allowed the CHWs and Project Manager (PhD candidate) to reflect on the process, the intervention, identify points for modifications and reach a consensus on how to go about implementing the intervention.

3.3. Study data analysis

The data analysis for this PhD involved both quantitative and qualitative methods.

3.3.1.1. Quantitative Analysis

The quantitative analysis of this PhD sought to explore the changes in BMI and its determinants from 2007 to 2018, contributing to Component 1 and Objective 1 of the PhD, with results presented in Chapter 4.

Descriptive statistics, including mean and standard deviation (or median/interquartile range, when data were non-normally distributed), mean Height-for-Age (HAZ), Weight-for-Age (WAZ), Weight-for Height (WHZ), BMI, and their 95% confidence intervals are presented. Cutoffs used in the analysis were as follows: patterns of stunting (HAZ <-2), underweight (WAZ <-2), and overweight and obesity for 12-20-year-olds by age and sex for both 2007 and 2018, allowing for the comparison of the two time periods [104,233].

Linear and logistic regression analyses were undertaken with the outcome and explanatory variables described above. Bivariate analysis was conducted first with all explanatory variables of interest followed by multivariate regression analysis. Only explanatory variables found to be significantly associated with the outcome variable (p-value <0.10) in the bivariate analysis were included in the multivariate regression analysis. A test for collinearity among the variables included in the multivariate analysis was done. Additionally, an interaction was tested between various variables with a p-value <0.10 at the bivariate level. Multivariate linear and logistic regression analysis was done to determine predictors of undernutrition and overweight/obesity and risk for hypertension for adolescents aged 12-20 years in 2007 and 2018. Quantitative analysis was undertaken using Stata 15 (College Station, TX, USA). A p-value of <0.05 was considered significant.

3.3.1.2. Qualitative Analysis

The qualitative analysis contributed to Objectives 2 and 3 of this thesis and results are presented in Chapters 5 and 6. Chapter 5 presents adolescents' views of obesity addressing Objective 3, while Chapter 6 assesses the feasibility and acceptability of a community-based intervention, addressing Objective 4.

Transcription of interviews was done in the local language (xiTsonga) and then translated to English by experienced fieldworkers conversant in both xiTsonga and English. The qualitative

data were analysed using Nvivo software [234,235]. The collected data was analysed to identify common themes, providing an overall understanding of the information gathered through the data collection. Thematic analysis was utilized to uncover prevailing viewpoints or social realities based on the data findings from the participants [236]. To ensure accurate interpretation and consistency, the identified themes were thoroughly reviewed and discussed with a second reviewer until consensus was formed, with findings analysed according to the objectives of the study (presented in Chapters 5 and 6). The analysis encompassed all transcripts and employed a constant comparative method to identify recurring themes, as well as variations among them [237].

3.4. Community participation and feedback

An established collaboration exists between the MRC/Wits-Agincourt Research Unit, the community, and the health services. A Public Engagement Office of the MRC/Wits-Agincourt Unit is responsible for community engagement which includes the introduction of all studies to the study communities prior to study commencement. Detailed information about the study was discussed with village leadership and then followed up by discussions with school principals and clinic operational managers. The PhD candidate and a member of the public engagement office attended a community meeting - conducted for both villages in one venue to introduce the project, discussed the concerns of the community and obtained permission to use a community venue for the intervention part of the project as described below. The schools were approached later for permission to use these as alternative venues for the intervention.

3.5. Ethical approval and informed consent considerations

The project received separate approval from the Human Research Ethics Committee (Medical) of the University of Witwatersrand for the different data used: the 2007 Growth Survey: M070244; the 2018 Ntshembo study: M171113; and the PhD itself: M180873. In addition, permission was obtained from the Mpumalanga Department of Health Research Committee (attached in appendix 1). Permission from village leadership was obtained through established processes of the Public Engagement Office of the MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt). The Agincourt Health and Socio-Demographic Surveillance System (HDSS) stores all qualitative and quantitative data securely on its internal server. Access to the data repository is managed through a robust system overseen by the Systems Administrator and IT team. All paper-based documents related to study to be destroyed.

Written informed consent was sought and obtained from participants 18 years and older, and assent was obtained from younger adolescents along with the consent of their caregivers/parents (Appendices 2,4,6 and 7). No travel or participation reimbursements were provided for participants in the study; however, refreshments were provided for participants after the FGDs. Fieldworkers and the CHWs were employed by the MRC/Wits-Agincourt Unit.

3.6.Researcher Positionality

The PhD candidate's role as a researcher was that of an outsider as I was not from the area in which the study was conducted (although I grew up in a similar environment) and could not speak xiTsonga. Furthermore, I came into the community focusing on research and working for a research unit that already does a lot of research work and employs some people within the communities. When transitioning from the controlled environment of the office to visiting the homes of study participants, there was a noticeable recognition of the participants' dynamics and expectations regarding the research unit. Driving through the study area, there were memories and similarities to where I grew up and I needed to be reminded that it is a different context, and be aware of the expectations and biases I could have of the community as someone who grew up in a similar area. The field staff were invaluable in educating me about the study area and social dynamics. As “insiders”, the field staff – all from the study communities – were instrumental through the data collection period, when collecting survey data, FGDs and IDIs from adolescents and parents/caregivers.

My prior work in an urban setting with diabetic adolescents, their families/community and healthcare providers influenced me tremendously regarding the importance of obesity prevention in reducing the risk of diabetes. The experience of having loved ones with diabetes and having lost loved ones to diabetes made me particularly passionate about finding feasible and acceptable ways to promote healthy lifestyles in order to reduce the risk of diabetes and other complications later in life. I therefore needed to be self-aware of how my personal experiences with healthy behaviour choices and growing up in a similar environment might hinder my ability to listen openly to what the data were saying, without introducing biases. However, cross-checking all analysis and collaborations with supervisors and other colleagues assisted with quality assurance through discussions that challenged personal biases to provide evidence for my assertions.

Chapter 4: Paper 1

The following paper is under review in BMC Public Health. It represents an exploration of the changing trends in BMI over a period of time and explores the determinants. It responds to the objective of understanding changing BMI overtime

What follows are the title and body of the paper formatted for this integrated document.

Trends in body mass index, blood pressure and associated determinants among rural South African adolescents, 2007 to 2018

Background

Child and adolescent malnutrition remain a significant barrier to health and human capital development worldwide. Low-and middle- income countries (LMICs) are experiencing a double burden of malnutrition (DBM) marked by persisting underweight and increasing overweight and obesity [1,2]. Evidence from the Global School-Based Student Health and Health Behaviour in School-Aged Children surveys suggest that 10.2% of adolescents aged 12-15 years in LMICs were stunted, whilst 5.5% were underweight and 21.4% were overweight or obese in the early 2000s [3]. The World Health Organization (WHO) estimated that 15% of adolescents in Africa were overweight or obese in 2010 and in South Africa around 30% were overweight or obese in the same decade.

South Africa, an upper-middle-income country, is undergoing significant epidemiological and nutritional transitions as evidenced by increasing levels of non-communicable diseases (NCDs) and persisting levels of communicable diseases, such as HIV and Tuberculosis. The unfolding transitions are broadly influenced by changes in culture, increased access to technology, as well as socioeconomic status (SES) and at least partially driven by increased access to calorie-dense and processed food [4]. This nutritional transition in particular is largely driven by the socio-economic transition, resulting in a shift from traditional diets composed of whole foods to energy-dense and nutrient-poor diets [5,6]. Furthermore, the increasing levels of overweight and obesity can be further explained by changes in the social environment (e.g. food consumption with peers and views around food)[7,8], food advertising and lower levels of physical activity [9]. This transition is occurring despite the persistence of undernutrition [2,10]. It is believed that as the nutrition transition advances in rural settings, rural adolescents will be more likely to adopt the poorer dietary practices that had previously been found more predominately in urban areas. These practices have been linked to a lack of knowledge about healthy foods amongst adolescents leading to risk later in life, including a higher risk of cardiovascular disease leading to possible impaired social and/or economic productivity in adulthood [2,11–14].

Previous studies from South Africa have highlighted the influence of SES, as a risk factor for obesity among adolescents [5,6,15,16]. Overall, individuals with lower SES were found to have a higher mean BMI [17]. As a result of the socioeconomic transition mentioned above, which

are linked to the double burden of malnutrition, the mean BMI of children and adolescents in South Africa is comparable to those found in developed countries and warrants further exploration.

Elevated blood pressure (BP) is another risk factor of NCDs and known to be associated with BMI from previous research in adults and more recently with adolescents [18,19]. Elevated blood pressure has been reported as becoming a health problem in sub-Saharan African adolescents [19, 20] and is even more pronounced in adults. Studies conducted in South Africa and India have found strong associations between overweight and elevated blood pressure in children [21–23]. While there has been research on elevated blood pressure and obesity amongst adolescents in South Africa [18, 20–22], evidence from rural settings remains limited. Given the rapid nature of the transitions underway in rural South Africa, understanding the association between high blood pressure and overweight/obesity is needed.

The increasing levels of overweight and obesity as well as elevated blood pressure in adolescents is concerning given that this age group represent the largest age group globally (1.2 billion), with a substantial proportion residing in LMICs. Adolescents account for over 17% of the South African population [5,24]. Considering the paucity of studies from rural South Africa examining trends in adolescent underweight, overweight and obesity, this paper aims to quantify the changes in body mass index (BMI) in 12-20-year-old males and females over a decade: 2007-2018. We further seek to evaluate the association of demographic, socioeconomic and blood pressure measurements with BMI in these rural adolescents.

Methods

Study setting

Data were collected within the Agincourt study area, part of the Bushbuckridge sub-district in rural northeast South Africa, 500km from Johannesburg and close to the Mozambique border. This is the location of the Medical Research Council / Wits Rural Public Health and Health Transitions Research Unit, which oversees the Agincourt Health and Socio-Demographic Surveillance System (HDSS) with 30 years of comprehensive, longitudinal, population-based information [31].

To examine the longitudinal trend of malnutrition amongst adolescents, defined in this analysis as individuals aged 12-20 years [32], two data sources collected 10 years apart were analysed.

The data forms part of two embedded studies undertaken by the MRC/Wits-Agincourt Research Unit: The Growth Study of 2007 [2,33,34] and the Ntshembo Study of 2018 [8]

In 2007, the HDSS followed some 70,000 people living in 11,500 households in 21 villages, with about 30% of the population being of Mozambican origin. The adolescent population (those aged 12-20 years and residents in their rural home for 12 months of the preceding year) was 34,775 with nearly equal proportions of males and females [31]. As of 2022, the HDSS comprised 31 villages and roughly 120,000 individuals residing in over 21,000 households. The demographics of the larger population in 2021 were similar to those of 2007, with 30% of the population of Mozambique origin and slightly more female than male adolescents (50.1% versus 49.9%, respectively).

Study sample

Growth Study (2007)

The Growth Study was conducted between April and July 2007 to investigate the prevalence and patterns of stunting and overweight and obesity among children and adolescents [2]. The study randomly sampled 4658 individuals aged 1-20 years from the Agincourt HDSS [2].

Individuals were invited to participate in the study if they had resided in the study area at least 80% of the time since birth or since the baseline Agincourt HDSS census in 1992.

To allow for comparison with the 2018 Ntshembo study, only individuals aged 12-20 years (i.e., adolescents; n=1309) at the time of recruitment for the 2007 Growth Study were included in the present analysis.

Ntshembo (2018)

The Ntshembo Study was conducted between September and November 2018. The study sample included 518 adolescents aged 12-20 years who resided in two villages within the Agincourt HDSS. Similar to the 2007 Growth Study, individuals were invited to participate in the study if they had resided in the study area at least 80% of the time during the 2017 census [31,35]. The data collected was part of pilot work for an adolescent trial presently underway.

In both studies, data and anthropometric measurements were collected by trained fieldworkers who visited the sampled individuals at home and invited them to participate. For adolescents < 18 years, adolescent assent and caregiver consent were obtained. For adolescents $\geq$ 18 years and

older, adolescent consent was obtained. Consent and data collection were undertaken in the local language (xiTsonga). Adolescents not able or willing to participate or provide consent/assent, and adolescents with intellectual and/or physical disabilities (such as mental, hearing and speech disabilities), were excluded from the study. Demographic information, including age and SES, were obtained from the Agincourt HDSS. SES quintiles were calculated using household assets indicators and principle components analysis [36].

Anthropometric measurements & BMI collected in 2007 and 2018

Anthropometric measurements including height, weight and waist circumference, were collected from all participants in 2007 and 2018. Height was measured to the nearest 0.1 centimeter (cm) in both studies using a SECA stadiometer. Weight (in kilograms; kg) was measured to the nearest 0.1 kg on a digital bathroom scale in 2007 and using a Microlife WS 80N Diagnostic Scale in 2018. The equipment in both years was calibrated before use.

The WHO 2007 child growth standards were used to develop height-for-age (HAZ), weight-for-age (WAZ), BMI-for-age (BMIZ) and weight-for-height (WHZ) Z-scores [37,38]. For adolescents, in interpreting BMI-for-age, overweight was defined as $> +1$ standard deviation (SD) (equivalent to BMI 25 kg/m² at 19 years and older) and obesity as $> +2SD$ (equivalent to BMI 30 kg/m² at 19 years and older) [37–39]. Stunting and underweight was interpreted as height-for-age z-score (HAZ) < -2 and < -1 for adolescents 17 years and younger (respectively). WHO classify underweights as BMI < 18.5 , normal between 18.5 and 24.9 and overweight/obese > 25 .

Waist circumference was measured using a tape measure in both 2007 and in 2018. Waist circumference was measured as the circumference at the adolescent's navel and reported to the nearest 0.1 cm. Height, weight and waist circumference were normally distributed and reported as mean and standard deviation [32].

Blood Pressure Measurements collected in 2007 and 2018

Systolic and diastolic blood pressure measurements were taken in both 2007 and 2018 using an Omron M6 blood pressure monitor. Three measurements were taken with the participant seated and the arm at the level of the heart. In 2007, those measurements were taken 5-10 minutes apart [2] and in 2018, taken 2 minutes apart. The difference in timing was due to prevailing standards at the time of the studies [19,22,40–42]. In both studies, the final two measurements of systolic

and diastolic were averaged, with these values used in the analysis. The measurements were further classified according to blood pressure percentiles. In participants <18 years of age, normal blood pressure was defined as average systolic blood pressure (SBP) < 90th percentile; pre-hypertension as SBP $\geq$ 90th and < 95th percentile; and hypertension as SBP $\geq$ 95th percentile. Elevated blood pressure was further classified as SBP $\geq$ 90th percentile, which is the combination of pre-hypertension and hypertension [21,43]. In participants $\geq$ 18 years, elevated blood pressure was defined as systolic of $\geq$ 120 mmHg and/or diastolic of $\geq$ 80mmHg and normal blood pressure as < 120/80 mmHg [41–43]

Socio-economic status (SES) for households 2007 and 2018

In both studies, SES was collected as part of the Agincourt HDSS platform. SES quintiles (1-5) are presented as absolute and constructed from self-reported household asset surveys, drawing from the type of material used to build the main dwelling, type of ablution facilities, access to water and energy sources as well as ownership of livestock and modern assets (such as TV, smartphones). The lowest quintile was used in the analysis as the reference group [44–46].

Data Analysis

STATA/MP 14 (College Station, USA) was used to undertake the analysis. Descriptive statistics, including mean and SD (or median/interquartile range, when non-normally distributed), were presented for both the explanatory and outcome variables. Z-scores were generated using the WHO 2007 reference charts [38,47]. Tests for association of predictors included socio-demographic characteristics (age, sex, education), SES and blood pressure categories (expressed dichotomously as normal or elevated). In the bivariate analysis, independent variables associated with underweight and overweight/obesity were included when the p-value $\leq$ 0.2 in the multiple logistic regression analysis. Significance was considered at p < 0.05.

Ethics

Both studies, as well as this current analysis, were each separately approved by the Human Research Ethics Committee (Medical) of the University of Witwatersrand (M070244, M171113, M180873, respectively), and the Mpumalanga Department of Health Research Committee. Permission from village leadership was obtained through established processes of the Public Engagement Office of the MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt).

Results

Socio-demographic characteristics of participants

2007 Participants

In 2007, 3489 (74.9%) of the 4658 children and adolescents aged 1-20 years randomly selected from the HDSS participated in the study [11,32]. After excluding those < 12 years, 1309 adolescents were included in the present analysis, of which 51.6% were female. The average age of participants was 15.7 years (SD: 2.3; range: 12-20), and the highest level of education achieved by most participants was grade 8 and 9.

2018 Participants

In 2018, 598 adolescents were identified as living in the two study villages. Of these, 20 adolescents (4%) were not found, 43 (8%) refused to participate and 10 (2%) were excluded from the study. In total, 518 (87%) completed all aspects of data collection, of which 47.9% were female. In 2018, the average age of participants was 16.5 years (SD: 2.2; range: 12-20) with most participants' highest level of education being grades 10 and 11.

Socio-demographic and socio-economic comparison between 2007 and 2018 participants

Comparing the adolescent population from the two studies, there was a significant difference in overall sex, age and education ($p < 0.001$), with 2018 participants significantly older and in higher grades. There were also significantly more females than males in the 2007 and 2018 samples at age of 16 years. There were also significant differences in SES between 2007 and 2018 participants ($p < 0.001$) with a greater proportion of 2018 participants being of higher SES quintiles (Table 1).

Hypertension

There was a significant difference in the overall prevalence of hypertension between 2007 and 2018, with hypertension more prevalent in 2007 than in 2018 (Table 1). Hypertension seems to be driven by systolic blood pressure in 2007 and diastolic in 2018. In 2007, there was a higher

proportion of males than females with elevated blood pressure in contrast to the higher proportion of females than males with elevated blood pressure in 2018.

Table 1: Socio-demographic characteristics of adolescent samples, Agincourt 2007 and 2018

	2007			2018		
	Males	Females	Overall	Males	Females	Overall
Age (years) (%)	n=646(%)	n=665(%)	n=1309(%)	n=270(%)	n=248(%)	n=518 (%)
12	53 (8.2)	42 (6.3)	95 (7.3)	3 (1.1)	6 (2.5)	9 (1.8)
13	97 (15.0)	95 (14.3)	192 (14.7)	27 (10.3)	22 (9.0)	49 (9.7)
14	77 (11.9)	94 (14.1)	171 (13.1)	23 (8.7)	36 (14.8)	59 (11.7)
15	90 (13.9)	95 (14.3)	185 (14.1)	31 (11.8)	35 (14.3)	66 (13.0)
16	82 (12.7)	100 (15.0)	182 (13.9)	46 (17.5)	27 (11.1)	73 (14.4) *
17	61 (9.4)	74 (11.1)	135 (10.3)	36 (13.7)	29 (11.9)	65 (12.8)
18	80 (12.4)	73 (10.9)	153 (11.7)	35 (13.3)	33 (13.5)	68 (13.4)
19	73 (11.3)	63 (9.5)	136 (10.4)	39 (14.8)	37 (15.2)	76 (15.0)
20	33 (5.1)	29 (4.4)	62 (4.7)	23 (8.7)	19 (7.8)	42 (8.2)
Education Status						
Grade 3 (%)	34 (5.4)	15 (2.2)	49 (3.7)	9 (3.3)	1 (0.4)	10 (1.9) *
Grade 4 (%)	66 (10.4)	51 (7.6)	117 (8.9)	8 (2.9)	3 (1.2)	11 (2.1)
Grade 5 (%)	91 (14.4)	90 (13.3)	181 (13.8)	19 (7)	13 (5.2)	32 (6.2)
Grade 6 (%)	70 (11.0)	77 (11.4)	147 (11.2)	29 (10.7)	26 (10.5)	55 (10.6)
Grade 7 (%)	85 (13.4)	92 (13.6)	177 (13.5)	33 (12.2)	29 (11.7)	62 (11.9)
Grade 8 (%)	84 (13.2)	103 (15.3)	187 (14.3)	32 (11.9)	30 (12.1)	62 (11.9)
Grade 9 (%)	91 (14.4)	111 (16.4)	202 (15.4)	50 (18.5)	27 (10.9)	77 (14.9)
Grade 10 (%)	71 (11.2)	61 (9.0)	132 (10.1)	40 (14.8)	43 (17.3)	83 (16) *
Grade 11 (%)	18 (2.8)	47 (7.0)	65 (5.0)	38 (14.1)	52 (20.9)	90 (17.4) *
Grade 12(%)	3 (0.5)	12 (1.8)	15 (1.1)	8 (2.9)	21 (8.5)	29 (5.6) *
Out of school/Unknown (%)	16 (2.5)	15 (2.2)	31 (2.4)	4 (1.5)	3 (1.2)	7 (1.4)
SES Quintile						
1 st (poorest)	58 (9.1)	63 (9.3)	121 (9.2)	53 (19.6)	39 (15.7)	92 (17.8) *

2 nd	81 (12.8)	97 (14.4)	178 (13.6)	54 (20.0)	50 (20.2)	104 (20.1) *
3 rd	118 (18.6)	149 (22.1)	267 (20.4)	37 (13.7)	58 (23.4)	95 (18.3) *
4 th	167 (26.3)	177 (26.2)	344 (26.3)	57 (21.1)	52 (21.0)	109 (21.0) *
5 th (least poor)	168 (26.5)	142 (21.0)	310 (23.7)	65 (24.1)	44 (17.7)	109 (21.0) *
Hypertension						
Elevated	152 (23.5)	177 (26.6)	329 (25.1)	45 (17.1)	11 (4.5)	56 (11.1) *
Normal	494 (76.5)	488 (73.3)	982(74.9)	218(82.9)	233 (95.5)	451 (88.9)

*Significant difference between 2007 and 2018; p-value=0.005

BMI changes: 2007 to 2018

There were significant changes in BMI for both males and females between 2007 to 2018, increasing BMI in ages 12, 16 and 20 years.

The overall changes in BMI were driven mainly by increases in males at ages 12,14-15 and 17 and females at ages 12,14,16 and 20 (supplementary table). There was some significant increase in height, significantly for females in the age ranges of 13-14 and 16-18 in 2007 and 2018, respectively.

Generally, waist circumference across ages increased, though there were no significant differences in waist circumference between males and females between the two time periods (Table 2).

Table 2: Differences in (a) BMI and (b) waist circumference, in the age range of 12-20 years by sex and year, Agincourt HDSS

A: BMI						
Age	Male (Mean (SD))			Female (Mean (SD))		
	2007	2018	p-value	2007	2018	p-value
12	19.8 (1.3)	16.4 (1.9)	0.0019	18.3 (2.6)	20.8 (4.4)	0.0235
13	17.0 (2.3)	17.8 (3.3)	0.0662	19.0 (3.2)	19.3 (3.2)	0.3658
14	17.3 (1.7)	18.7 (2.1)	0.0019	19.8 (3.6)	20.8 (4.2)	0.0768
15	18.4 (3.2)	19.0 (2.7)	0.1554	21.1 (4.5)	20.8 (3.6)	0.6552
16	19.5 (3.2)	20.6 (5.9)	0.0863	21.0 (3.1)	23.8 (4.1)	0.0002
17	19.5 (2.6)	21.5 (5.1)	0.0054	21.7 (5.2)	21.3 (5.3)	0.6365

18	20.3 (2.3)	21.5 (4.1)	0.0269	22.6 (3.9)	23.2 (5.3)	0.2579
19	20.2 (2.5)	20.2 (2.4)	0.4974	22.9 (4.8)	22.8 (3.3)	0.5498
20	21.1 (3.2)	26.6 (19.8)	0.0557	21.1 (3.7)	25.1 (5.3)	0.0017
B: Waist circumference						
Age	Male (Mean (SD))			Female (Mean (SD))		
	2007	2018	p-value	2007	2018	p-value
12	61.2 (3.9)	59.5 (6.1)	0.8110	64.4 (4.6)	64.7 (10.1)	0.4378
13	63.3 (5.4)	63.1 (9.2)	0.5519	66.7 (6.9)	66.5 (6.6)	0.5567
14	64.9 (4.3)	65.2 (10.5)	0.4299	67.9 (7.5)	68.9 (9.7)	0.2499
15	67.6 (6.4)	65.9 (6.0)	0.1155	70.8 (8.2)	69.9 (7.2)	0.7229
16	70.1 (6.9)	69.5 (18.2)	0.3957	70.4 (7.1)	72.0 (15.4)	0.3982
17	70.3 (4.8)	70.6 (6.9)	0.3982	71.9 (8.3)	71.4 (10.3)	0.4061
18	72.0 (4.4)	71.3 (7.9)	0.2750	74.2 (8.1)	74.1 (12.3)	0.4709
19	73.0 (5.2)	70.8 (4.3)	0.0112	74.7 (10.7)	73.5 (8.4)	0.2775
20	74.2 (6.2)	74.8 (9.1)	0.3842	73.6 (6.8)	79.2 (12.2)	0.0234

BMI= Body Mass Index; SD=Standard deviation

Differences in the distribution of BMI in 2007 and 2018

The results show a consistent pattern of higher BMI amongst adolescent in the later study, most pronounced in younger and older ages (Figure 1) and higher BMI amongst females than males in both time periods (Figure 2).

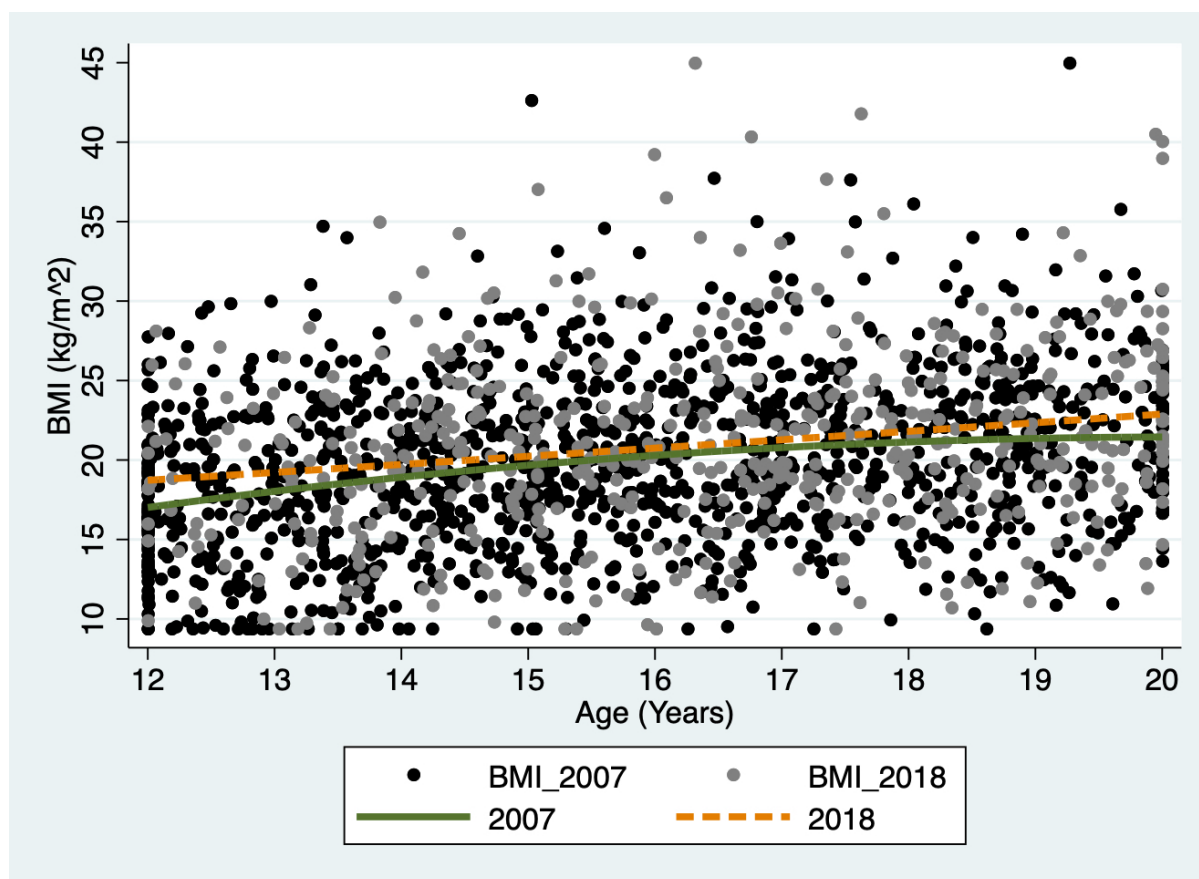


Figure 1: Individual BMI measurements by age in 2007 and 2018 with fitted line to highlight trends, Agincourt HDSS

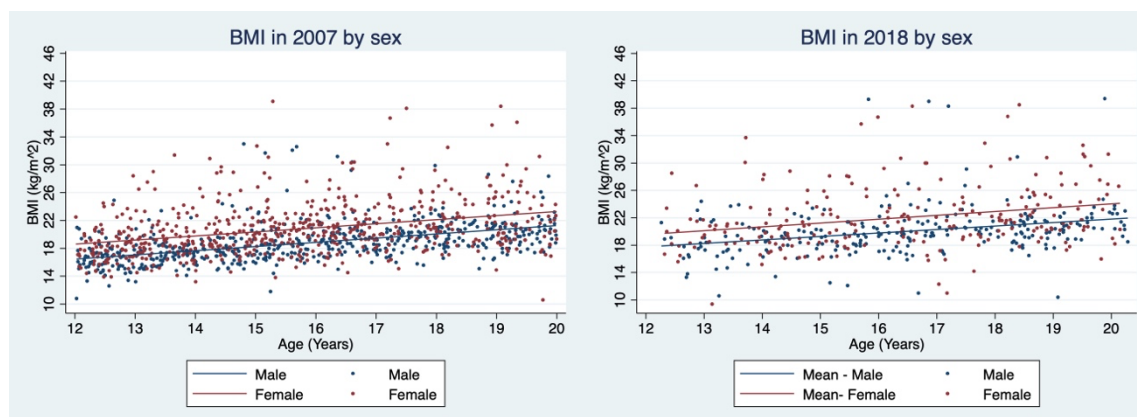


Figure 2: Individual BMI measurements by age and sex in 2007 and 2018 with fitted line to highlight trends, Agincourt HDSS

Prevalence of Stunting, Underweight and Overweight/obesity in 2007 and 2018

Stunting decreased in the later study (Figure 3) amongst adolescents 12-17 years of age, with individuals aged 13-15 years experiencing the highest levels- ranging from 12.8- 24.9% in 2007

and slightly lower, 19.3- 24.7%, in 2018. Overall, the prevalence of stunting peaked in the 15-year age group in 2018, two years later than the peak seen in 2007. This was seen in both males and females, with females having significantly lower levels of stunting than males in both 2007 and 2018, with a slightly lower prevalence of stunting amongst males seen in 2018 compared to 2007 and a slightly higher prevalence of stunting among females.

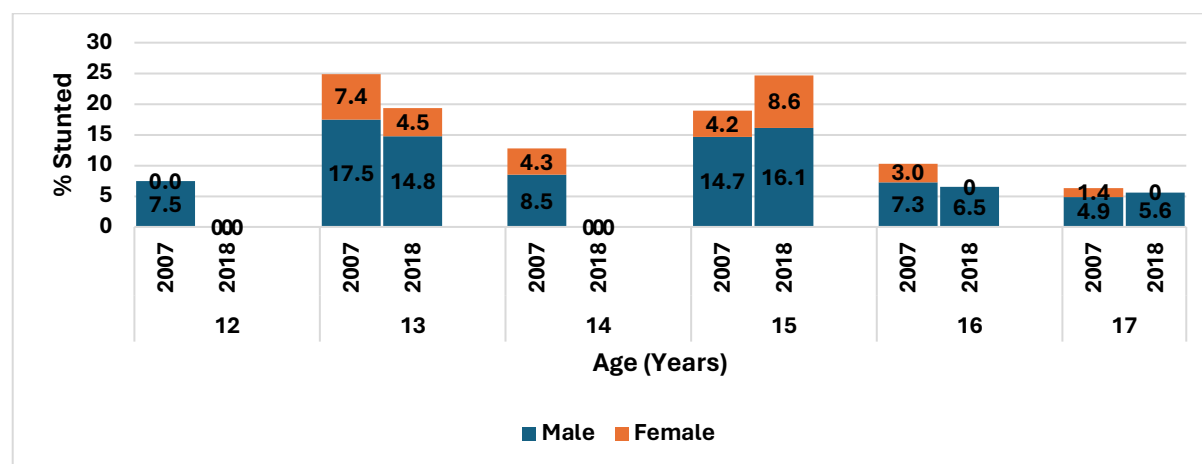


Figure 3: Proportion (%) of adolescents stunted in 2007 versus 2018 by age and sex, Agincourt HDSS

The overall prevalence of underweight decreased from 12.2% in 2007 to 7.9% in 2018. In both studies, male prevalence of underweight across all ages was substantially higher than females. The prevalence of underweight was lowest among adolescents 14 years and younger in 2007 and 16 years and younger in 2018, increasing after the age of 15 years to 15-18% (Figure 4) in 2007 and 9-12% after the age of 17 years in 2018.

In 2018, the overall prevalence of overweight and obesity was 17.8% amongst adolescents of all ages, a substantial increase from the overall prevalence of 10.9% in 2007. The prevalence of overweight and obesity rose by age in both studies, with the highest levels seen at age 19 (16.2%) in 2007 and 28.6% at age 20 in 2018 (Figure 4). The prevalence was highest amongst females compared to males in both studies, with the overall increases largely driven by older female adolescents.

An overall decrease in normal BMI (i.e., not stunted, underweight, overweight or obese) was observed in adolescents, with the greatest change observed in males <18 years of (81% in 2007 compared to 74% in 2018) and females (74% in 2007 compared to 71% in 2018). In adolescents

over the age of 18 years, females had a greater change in BMI with a decrease from 66% in 2007 to 58% in 2018. While there was an increase in normal BMI in males of 76% in 2007 compared to 84% in 2018.

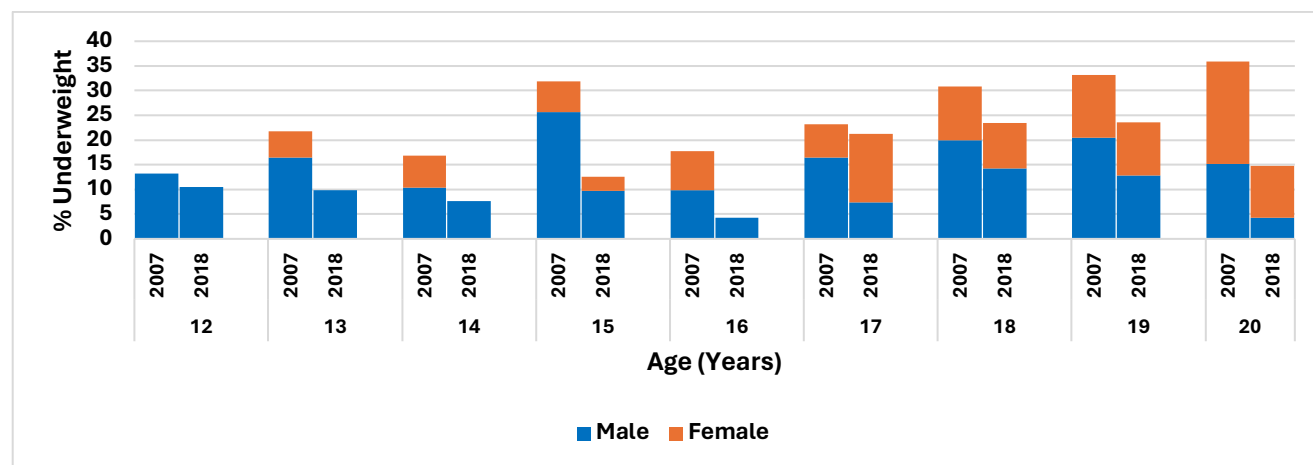


Figure 4: Proportion (%) of adolescents underweight by age and sex in 2007 and 2018, Agincourt HDSS

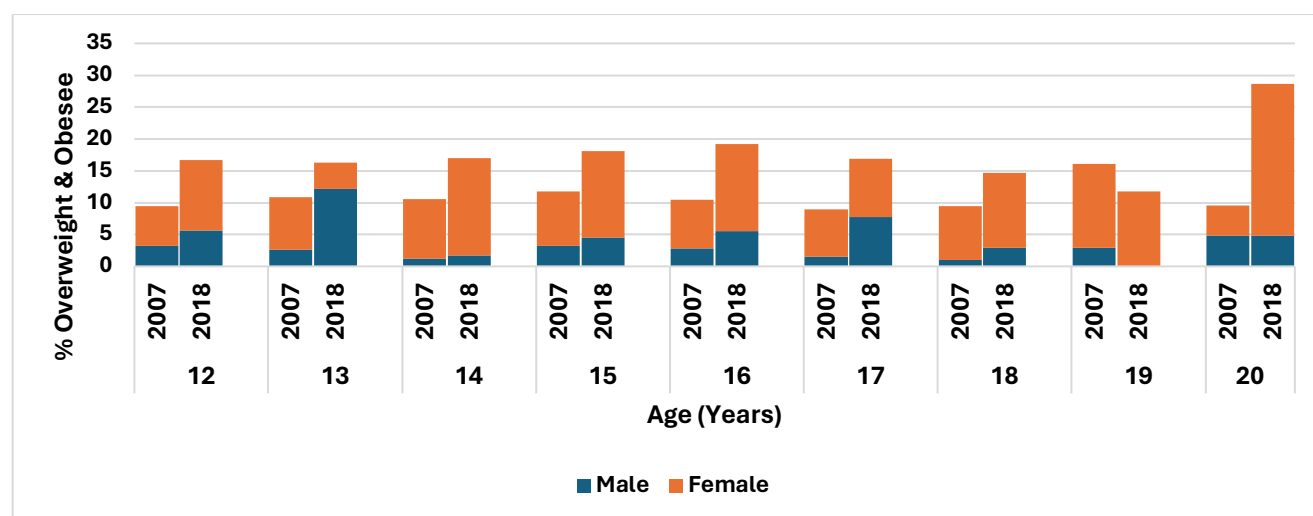


Figure 5: Proportion (%) of adolescents overweight and obese by age and sex in 2007 and 2018, Agincourt HDSS

Determinants of underweight and overweight/obesity amongst adolescents

In the bivariate age, sex and SES were found to be significantly associated and were then included in the model for analysis. In the multiple regression (Table 3), participants' age, sex and higher SES were strongly associated with increasing weight-for-age in 2007 and 2018. An

increase in age and higher SES were significantly associated with weight-for-age in both 2007 and 2018. There was also a significant association between BMI and age as well as between BMI and sex (specifically, being female) in both 2007 and 2018.

Being underweight (Table 4) was significantly associated with younger ages ($p < 0.001$) in both studies. In 2018, there was a significant association between being underweight and lower SES. There was no significant association between blood pressure and being underweight.

Being female and older was significantly associated with being overweight or obese in both studies, resulting in a 1.98 times likelihood of being overweight or obese in 2007 and increasing to 2.80 in 2018. Adolescents who were overweight or obese were 3.3 times more likely to also have hypertension in 2018 compared to those of normal weight (Table 4).

1 Table 3: Linear regression analysis of associations between factors and height-for-age, weight-for-age, and weight-for-height z-scores
2 among adolescents in 2007 and 2018, Agincourt, South Africa

	Weight-for-age					Height-for-age					BMI z scores			
	2007		2018			2007		2018			2007		2018	
	Coeff [95%CI]	p- valu e	coeff [95%CI]	p- val ue		Coeff [95%CI]	p- val ue	OR [95%CI]	p- val ue		OR [95%CI]	p- value	OR [95%CI]	p- valu e
Age	-0.18 [-0.19 , -0.16]	0.00	-0.09 [-0.14 , -0.04]	0.00	Age	-0.05 [-0.07 , -0.012]	0.01	-0.16 [-0.07 , 0.042]	0.59	Age	-0.16 [-0.18 , -0.14]	0.00	-0.10 [-0.16 , -0.04]	0.002
Sex					Sex					Sex				
Male	ref		ref		Male			ref		Male	ref		ref	
Female	0.5 [0.39 , 0.55]	0.00	0.57 [0.38, 0.76]	0.00	Female	0.26 [0.15 , 0.38]	0.00	0.38 [0.16 , 0.60]	0.00 1	Female	0.49 [0.41 , 0.57]	0.00	0.46 [0.23 , 0.69]	0.00
SES					SES					SES	ref		ref	
1	ref		ref		1	ref		ref		1	0.04 [-0.13 , 0.20]	0.66	0.29 [-0.07 , 0.65]	0.11
2	0.05 [-0.12 , 0.21]	0.58	0.13 [-0.17 , 0.42]	0.40	2	0.06 [-0.17 , 0.29]	0.60	-0.17 [-0.48 , 0.21]	0.44	2	0.07 [-0.08 , 0.22]	0.38	0.36 [-0.03 , 0.74]	0.07
3	0.09 [-0.06 , 0.24]	0.24	0.21 [-0.11 , 0.53]	0.19	3	0.09 [-0.12 , 0.30]	0.41	-0.06 [-0.43 , 0.32]	0.77	3	0.16 [0.02 , 0.31]	0.03	0.49 [0.13 , 0.85]	0.01
4	0.21 [0.07 , 0.36]	0.00 4	0.40 [0.09 , 0.69]	0.01	4	0.17 [-0.04 , 0.38]	0.11	0.08 [-0.26 , 0.43]	0.63	4	0.20 [0.05 , 0.35]	0.01	0.21 [-0.15 , 0.57]	0.25
5	0.21 [0.06 , 0.35]	0.01	0.14 [-0.16 , 0.43]	0.36	5	0.11 [-0.09 , 0.32]	0.29	-0.00 [-0.35 , 0.35]	0.99	5	0.13 [0.12 , 0.14]	0.00	0.06 [0.05 , 0.07]	0.00

3 Coeff=coefficient; CI=confidence interval; OR=odds ratio;SES= socioeconomic status

4 **Table 4: Logistic regression analysis as predictors of stunting, underweight, and overweight among adolescents in 2007 and 2018,**
5 **Agincourt, South Africa**

	Underweight					Overweight			
	2007		2018			2007		2018	
	OR [95%CI]	p-value	OR [95%CI]	p-value		OR [95%CI]	p-value	OR [95%CI]	p-value
Age	4.22 [3.50 , 5.09]	0.00	6.06 [4.31 , 8.55]	0.00	Age	0.48 [0.39 , 0.59]	0.00	0.76 [0.66 , 0.88]	0.00
Sex					Sex				
Male	ref				Male	ref		ref	
Female	0.98 [0.64 , 1.50]	0.91	1.08 [0.55 , 2.09]	0.82	Female	1.98 [0.97 , 4.07]	0.06	2.80 [1.50 , 5.22]	0.001
SES					SES				
1	ref		ref		1	ref		ref	
2	0.56 [0.22 , 1.40]	0.21	0.28 [0.09 , 0.81]	0.02	2	1.68 [0.35 , 7.98]	0.52	1.13 [0.43 , 3.03]	0.80
3	0.78 [0.34 , 1.81]	0.56	0.17 [0.05 , 0.56]	0.00	3	1.36 [0.31 , 6.08]	0.69	1.18 [0.43 , 3.22]	0.75
4	0.83 [0.36 , 1.90]	0.66	0.25 [0.08 , 0.72]	0.01	4	3.61 [0.88 , 14.79]	0.07	1.56 [0.60 , 4.04]	0.36
5	0.73 [0.32 , 1.67]	0.46	0.30 [0.09 , 0.91]	0.03	5	2.38 [0.59 , 9.78]	0.23	1.01 [0.38 , 2.71]	0.98
Blood pressure					Blood pressure				
Not elevated		ref	ref		Not elevated	ref		ref	
Elevated	1.24 [0.70 , 2.19]	0.45	1.56 [0.42 , 5.86]	0.51	Elevated	1.35 [0.67 , 2.70]	0.40	3.32 [1.07 , 10.30]	0.04

6 Coeff=coefficient; CI=confidence interval; OR=odds ratio; SES= socioeconomic status

Discussion

This paper builds upon 2007 research by Kimani and colleagues [2] by presenting evidence of a continuing double burden of malnutrition 10 years later, marked by the combination of early stunting and underweight in adolescents, and an increasing prevalence of overweight and obesity, especially in females. Collectively, this raises critical concerns congruent with the rising public health focus on metabolic diseases in LMICs. This persistent double burden of malnutrition (DBM) is recognised both globally and in South Africa [1,48,49] and is a central risk for NCDs later in adulthood [2,50]. Trends by age and sex between this study and Kimani's from 2007 were similar, with significantly more overweight and obesity amongst females (especially older females) and less underweight males in this study compared to the earlier study. Of concern, the overall percentage of adolescents considered to be of normal weight (i.e. a normal BMI) decreased between studies, contributing further evidence to the persisting double burden of malnutrition marked by stunting and underweight on the one hand and overweight and obesity on the other.

This work supports findings from previous studies by providing further evidence of the projected increase of obesity amongst adolescents in LMICs [51], with previous studies suggesting that 23%-38% of adolescent females residing in LMICs will be overweight or obese by 2050 [48], figures similar to our results. Like this study, previous research has found that rural South African adolescent females are most at risk of obesity. The levels of overweight and obesity increased with age [52,53], highlighting a potential risk for poor health outcomes later in life [54,55]. Compared to studies from other sub-Saharan African countries such as Sierra Leone (16.9%), Comoros (15.9%), Malawi (14.5%), Ethiopia (3.0%), Togo (2.6%), and Senegal (2.0%), we found higher levels of overweight and obesity. The rise in prevalence may be fuelled by etiological factors such as genetic, environmental, and socio-economic status and future research should seek to understand how these factors both individually and synergistically contribute to increases in BMI.

According to the United Nations Children's Fund, the prevalence of overweight and obesity amongst South African adolescents aged 15-19 years ranges from 8.6% to 31.0% [3]. The upper end of these estimates is higher than the global estimated range of obesity. In our analysis, the prevalence of overweight and obesity in both time periods fell within the national range [5,56,57]. In 2018, the prevalence of overweight and obesity amongst rural female South

African adolescents was similar to the prevalence found among adolescents in urban high schools in more affluent communities in the Western Cape.

Our results are similar to other African studies that found increasing overweight and obesity amongst rural populations [58–61], with levels in rural settings approaching those of urban areas [62,63]. This is likely a result of the nutritional transition that has been taking place in rural communities over the last few years. While this study did not measure increased access to fast food outlets, there has been a documented shift in the consumption of processed foods and a shift away from homegrown farming and consumption in rural African communities [64,65]. The reported increases highlight the importance of identifying key determinants of BMI changes.

This study found significant associations between age, and sex with being underweight and overweight or obese, which is consistent with previous studies [5,10,17,34,66]. Similar to this study's findings, an association between SES and overweight/obesity has been reported by various studies in women and in older age groups globally. Previous research has reported associations between higher SES and obesity in South Africa despite inflation and increased cost of living [17,20,67]. This may be the result of greater access to processed fast foods or limited time available to prepare meals. In our analysis, a significant association was found between SES and being underweight in 2018 but not in 2007, possibly due to changing environmental factors such as food access over time. This finding warrants further investigation.

The prevalence of hypertension amongst adolescents over the period of 2007 to 2018 is of concern, with results consistent with other studies on blood pressure in children and adolescents from other geographic contexts [19,20,36,68]. The current study adds to the growing body of evidence highlighting an association between BMI and blood pressure among adolescents [52,53,69].

Several studies have been conducted in South Africa, elsewhere in Africa and globally focusing on obesity interventions, often behavioural change studies focused on overweight/obese adolescents [70–72]. Most interventions have focused on either underweight or stunted children or adolescents only, or focused on overweight adolescents only [73,74]. The findings of this study suggest that a public health intervention approach that addresses targeting both underweight and overweight and obese adolescents – the so-called double burden of

malnutrition- in an effort to shift BMI to within the normal range, is needed. The targeting of both the underweight and overweight and obese, with gender-specific interventions (e.g. interventions for adolescent females) may provide important opportunities to potentially address later life health implications and interrupt the reported recurrence of the burden of malnutrition in successive generations.

Strengths and Limitations

The analysis presented relied on two robustly undertaken population-based studies collected within the same well-established rural research site roughly a decade apart. The same scientific team was involved in conducting both studies, which relied on standardised measures and the same standard operating procedures. That said, several limitations to the current analysis do exist. Firstly, neither study included diet-related questions to ascertain processed food consumption patterns. This would have allowed for the exploration of a hypothesized driving factor of increased obesity seen in this context and could have provided insight into the dietary transition underway. Furthermore, this study did not collect any data on pubertal status. As a result, stunting figures may be inflated in males compared to females due to known differences in pubertal development. Furthermore, BMI is recognized as a somewhat crude measure of health status and does not take into consideration body composition (body fat or body lean mass), which can be collected through more intensive measuring, such as through Dual-Energy X-ray Absorptiometry (DXA). Whilst DXA may offer more accuracy, this technology not readily available in many rural contexts and BMI continues to serve as a well-published, albeit limited, measure of health status.

Conclusion

Rural South African adolescents continue to experience a double burden of malnutrition, marked by a decreasing proportion of adolescents with normal weight, increasing levels of overweight and obesity, especially amongst females, and persisting but lower levels of stunting and underweight in adolescent males. Given the continued double burden of malnutrition amongst adolescents and the implications this has on NCD risk later in life, understanding the mechanisms contributing to this rise is necessary. Understanding the associations between adolescent obesity and other determinants, such as dietary consumption is important for future research. Developing context-specific interventions to mitigate this double burden, targeting

those most affected, is necessary and may ultimately mitigate the continuing rise of NCDs and accompanying complications often seen later in life.

Declaration

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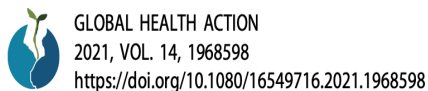
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Chapter 5: Paper 2

The following paper was published in Global Health Action in 2021. It represents an exploration of in-depth interviews with adolescents about their views and understanding on obesity. It responds to the objective of exploring adolescents' understanding of obesity, in the context of rural adolescents in South Africa. The official citation and URL are as follows:

Tshegofatso M. Seabi, Ryan G. Wagner, Shane A. Norris, Stephen M. Tollman, Rhian Twine, David B. Dunger & Kathleen Kahn (2021) Adolescents' understanding of obesity: a qualitative study from rural South Africa, Global Health Action, 14:1, 1968598, DOI: 10.1080/16549716.2021.1968598

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ORIGINAL ARTICLE

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Adolescents' understanding of obesity: a qualitative study from rural South Africa

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Figure X:

What follows are the title and body of the paper formatted for this integrated document.

Adolescents' understanding of obesity: a qualitative study from rural South Africa

Background

Sub-Saharan Africa is predicted to experience an increasing number of adolescents in the coming years [1], despite having the worst adolescent health profile globally [2,3]. High levels of mortality from maternal and infectious causes (including HIV [3]) persist and are coupled with increasing behavioural risks for non-communicable diseases (NCDs), including high levels of tobacco and alcohol use, low levels of physical activity [4], poor diet and increasing levels of overweight and obesity [5,6]. In studies from rural South Africa and other parts of sub-Saharan Africa [7–9], the double burden of malnutrition, particularly stunting, in the early years of life, coupled with increasing overweight and obesity in adolescent girls and young women, has been documented in both rural and urban SA [9]. In order to mitigate the growing epidemic of obesity, understanding adolescents' knowledge and views of obesity is needed to tailor interventions aimed at changing behaviour to reduce levels of obesity.

Obesity is a complex, multifactorial and usually preventable condition that likely results from a combination of individual, social, community and societal level determinants [10].

Traditionally defined as a body-mass index (BMI) >30 , the prevalence of obesity continues to rise globally, a trend reflected in sub-Saharan Africa [11], where levels of obesity differ between males and females, with South African females seeing a rapid rise during adolescence [8,9].

Childhood and adolescent obesity have serious consequences for health and social wellbeing in later life and it is widely agreed that obesity in these age groups should be reduced [12,13]. As part of the reducing childhood obesity mandate, an important factor for context specific interventions is to understand obesity from the perspective of this the age group.

The behaviour change approach promotes health through individual lifestyle changes that are appropriate to one's unique context [14]. The approach posits that before individuals are able to change their lifestyles, they must first understand basic facts about a particular health issue, adopt key attitudes, learn a set of skills and be given access to appropriate services [15].

Fundamentally it is believed that people do not resist change, but resist being changed [15].

Thus, the approach promotes health collaboratively, tailored to an individual's specific context.

In order to provide individuals with information to enact behaviour change, it is important to understand both the knowledge base that individuals currently have and the context from which their views emerge. This has formed the basis for this study: to develop an understanding of

rural SA adolescents' views of obesity. The social cognitive theory is one theory that has been used to understand behaviour and in behaviour change interventions. It has been used in various interventions such as Healthy Relationships, an intervention that is specifically designed to engage with persons living with HIV/AIDS directly addressing prevention of transmission to others [16,17].

Few studies from either rural or urban South Africa have explored views and understanding of obesity. Studies from urban Soweto have specifically examined body image and satisfaction, body shapes, eating habits and attitudes mostly among female adolescents [18– 20]. They concluded that South African female adolescents are struggling with body image and desire “unhealthy” body shapes, with the majority of participants having a distorted body image [21– 24]. While these studies examined body image, they fell short of exploring reasons for the adolescents' understanding of the causes of obesity and did not discuss possible interventions to change BMI levels. Furthermore, adolescent males and rural participants have been largely excluded from these types of studies.

Due to the paucity of empirical data, we set out to explore rural South African adolescents' views of obesity, including their understanding of its causes and consequences. Views are defined for the purpose of this study as reported attitudes, opinions, beliefs, feelings, understandings or experiences of adolescents in relation to obesity [25].

Methods

Study setting

This work was undertaken at the MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt) study area, located in rural Mpumalanga Province, northeast South Africa close to the Mozambique border. The Unit runs the Agincourt Health and socio-Demographic Surveillance System (HDSS) which has accumulated over 25 years of comprehensive surveillance data on a population of some 116,538 people living in 31 villages in 2018. The resident adolescent population aged 14-19 in 2018 numbered 14,154, of which 50.7 % were female.

Study sample

This study design is a qualitative phenomenology approach. The focus of the approach is on experience from the perspective of the individual, their personal knowledge and subjectivity, and

emphasizes the importance of personal perspective and interpretation. As such it is useful for understanding subjective experience and gaining insights into an individual's motivations and actions. Qualitative data were collected during focus group discussions (FGDs).

Participants for the FGDs were conveniently recruited from one village within the MRC/Wits Agincourt Unit study area. Using information from the Agincourt HDSS, households with adolescents were visited by trained fieldworkers who invited adolescents and their caregivers to participate. Adolescents, for the purpose of this study, were defined as males and females 14-19 years of age at the time of enrolment. For adolescents younger than 18 years, caregiver consent and adolescent assent was sought. For participants older than 18 years, adolescent consent alone was sought. Consent and assent were conducted in the local language (xiTsonga).

The groups were constituted by age and sex: one all-male, one all-female and one mixed male/female group (Table 1). The differing compositions aimed to respond to the dynamic that participants around the same gender are more likely to express themselves freely and in mixed sex group, it was expected that different perspectives would arise. Each FGD had 8- 10 participants and most of the participants were in grade 10 or 11 at different high schools (Table 1). Participants chose which day and which group (either the all-male, all female or mixed group) they wanted to participate in, with the FGDs carried out at a central venue within the village. The FGDs averaged 50 minutes (ranging between 45-50 minutes in the three groups). After undertaking three (3) FGDs, saturation was reached on the key elements of the points of discussion.

The FGDs explored rural adolescents' understanding of overweight and obesity, particularly causes and consequences on health, using a semi-structured interview guide. Interviewers (one male and one female) were trained on the interview guide [26]. Interviewers had all completed secondary school, had previous experience working in the community and were fluent in both English and xiTsonga.

FGDs were conducted in xiTsonga and audio recorded. They were then transcribed and translated to English by the interviewers who facilitated the FGDs. Thematic analysis principles to analyse the data were used [26]. Thematic analysis allows for flexibility in analysis and the summary of key themes of data. To ensure rigour, the transcripts were coded independently by a second researcher and themes were identified and validated to agreement.

Theoretical Framework

The Social Cognitive theory (SCT) provides a framework for understanding, predicting and changing human behaviour [27]. Developed from social learning theory, SCT offers a comprehensive framework for understanding health-related behaviours and changing them [28]. The key SCT construct of reciprocal determinism means that a person is understood to be both an agent for change and a responder to change. Thus, changes in the environment, and reinforcements, can be used to promote healthier behaviour [29].

The three primary factors of SCT are as follows: firstly, behavioural factors which include an individual's ability to perform the behaviour when desired and obtain desired outcomes, as well as the confidence that one can perform a specific behaviour under a variety of circumstances. Secondly, environmental factors such as learning how to do a behaviour by watching someone do it and receiving reinforcement for it, such as community/ family norms and access [28]. Lastly, are cognitive factors and these focus on an individual's knowledge, expectations and thought processes. The primary driver for behaviour change interventions using the SCT model is acknowledgement of the bidirectionality of these three key elements (Figure 1) [30], highlighting the individual's control of his/her own behaviour. Individuals can achieve self-control by setting specific behavioural change goals, monitoring their own behaviour through the process of change, and making changes as needed [29]. This paper uses the SCT to discuss the findings of rural South African adolescents' views on obesity.

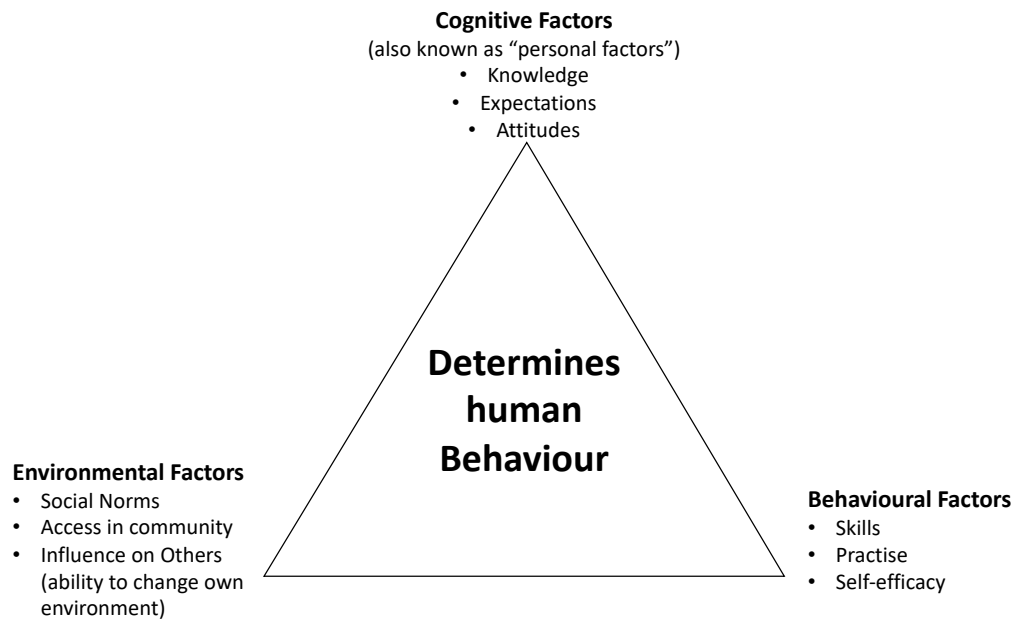


Figure 1: Social Cognitive Theory [29,31]

Ethics

The study was approved by the Human Research Ethics Committee (Medical) of the University of Witwatersrand (M171113, M180873), and the Mpumalanga Research Committee. Permission from village leadership was obtained through established processes of the Public Engagement Office of the MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt).

Results

Table 1

	Mixed Sex FGD	All male FGD	All female FGD
Number of Participants	9 (5 girls, 4 boys)	12	10
Age range (in years)	14-18	16-19	15-19

Thirty-one adolescents consented to participate in the FGDs. The average age was 16 years (range: 16-18 years). All participants resided in the same village, and the average BMI for the FGD participants was 20.8 for males and 22.5 for females (both considered to be normal) [32]. Table 2 shows the guiding questions that were posed to the focus group participants.

Table 2: Guiding questions for the Focus Group Discussions

Personal/Cognitive Factors

- Sometimes, people refer to others as “obese”. What do you understand by this?
- What are your thoughts and feelings about food?
- What are your thoughts and feelings about exercise?
- We are interested in factors that lead to people being light or heavy. What do you think are reasons that some people are heavy, and others are light?
- In your views, what do you think the best size and shape is for young people? And why?

Behaviour

- What are your thoughts and feelings about food?
- What food is eaten by the adolescents in your community? Would they be considered healthy or unhealthy?
- What are your thoughts and feelings about exercise? What exercise do you do?

Environmental Factors

- What are some of the things that you have heard or seen about obesity in young people?
1. What are some of the consequences of obesity that you have heard about?
 2. Do you think your chances of being overweight or obese is very high when parents and/or family are overweight and/or obese? Are there other factors?

Closing/overall question:

- Thank you for your participation, lastly, what do you think can be done or what is your wish to happen in order to reduce obesity amongst adolescents?

Main findings from the FGDs

Two broad topics emerged from the FGDs; firstly, rural South African adolescents' knowledge of obesity is complex, and adolescents recognise multiple factors or pathways as they relate to their general views and causes of obesity. Secondly, rural South African adolescents view medical treatment as a way to intervene with obesity. The findings are discussed under two broad themes: 'Knowledge of obesity' and 'Ways to address obesity'. This will be discussed using illustrative subthemes and quotes from the focus group discussions through the lens of the SCT.

1. Knowledge of obesity

Overall, adolescents expressed conflicting views on obesity, with both males and females providing positive and negative views as part of the cognitive/personal factors of the SCT model. The causes of obesity given were multi-factorial, showing behavioural and environmental factors.

Positive views included the suggestion that obese people were happy and without problems.

"...Like happiness can make you fat..." (P1_all female FGD)

"...Some people become fat if they don't have problems..." (P2_mixed FGD)

Whilst others negatively suggested that obese people were lazy.

"...In most cases people who are fat or obese or overweight are lazy..." (P1_all male FGD)

Causes of obesity

Adolescents suggested four main causes of obesity: diet, physical activity, genetics, and the use of medications.

Diet and Location

Adolescents identified diet as a major cause of obesity, discussing what they believed to be healthy and unhealthy food choices and how these choices relate to obesity. Adolescents identified vegetables, such as leafy green "*morogo*" grown in the community and fruit as healthy food and identified "*kotas*" (made from refined bread, green mangoes fermented in oil and spices, processed meat, deep fried chips and sometimes cheese) and "*vetkoek*" (dough that is

deep fried), sweets or candy and crisps, as unhealthy food. Adolescents mentioned that it is the excessive eating of unhealthy, oily foods that caused obesity in their community.

In addition to describing poor diet as a contributor to obesity, adolescents further differentiated the locations of where healthy and unhealthy foods were consumed. They mentioned that at school (referring to the school feeding program) and at home they ate what they considered to be healthy food, while on school trips and with their peers within the community, they ate what they considered to be unhealthy food, suggesting that the ability access healthy or unhealthy is dependent on location and peer presence.

[At school] beans, samp [African food consisting of dried corn kernels that have been stamped and chopped until broken], rice, milk and at home we eat Nkanka, bangala [traditional vegetables] (P7_all male FGD) xiendla hi vomu [corn and crushed nuts] tihove [samp, ground nuts and crushed nuts] and porridge (P8_all male FGD)

Just like when you have gone out with friends or maybe you went on a trip, you would want to buy food that is a bit expensive depending on how much they have given you at home. That's when we go to Debonairs or KFC [fast food outlets] but when we are here at home [talking about when they are with their peers in the community], we eat chips and cold drinks [referring to eating with friends] (P6_all female FGD)

Physical Activity

Physical activity, in the form of exercise or the lack thereof, was also mentioned as a cause of obesity. There were different forms of physical activity that adolescents described, from walking to school on a daily basis and house chores, to playing soccer for male adolescents. Undertaking physical activity seemed to be more strongly related to the ability to defend or protect oneself in the community for male adolescents and less about being healthy. The adolescent males prefaced the discussion with “these days it is not about exercising”. Adolescent males also expressed common use of steroids as a way to lose weight, build muscle and defend themselves.

Steroids are pills or the juice that we drink that makes you very fit or have muscles... It causes your body to develop faster than the way it was supposed to ... When they are busy provoking him, you find that they just hit him with a fist and run away and another one comes and does the same and runs away, so he must be fit to run after them (P6_all male FGD) ...

In the all-female group, while lack of physical inactivity was mentioned as a cause of obesity, it seemed to be considered less important

others don't consider it [referring to exercise] as important (P8_all female FGD) ...I don't do it because when you do it once, when you wake up in the morning you need to do it again and if not, your knees can be painful (P6_all female FGD)

Environmental factors

Environmental factors were mentioned as another likely contributor to obesity. Participants expressed that obese adolescents often resided with other obese family members. This sentiment was shared by most participants. However, some participants, particularly male participants, disagreed, noting that individuals can have different body compositions when compared to their relatives.

Because there was a time where I was seeing myself as very thin and I tried to eat a lot as I was thinking that I will be fatter than they [referring to family members] are but it didn't work. It doesn't matter as to whether I eat lot of fatty foods or what, I am always like this (P6_all male FGD)

I think that it also depends on how you want your body to be like because when I look at both my parents, they look like they can't manage their body because they are fat. So, it is better for me to stay the way I look now so that I can be able to do my own things (P7_all male FGD)

Medication and disease

In addition to diet, physical activity and environmental factors, adolescents mentioned the use of some medications particularly contraceptives and HIV medication as causes of obesity. The all-female group highlighted the link between contraception (or oral *prevention* as it was referred to) and obesity, suggesting that some females that were obese were so not because of diet, but because they were on oral contraceptives. Participants expressed the belief that HIV treatment caused obesity as well. Some adolescents described it as “being liked by the treatment” while another related it to the medication causing an increased intake of food.

And nowadays we are preventing, in the mobile[clinic], the injection can make you fat. The medication they are taking... and Prevention [contraception] (P3_ all female FGD) ...HIV... if you took treatment correctly and don't skip or miss you can be fat (P4_ all female FGD)

Adolescents also mentioned consequences of obesity, particularly physical impairment and diseases such as diabetes, hypertension, and heart disease.

Some people when they are obese, when they grow up you find that they are no longer able to walk (P1_ all female FGD) ... And they have some diseases, heart attack (P3_ all female FGD) ... sugar diabetes and high blood [pressure]

2. Solutions to address obesity

Rural South African adolescents' views on obesity reflect a complex and multi-causal picture that ultimately results in adverse effects on individuals. When asked about how to reduce obesity, adolescents described obesity as an illness or disease that needs to be treated. They discussed three ways to address obesity in their community: closing down or reducing the number of fast-food outlets, using substances such as marijuana, and lastly the use of medication or hospitalisation.

2.1. Fast food outlets

Participants suggested shutting down shops that sell unhealthy food as a way to intervene. Participants externalised responsibility for obesity to food outlets in their community rather to their own choices and practices. They particularly mentioned shops owned by other ethnic groups as problematic. This suggests that adolescents may not view their own behaviour or actions as a solution to overweight/obesity, but that targeting environmental factors, such as fast-food outlets, were better interventions for reducing obesity, thus not claiming responsibility for their own choices of buying and consuming food from those shops.

"...We need to shut down the Indian shops in the community...They are selling us things that are not healthy, and they don't even eat those things, but they want us to eat them..." (P6_ all male FGD)

2.2. Substance use

Adolescents offer a justification for the use of substances such as marijuana (dagga) as a way to reduce obesity. While acknowledging its use increases the likelihood of risky behaviour,

adolescents mentioned these substances are helpful in dealing with psychosocial challenges such as stress, humiliation from peers, and bullying, as well as weight loss. Participants described it more as self-medication to address obesity than as a substance abuse issue amongst overweight and obese adolescents. This highlights the interplay between personal factors, behaviour and the availability of these substances.

“...So, emotionally people can laugh at you to an extent that you will feel sad about it... people finally smoke dagga or marijuana because they want to get slim (P6_all male FGD) ...”

“...Other people go to smoke dagga/marijuana thinking that it will make them lose weight because they are stressed that other people will laugh at them...” (P2_all female FGD)

2.3. Hospitalisation and medications

Participants suggested that obese individuals should be hospitalised or given medication, pills or injections, to help them reduce weight. The strong discourse around helping obese or overweight individuals in terms of hospitalising them, reiterates the prevailing sense that adolescents do not immediately identify themselves as agents capable of impacting their own BMI. Most participants viewed obesity as a disease or a reflection of disease, and therefore a condition that should be treated clinically.

“...I was thinking that it will be better if they can build a hospital for the obese people so that they can... fix them, they give them some injectables or tablets, things like that...or make them exercise...” (P7_all male FGD)

While adolescents suggested clinical treatment of obesity, they also acknowledged that people need to be educated about obesity and its outcomes and this education should extend to their families and household. This suggests that individual knowledge and skills including targeting their immediate environment may help to reduce obesity.

“...have this mindset of teaching people about obesity and telling them that being obese can cause diseases as I believe that lot of people are very scared of being sick... “(P6_all male FGD) ... share the information with our brothers, sisters and everyone at home (P7_all male FGD)

Discussion

Rural South African adolescent males and females identified multiple factors as they relate to obesity, including knowledge, systemic and relational issues. This research highlighted, firstly, that rural South African adolescents have some knowledge of the health risk that obesity imposes on an individual, recognising that obesity is a result of multiple factors.

However, the knowledge does not appear to translate into changes in attitude or behaviour as commonly noted in the literature. Secondly, adolescents in this context do not see themselves as agents of behaviour change or even view themselves as having a direct impact on their behaviour as it relates to obesity, but instead see the solutions to obesity as external by highlighting the use of substances, medications and institutionalisation as possible ways of dealing with obesity.

In terms of the knowledge of obesity, adolescents' views were conflicted with both positive and negative views expressed. The positive views expressed correlate with a long standing perception in South Africa and other African countries that larger women are considered desirable; as size represents happiness, beauty, and the absence of illness [18,33,34]. A study among 10–19 year-old black adolescent females living in an urban South African setting has shown that there is still a desire for a higher BMI [35–37]. However, negative views expressed by adolescents conflicted with these positive views, which again has been seen in previous literature where some adolescents express thinness is ideal - a belief often found on social media [38]. These competing views have also been found amongst urban adolescents in South Africa [35]. Amongst the negative views of obesity among adolescents is the belief that obesity is a sign of laziness, found in other studies in varying contexts [39]. These conflicting views may have implications for interventions focused on obesity. The opposing views should be acknowledged and an understanding where they come from understood so that they can be addressed in interventions.

The cultural belief that a bigger body is better preceded the HIV pandemic [33,39–43] however, the cultural belief was further fuelled by the pandemic and the perception that thinness equated to sickness or the presence of HIV. This shaped the cultural beliefs of South Africans and led to higher body weight being seen as healthy and symbolising happiness [44,45]. Interestingly, in this study, adolescents identified HIV treatment as a possible cause of obesity whereas historically, HIV/AIDS was described as the 'wasting' disease, with weight loss viewed as a marker of disease progression [46]. In recent years, it has been noted that a significant proportion of women initiated in new first line ART regimen do become overweight or obese

[45,47–50], not just gaining the weight that they have lost but also gaining additional weight [51]. The findings from this study highlight a clear shift in the perception of HIV and obesity: from HIV as a disease of wasting; to HIV and its treatment, as a disease of obesity. As a result of these transitioning views, shared not only by adolescents, but adults in urban Soweto as well [37], there now may be HIV stigma associated with obese people who may not be HIV positive; the same type of HIV stigma that thin people previously experienced. Our study did not specifically explore how adolescents' views on the association between HIV and obesity developed. However, the association has shifted cultural understanding of obesity as a possible “tell” for being on HIV treatment. This may have implications for interventions for both HIV and obesity amongst rural South African adolescents.

In combating obesity, adolescents suggested: (i) the closure of local community vendors (ii) the use of medications or hospitalization of those who are obese and (iii) the use of education for adolescents and their families. With regard to external services such as closing vendors and medications they believe are needed to address obesity, rather than identifying individual behaviours they could modify in their own lives. Adolescents suggested social and health system systemic interventions and more inclusive education about prevention of obesity for their families as part of the treatment. This highlights the importance of the bidirectionality of personal, environmental and cognitive factors in addressing obesity in this context. While adolescents have knowledge and recognise, to a degree, various environmental factors that could cause change in their behaviour, they do not put themselves directly as agents of that change. This suggests that interventions need to address cognitive, personal and environmental factors in order to effect change.

Adolescents suggested that community fast food vendors could be closed as a way to reduce access to unhealthy foods and so address obesity in the community. With the socio-economic transition underway in urban and rural South Africa, there has been an increase of easily accessible informal street vendors selling low-cost fast foods and snacks [33,52], which adolescents frequent with their peers [53]. A study from Cape Town highlighted that local shops lacked healthy food choices such as fruits and vegetables and unhealthy foods were more readily available in many of these local shops. This moved away from other studies that recommended that efforts be made to encourage local food shops to stock healthy food items for access by the people [54]. The closing down of the shops as suggested by adolescents may not be feasible

given the economic hardship in these communities; however, it is important to consider and address the foods sold in the shops that are accessible to adolescents in interventions of obesity.

Adolescents suggested hospitalization or medications as an avenue to address obesity. This indicates a general lack in understanding of community-based approaches to addressing obesity and also shifted the responsibility to away from the individual. Previous research, including work from South Africa, suggests that behaviour change approaches, which are considered the cornerstone of health promotion interventions, should be conducted and if those fail, then weight loss medication and/or surgery can be considered for those who do not respond to the behaviour change strategies [55,56]. Our study did not specifically ask which obese people adolescents consider needing hospitalisation. That may be an important aspect to consider as it may speak to what boundaries adolescents consider as obese, and perhaps these will not be the more biomedical cut-offs that are traditionally used to define overweight and obesity.

Our research suggests that adolescents felt education on obesity not just important for themselves but for their families as well. This finding highlights the importance of not only intervening at an individual level but also targeting households (environmental factors), leading to buy-in from the family which may enhance the impact of interventions targeted at reducing obesity amongst adolescents.

In South Africa, intervention studies in recent years have focused on specific aspects of reducing the burden of obesity in adolescents. “HealthKick”, a school-based intervention, comprised diet and physical activity interventions aimed at preventing overweight in children and adolescents and thereby reducing the risk of chronic diseases such as Type 2 diabetes mellitus. The study identified significant improvement in self-efficacy and nutrition knowledge but not in children’s dietary behaviour [57]. Notable challenges included lack of parental involvement, time and available resources, poor physical environment at schools and socio-economic considerations within households. The study concluded that increased parental involvement and greater support from schools were important aspects to consider for future interventions. A study underway in KwaZulu-Natal [58] highlights the importance of not only focusing on adolescents’ attitudes, behaviours and choices, but on how different individual, social and societal aspects may influence adolescents’ decisions. Understanding how adolescent’s behavioural practices are formed, and the process of leading to rejecting or accepting behaviours is likely to be important

to developing impactful, contextually relevant interventions aimed at mitigating obesity among adolescents.

Applying SCT to the development of adolescent behaviour change interventions in context of our findings, would suggest: (i) the adolescents need to understand that they encompass both an agent for change and a responder to change; (ii) Adolescents (individually and with peers) and their families need to be educated separately and together on obesity in order to influence behaviour change in their environment enabling change in social norms; and (iii) adolescents need to be empowered to know that they are in control of their own behaviour and need to be supported through the process of change.

Limitations

The findings of this study cannot be generalized to wider adolescent populations. In our study, we explored understanding of obesity amongst rural South African adolescents but did not ask adolescents where they obtained their information, which may be useful in the design and targeting of future interventions.

Conclusion

Findings from this research provide rural South African adolescents' perspectives of the causes and consequences of obesity and propose their solutions to reduce obesity in their community. Adolescents appear to understand the causes and health consequences of obesity; however, they do not associate current health behaviours to risk of disease later in life.

Adolescents have a 'medicalised' view of treatment for obesity and do not view themselves as agents of their own behaviour change. Interventions aimed at changing adolescents' views on personal behaviour and promoting healthy lifestyle choices are needed to mitigate the risk of obesity in rural South Africa, and formative work, such as this work, is essential in order to tailor interventions to adolescents' knowledge and views of obesity.

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Chapter 6: Paper 3

The following paper is under review in Global Public Health. It represents an exploration of the feasibility and acceptability of a CHWS-led community based intervention promoting health. This is explored through attendance, focus groups and in-depth interviews with adolescents, parents and CHWs. It responds to the objective of examining the feasibility and acceptability of a health promotion intervention, in the context of rural adolescents in South Africa.

What follows are the title and body of the paper formatted for this integrated document.

Assessing the feasibility of a community health worker-led, community-based health promotion intervention for rural South African adolescents

Background

Adolescents constitute almost one-quarter of the world's population. As individuals progress through adolescence, their exposure to social determinants of health, including access to health services, food security, education, and employment undergoes considerable change. The parental/family-dominated determinants of lifestyle choices in childhood expand to include the influence of peers, the community, culture, education, and the media [1]. Thus, the adolescent population presents unique public health challenges as adolescents transition from parent-managed to personal responsibility for health behaviours [2]. Some studies have shown that this transition can lead to physical inactivity, sedentary behaviour, unhealthy dietary habits, and increased body mass index (BMI). These factors are becoming increasingly prevalent in adolescents globally and have been linked with increased risk of non-communicable diseases (NCDs) later in life [3–9]. This presents a major public health concern worldwide resulting in associated morbidity and mortality and long-term negative implications on overall individual health (such as NCDs) and socio-economic development [10–15].

As part of policy efforts to improve adolescent health in South Africa, adolescent-friendly health services (AFHS) were introduced into the South African healthcare system in 2006 [16–21]. Even with the substantial allocation of funding to this program, a shortage of healthcare providers to meet these needs persists, resulting in the need to shift tasks to a unique cadre of trained individuals - community health workers (CHWs). CHWs are typically members of the communities where they work, often selected by the community, answerable to the community for their activities, are supported by the government health system but not necessarily a part of its organisation, and have shorter training than professional workers [22,23]. CHWs, when used effectively, can make major improvements in health priorities in the areas where they work. In South Africa, CHWs are being deployed for a range of roles including providing health education, health screening and treatment adherence for tuberculosis (TB) and HIV as part of the Ward Based Outreach Teams [24–26][27–30]. CHWs present an extension for delivering health services, and some have argued that, in addition to already available primary healthcare services,

CHWs who specialise in adolescent health may be able to increase adolescents' health coverage by targeting households with adolescents [31,32]. CHWs could help increase awareness of adolescent-friendly health services, focus on key messages to enhance behaviour change in adolescents, and develop a high level of expertise in adolescent health [18]. More evidence is necessary, however, to determine the feasibility of using CHWs as drivers of a community-based behaviour change intervention for adolescents.

The behaviour change wheel approach has been identified and promotes health through individual lifestyle changes that are contextually appropriate [33–35]. The assumption of the approach is that, before people can change their lifestyle, they must first understand basic facts about a particular health issue, adopt key attitudes, learn skills, and be given access to appropriate services[33,35]. However, fundamentally it is believed that people do not resist change, but resist being changed, suggesting that an intervention for behaviour change in adolescents must be collaborative and empower the adolescent participant to change by providing them with the information necessary to change.

The understanding of health-promoting behaviours in adolescents may not simply be an application of existing knowledge related to health promotion in adults. Rather the development of independence and the associated tasks of adolescent development contribute to the unique body of knowledge on health promotion in adolescents [2,36]. Over the past few decades, considerable funding has been invested in implementing community-based programs designed to reduce the risk of major chronic diseases in the population. The community-based interventions are described as having some advantages including the fact that they do not primarily depend on the primary health care system. The interventions can reach persons of all risk groups, in this case, adolescents who are not always inclined to go to health facilities (Omotoso et al., 2022). These interventions can also influence contextual factors that shape lifestyle but are not under the control of the individual.

Given the paucity of research from low-and middle-income countries (LMICs) on adolescent involvement in health-related interventions and evaluation of community-based intervention methods, there is an urgent need for more research in this area and more interventions that are specifically adolescent-focused in LMICs, including rural South Africa [11]. The aim of this paper was to explore the feasibility and acceptability of a community-based, CHW-led health

promotion intervention for adolescents in rural South Africa from the perspective of adolescents, their parents and the CHWs who delivered the intervention.

Methods

Study design and setting

An exploratory mixed methods research design was used. The intervention was undertaken in rural Mpumalanga Province, South Africa at the MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt) study site. The Unit operates the Agincourt HDSS which has accumulated over 30 years of comprehensive population-based surveillance data in a population of some 117 000 people living in 31 villages with the limited road, water and sanitary infrastructure. The resident adolescent population (aged 12-19 years) in 2018 was 14,154, of which 50.7 % were female [37]. Most adolescents in the context are attending secondary school. Within the study site, a double burden of malnutrition which is predicated by a high prevalence of undernutrition found in children and adolescents, coupled with an increase in overweight and obesity, particularly in females has been documented (Seabi TM et al.,(under review). This double burden of malnutrition is likely associated with the nutritional transition underway in the rural context and likely contributes to the emerging burden of noncommunicable diseases (NCDs). The risk for NCDs is increased by overweight/obesity, central obesity (fat mass in the abdominal region), and elevated blood pressure [39]. HIV/AIDS is highly prevalent and an increasing prevalence of cardiovascular and metabolic diseases has been observed in this population [40–45]. These trends further support the need from the community perspective on health promotion interventions amongst adolescents.

Intervention and health promotion material

The CHW-led health promotion intervention comprised of community-based peer-groups that focused on broad health promotion in the form of the delivery of health literacy material (*Information 4 My Life*). CHWs engaged with reflective information about healthy lifestyle choices and behaviours and identified contextually relevant ways in which adolescents could implement positive choices and behaviour through goal setting. The intervention was delivered by specifically trained individuals as community health workers (CHWs) delivering a structured programme to adolescents. This allowed the exploration of components of health promotion-based behaviour change interventions amongst rural adolescents.

The activity book, known as *Information 4 My Life*, was developed through formative work conducted with adolescents in the study area as well as local stakeholders, including educators, nutritionists and adolescents. The materials in the workbook included the results of research conducted in the Agincourt area that focused on adolescent health and how study results can be made practical to an adolescent audience. Each adolescent was given a copy of the workbook to keep, allowing participants to engage with the material both during and after group sessions. Topics covered in the workbook included: 1) the power of information, 2) making the right choices, 3) choosing healthy food, 4) choosing to be healthy and active, 5) choosing healthy sexual behaviour, and 6) support for goal setting (Table 1). Adolescents completed the workbook's activities and were encouraged to implement the learned behaviour changes suggested in the workbook (Table 1). The workbook was intentionally designed for interaction and engagement and differed from the more didactic form of content delivery common in schools. This engagement allowed adolescents to engage with the materials as individuals and with their peers through the peer-groups.

Table 1: Details of topics in the *Information 4 My Life* workbook

Topic	Activity book topics: completed activities within the sessions
	Session 1 (4 hours)
Information is powerful	Focus: everyday choices made by adolescents; importance and influence of information consumed daily; where adolescents get their information. Five activities, two self-studies (open spaces to reflect on topics discussed) and a group activity to share ideas with peers. Activities involved identifying sources of information and discussion on how these can impact choices.
Make the right choices	Focus: understanding the consequences of choices Three activities included: topical role playing, group activities to share ideas and a home creative piece. CHWs measured height and weight to allow adolescents to calculate BMI forming part of discussion.
Choose healthy foods	Focus: food choices in various environments, healthy foods and portions, importance of all food groups and food choices. Five activities including self-activities and group ideas-sharing. This included discussions on what fast foods adolescents eat, and leading discussions on food groups and activities to create the ideal plate.
	Session 2 (4 hours)
Choose to be healthy and active	Focus: physical activity – its importance for health, types, times and motivations for physical activity. Four activities including case stories and exercises.
Choose healthy sexual behaviour	Focus: sexual behaviour choices including partners, birth control and pregnancy, sexually transmitted diseases such as HIV. Eight activities included role plays, case stories and written activities.
Support for my health goals	Focus: Aspiration and goals for the future. Reflecting back on topics covered and relation to health. Group discussion on how decisions impact the future, where adolescents can seek support for their goals and move goals to actions.

Recruitment of participants

Participants were purposively recruited from all adolescents residing in one HDSS village who were previously surveyed as part of a larger study (Seabi TM et al.,(under review). Adolescents were defined as individuals aged 12-19 years of age at the time of enrolment in this study. Using information from the Agincourt HDSS, all households with adolescents who participated in the previous study were visited by specially-trained CHWs who invited adolescents and their caregivers to participate. Caregiver consent and adolescent assent were sought for individuals less than 18 years and consent alone was sought for individuals 18 years or older. All study procedures, including informed consent, were conducted in the local language (xiTsonga).

Who delivered the Intervention (change agent)

CHWs were employed to deliver the intervention. All the CHWs involved in the study had a matric certificate (graduated from secondary school; in line with national requirements for CHW employment (Perry et al., 2021)); previous experience within the MRC/Wits Agincourt Research Unit or other local NGOs working on adolescent HIV counselling and testing; resided within the Agincourt HDSS study site; spoke the same language (xiTsonga) as the adolescents; and were trained to conduct the consenting process, present the intervention material and facilitate the group sessions. The training of the CHWs was conducted by the project manager (TS) in collaboration from the MRC/Wits-Agincourt Research Unit's Public Engagement Office (whose role is to serve as a link between the Research Unit and the community). The training occurred over a two-week period and included both theory and practice, with role-playing activities used to prepare the CHWs for the delivery of the intervention. There were one male and two female CHWs employed, all between the age of 30-45 years of age.

How the intervention was delivered

The intervention was originally designed to be delivered to adolescent peer-groups on two Saturdays at a centrally located community meeting hall. Each session was planned to last four hours and cover three topics (as described in Table 1), with a light snack provided at the conclusion. Participants were expected to attend both Saturday sessions.

Data Collection

Assessment of feasibility

In this study, feasibility explores the practicality, adaptation, and implementation barriers and facilitators of the intervention [47,48]. Acceptability in this study explores the extent to which an intervention is suitable (health literacy material), satisfying, and appealing, from the perspective of the adolescents as recipients and CHWs as change agents [49,50]. Quantitative and qualitative data were collected to assess the feasibility and acceptability.

Quantitative data

Participants were required to sign in at each session, a process monitored by the CHWs facilitating each session. Sign-in occurred at the start and at the end of each session. These sign-in registers were used to assess the attendance at sessions (feasibility).

Qualitative data

After the intervention, six focus group discussions (FGDs) were conducted with adolescents who attended both sessions of the intervention and agreed to take part in the FGDs. In the FGDs, adolescents were asked about their experience of being part of the intervention to assess the acceptability of the intervention. The FGDs averaged 50 minutes and both male and female adolescents were present in all groups.

Semi-structured individual interviews with adolescents (n=20), caregivers (n=5) and CHWs (n=3) were conducted to explore the modifications made to the intervention, their experiences of being part of the intervention, and the acceptability of the modified programme. The interviews and FGDs were conducted in xiTsonga, recorded, translated and transcribed into English. The interviews and FGDs were conducted by two fieldworkers trained in qualitative data collection who were not involved in the intervention. The focus group discussions allowed the researchers to gather insights from a group perspective and the interviews were conducted to allow for triangulation and more personal perspectives.

The project manager and CHWs held weekly debriefing meetings to discuss intervention elements and experiences during the previous week, including issues or questions from

adolescents. Challenges encountered by the CHWs during the administration of the sessions were also discussed. This allowed for the implementation of modifications to the intervention.

Data Analysis

Quantitative Data

Descriptive analysis was used to analyse attendance and retention of participants throughout the intervention by age and sex, with percentages reported.

Qualitative Data

FGDs and interviews were transcribed and translated. To address bias and ensure rigour, transcripts were coded independently by TS and a second researcher and themes were identified and validated to agreement [51]. NVivo (9.2) software was used to code data so that themes could be related. The inductive thematic analysis approach [52] was used to identify themes and to allow for data-driven analysis. This approach also allowed the researcher to determine the outcomes based on the data collected as opposed to being bound to a specific theoretical framework [53–55].

Ethics

The study was approved by the Human Research Ethics Committee (Medical) of the University of Witwatersrand (M171113, M180873), and the Mpumalanga Province Department of Health Research and Ethics Committee. Permission from village leadership was obtained through established processes of the Public Engagement Office of the MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt). Permission was obtained from the high school principal where intervention sessions were held.

Results

The results of the study highlight the feasibility and acceptability of the intervention and are presented in these two broad themes. Feasibility describes the delivery, attendance and modifications to the intervention. Acceptability will be presented into four subthemes; 1) affective attitude, 2) opportunity costs, 3) perceived benefits and 4) adolescents' confidence to implement learnings.

1. Feasibility to implement (CHWs) and attend the intervention (adolescents)

CHWs reported that during the consenting process, during which the CHWs communicated details of the sessions including duration and venue, adolescents seemed interested in participating. Of the 186 adolescents that they approached, 164 (88.2%) consented to participate. Adolescents participating in sessions had a mean age of 16.3 years (standard deviation: 1.8) with an age range of 14-19 years. Participants were 52% males and 48% females (Table 2).

Table 2: Socio-demographic characteristics of intervention participants

	Female (standard deviation)	Male (standard deviation)
Age	16.2 (1.9)	16.5 (1.7)
Socio-economic status	3.1 (1.4)	3.2 (1.4)
Education	Grade 11	Grade 10

CHWs reported that within the first sessions, they found that adolescents were engaged and participated throughout asking asking and freely discussing the material being presented

*“...when we meet to our sessions we first set some grounds rules, go to expectations... after expectations, **you found that the participants were wanting more information about health...**” (CHW 3_IDI)*

*“...when we are busy discussing topics... **adolescents had many questions about goals and peer pressures and how they can avoid it...the adolescents were very open to me and peers... they asked many questions...**” (CHW 1_IDI)*

While several participants attended the first sessions, there were numerous participants who reported logistical barriers to attending Saturday sessions despite reported positive attitudes towards the program. Of the adolescents who consented, 72 (44%) came to the first Saturday session and only 38 of the 72 (53%) returned for the second (Table 5). Barriers to attending the weekend sessions varied amongst adolescents and included having other commitments at the

time of the sessions, such as jobs and Saturday classes, and unforeseen social responsibilities, such as funerals. Others struggled with transportation to access the weekend venue.

“...she [teacher] cannot allow us [with regards to Saturday] because she wants to teach. And the other thing is the work that the teacher is doing is not the same as the things during the week ...” (AD 11_IDI (non-attendance))

“...I thought they would have come and fetch me at home ...and they didn't come...I didn't have another way to contact them, they have my numbers and a way to come...I would be better to do it at school...” (AD_13_IDI)

“...I would have attended... I heard [about the session] but I didn't make any follow-ups to attend...” (AD_18_IDI)

Due to the challenges encountered, several modifications to the intervention were introduced including 1.) moving sessions from Saturdays to weekdays after school ended, 2.) changing the venue from a central community meeting hall to the school premises, and 3.) reducing the duration of the session from 4 to 2.5 hours. Table 4 gives a brief description of the program and its modifications (adapted from the FRAME-IS [56]).

The use of the school premises was convenient and easily accessible. The goal of the modifications made, shown in Table 4, was to mitigate the challenges of accessing the venue and attendance and retention of adolescents in the intervention sessions.

Table 4: Modifications made to the original intervention, adapted from FRAME-IS

Modifications to adolescent behaviour change intervention	
Intervention implemented is:	Promoting healthier lifestyles through behaviour change by using lay health workers to deliver content and activities
Implementation strategy being modified is:	Day, time and venue for the intervention
Modifications being made are:	1. Change of venue from community meeting hall to the school (where adolescents attended) 2. Sessions reduced from 4 hours to 2.5 hours
Reason for the modifications are to:	1. Improve attendance and retention 2. Improve feasibility
What is modified?	Context: Day and location of session. Held after school program and on school premises Content: removing selected exercises within the session and encouraging these to be done at home to fit within shortened time
What is the nature of the content, evaluation, or training modification?	Strengthening intervention implementation process by tailoring both venue and material
What is the goal?	To mitigate challenges of attendance and retention of adolescents in interventions due to time constraints, and feasibility of the implementation effort

What is the level of the rationale for the modification?	Understanding and addressing the challenges of convening adolescents in a rural community
When is the modification initiated?	It was initiated during the study
Is the modification planned?	The modification was not planned
Who participates in the decision to modify?	Project manager through consultation with adolescents, teachers/principals, CHWs and the senior research team.
How widespread is the modification?	The modifications were only implemented after the intervention sessions had begun. A number of adolescents who consented to participate but never made to the Saturday sessions were then invited to participate after the modification. This modification included the schools with the teachers and principals as part of the stakeholders.

In addition to the logistical barriers to attendance, CHWs experienced challenges delivering the intervention as planned due to time constraints, as there were delays in adolescents arriving for the sessions due to challenges of school attendance as described above. The delivery style and content of the intervention remained the same, only the day and time were changed.

After discussions with the study team, the exercises conducted within the session were adjusted to fit into the new time and selected exercises intended for the group sessions were encouraged to be done at home. CHWs then summarised with adolescents in the following session and reviewed their workbooks (Table 3). The project manager and CHWs consulted with school principals and adolescents regarding the modifications. CHWs were retrained with the adapted and shortened material for the sessions. There was debriefing after sessions for the CHWs to review the modifications. Similar to the intended intervention, the sessions were kept to two sessions covering three topics in each session.

Table 3: Details of topics in the *Information 4 My Life* activity after the modifications

Topic	Activities after modifications: activities within the sessions as part of the modification
	<i>Session 1</i>
Information is powerful	Only two activities discussed: research findings within their context; and group activity on what information adolescents consume, where it comes from and how to think about choices based on the information. This was group discussion where adolescent mapped where they get information CHWs encouraged adolescents to complete remaining activities at home.
Make the right choices	Modification retained CHWs measuring height and weight and the group activities to share ideas on choice and scenarios

	discussing processes to make a choice, with the rest of activities to be done in adolescents' own time.
Choose healthy foods	CHWs focused on group activities discussing food portions and sugar content in foods. Group activity required adolescents to learn about various food groups and portions required per meal.
	Session 2
Choose to be healthy and active	CHWs focused on doing exercises with adolescents to demonstrate physical activity. One written activity.
Choose healthy sexual behaviour	CHWs focused on case stories and role plays to facilitate discussion on sexual behaviours.
Support for my health goals	CHWs focused on goal setting and discussions on support for their goals.

To assess if the adaptations improved feasibility, a subset of adolescents (about one-third; n=18), who initially provided consent but did not participate in the sessions, were sampled and invited again to participate. Of these, all but one attended both sessions (with three additional adolescents who were not invited, also attending the second session) (Table 5). The intervention was delivered on a Wednesday on school premises in classrooms provided by the school.

Table 5: Intervention attendance: pre-and post-modification

	Pre-modification (Saturday sessions, community venue)			Post-modification (weekday afternoon, school venue)		
	Consented n=164			Invited n=18		
	Male	Female	Overall Attendance	Male	Female	Overall Attendance
Session 1	31	41	72 [44%]	8	10	18 [100%]
Session 2	14	24	38 [53%]	12	9	21 [117%]

By shortening our sessions and moving the sessions to a weekday afternoon, our results suggest that the intervention was more feasible, resulting in higher retention.

2. Acceptability of the intervention

2.1. Affective attitude of the intervention

The intervention was positively received by adolescents who reported that session materials were so useful that they shared the material with family and friends extending the potential impact of the intervention beyond the adolescents who participated in the peer-groups.

“...It feels good because I end up getting knowledge about something that can help me and also helps my siblings because I have told them what we have learned...” (P1_FGD 2)

“...at school, there are people that we are discussing with about the book... I am just talking to them, but some were participating in the study... even today some they want the book...” (AD 7_IDI)

In discussing the intervention with family members, the adolescents began to implement some of the suggested behaviour changes, particularly around food choices and portion sizes. A mother of an adolescent reflects:

“...The change that I’m talking about is ...If he found us cooking something that we need to eat here at home... he doesn’t go and find his own foods... We all eat the same food that I cooked...But before he attended the sessions, when he found you cook something he didn’t want, he was saying I don’t want to eat. Our diet has changed since he joined the sessions...we [family] have started to avoid some of the things when my son told us what they learned in the session. So that is why there is a change when it comes to cooking, when we cook now we avoid pouring lots of oil ...” (PA_1_IDI)

2.2.Opportunity costs to participating

We explored adolescent acceptability toward CHWs delivering the intervention. Adolescents did not express any objections to CHWs delivering the intervention. Rather, they expressed positive views regarding the CHWs delivering the intervention. The adolescents explained that CHWs provided important information, listened to them and allowed them (the adolescents) to be more open with the CHWs than with their parents.

*“...Wits [research/project staff] people talk to us nice...**the nurses [at the health facilities] won’t give you all the necessary information and tells you their job is to treat not give information** so from Wits people[CHWs] we got all the necessary information and they encouraged us...**the Wits people [CHWs] will listen...**”(AD 5_IDI)*

“...I am afraid to ask or answer about some things in front of our parents but when we are here [in sessions] a group of peers and CHWs... it’s easy to talk...” (AD 1_IDI)

Adolescents appreciated the convenience of having the sessions take place at their schools, which were close to their homes. Some adolescents expressed enthusiasm about the convenience of CHWs potentially coming to their homes in future and the sessions taking place within their community in the school which is where adolescents spend most of their time. Amongst other advantages, this would allow the inclusion of adolescents with disabilities.

“...if you seek help to the Nurses you need to go to the clinic and you also use your money to travel but if Wits people [CHWs] come to our houses [referring to the idea of being visited by the CHWs]...” (AD 6_IDI)

“...I can also say that we are thankful for the CHW team... we have learned a lot that can help us and keep on teaching us and don't give up...but I would like to say also encourage the disabled people...that the way there are they have to stay at home and do nothing because they can't walk or in a wheelchair, they have to be encouraged that there's a lot that they can do to help themselves...” (P4_FGD2)

Notably, participants were also enthusiastic about receiving information about their health without having to go to a health facility where they expressed not feeling comfortable. Importantly, CHWs were from the area and were matched culturally and linguistically, which was appreciated. Adolescents expressed that it was important to have someone from their area; however, for confidentiality reasons, not a member of the immediate community.

“...home-based care [referring to lay health workers that adolescents were previously exposed to] they don't give more information and they give the information on how to prevent diseases.... and the information on what to eat and how to reach your goal they don't include it ...nurses are rude, if you went to test HIV they say you young and why you want to test ...”(AD 5_IDI)

The acceptability of the material for future use was explored, and participants indicated that the program was valuable to them and that they enjoyed the sessions. They felt the material provided them with insights and allowed them to better understand healthy lifestyles and the importance of making choices, particularly around the health consequences of food. However, adolescents mentioned topics they felt were missing and needed to be added to interventions, such as how to deal with peer pressure and sexual relationships with potential violence.

“...These days it seems like smoking dagga is fashionable... **if you don't smoke you are out of style ...** People don't take you seriously...when you don't smoke... **girls don't take you seriously... they think you are stupid** and when you smoke they say you are ok... how to do we fit it, *smoking because of peer pressure?...*” (P7_FGD 6-mixed)

“...you can have an argument but if you date a sugar daddy... you will be afraid to argue with them [referring to the use of condoms]... for example, when a sugar daddy says let's go home I will go... because I will be afraid to be beaten but when I date a guy from my age I will say no...” (P9_FGD 6-mixed)

As part of the activities included in the sessions, CHWs measured adolescents' weight and height in order to calculate BMI. The calculation of BMI was followed and also included in the

discussion of food choices and physical activity in addition to adding issues such as peer pressure and sexual relationships, they also felt that services for sexual health such as HIV counselling and testing as well as the provision of contraception by the CHWs needed to be added as part of the intervention with adolescents.

“...why do you have height and waist testing equipment but when it comes to topics of STI [HIV and others] you don't have testing equipment to test us as it will be better...” (P1_FGD 1)

2.3. Perceived effectiveness of the intervention

Participants seemed more enthusiastic about certain topics, particularly the discussion around food choices. During the sessions, the participants voiced their opinions and even challenged what they believed was not correct, which led to engagement within peer-groups and with the CHWs. The CHWs reflected on delivering the sessions and recognised that the sessions changed their own perspectives on some topics.

“...that is why I enjoy facilitating the studies because when I was younger, I was struggling...about how to identify my goals... Always following what others were doing and it showed that I didn't know my own dreams and support to reach those dreams...” (CHW 1_IDI)

“...It was interesting [learning and facilitating the material] because as a Community health worker in this study it helped us, inspired us to not give adolescents [participating in the study] the information only, it is helpful that we need live and practice [the material] to our own adolescents at home...”
(CHW 3_IDI)

2.4. Adolescent's confidence to implement learnings

The participants appreciated what they learned during the sessions and began implementing changes suggested in the workbook. Participants highlighted that some of what they learned was new to them and appreciated learning about eating behaviours and sexual health, describing these issues as informative.

“...The new thing to me is, I was never taught about sex ever in my life...” “...I was hanging around with friends who smoke and drink alcohol...now after the sessions, I don't go around with them a lot...I make other friends...” (AD 2_IDI)

“...We found all the information about how to take care of yourself Mm... what to eat...to do exercises and how to reach your goal...” (AD 5_IDI)

“...I wasn't eating traditional vegetables like muroho [leafy, green vegetable], I was eating mostly something that has lots of oil and now I don't eat them a lot...I eat smaller [amounts of] food as well.”
“...after the sessions, I am jogging...” (AD 8_IDI)

While some adolescents started to implement and change after participating in the intervention, there were others who reportedly did not, as one parent describes below:

“...according to my thoughts about the one who attended the sessions... there is no change I have seen...the chips and the fat cakes that you teach them...they continued eating it ... so when it comes to eating (muroho)vegetables ... when you cook it ... they say I don't want to eat it... they want meat, so there is no change because he/she still continue eating it...(PA_2_IDI)

Discussion

This paper explored the delivery of an adolescent-focused intervention, including necessary modifications, delivered by CHWs. Our data showed that the intervention and its delivery by CHWs were acceptable and appropriate in this rural South African context. The implementation was also feasible after making some critical contextual adjustments. The modifications made highlight that engaging adolescents at a place in which they are already spending most of their time (i.e., school) may be a more convenient option for group activities, whilst retaining home visits that may be useful for individual activities for adolescents. The findings also provide valuable contextual insights into the extent to which the program, as described, can be delivered as intended within a rural setting.

Adolescent health interventions

Interventions targeting adolescent behaviour change through the promotion of healthy lifestyles, including physical activity have been undertaken in different communities [57–60]. There have been school-based interventions on obesity amongst adolescents in various contexts in Asia and sub-Saharan Africa [61–65]. It has been found that school programs can be effective in the prevention of childhood and adolescent overweight and obesity [57,66,67] and our results support this; rural South African adolescents were enthusiastic about the intervention in this context.

The Intervention Venue

In previous intervention mapping work conducted in this context, community-based interventions were proposed for several reasons including the reluctance of adolescents accessing facility-based health services because staff may disclose the visit to the adolescent's caregivers [68]. Thus, the current study's intervention location was outside the health facility at a central community meeting hall. However, the initial results quickly highlighted that using

venues other than schools was challenging in terms of attendance and retention, supporting the use of schools for delivery of an adolescent-focused intervention. This extends the work of previous research finding the use of schools as a venue to be acceptable in the delivery of an intervention to a younger age group [57,66,69]. The current study found that attendance increased at the school venue due to its convenience; however undertaking the intervention after the school day increases the length of time an adolescent spends in a classroom setting and may affect how much information is retained.

The low attendance and retention in community-based interventions, particularly with adolescents [70,71] are recurring challenges and the current study shared similar challenges to those previously acknowledged in other countries and in urban areas [67,72]. While the intention of the intervention in using a central community venue in a rural context is to mitigate transportation barriers, the lessons from this study show adolescents may continue to face challenges in accessing even central community venues. Using the most convenient location (ideally, where the adolescents need to be – e.g. a school-setting in this instance) is essential to maximise attendance and retention of the target population. Furthermore, such interventions should consider school schedules and have buy-in from educators and caregivers.

The use of CHWs

CHWs have been used in various ways as an extension of health services around the world, including cancer screening [30,59,73], reducing undernutrition, and increasing access to healthcare facilities in LMICs [29]. Findings have shown that CHWs have contributed to a reduction in under-5 mortality; improved women's health; assisted in reducing the spread of HIV/AIDS; the delivery of treatment and adherence promotion; and attended to malaria, TB and diabetes in different communities [27–30]. In South Africa, CHWs are most often women and have often been employed to focus on specific diseases in rural communities.

The present study found that rural South African adolescents were receptive to CHWs as implementers of a health behaviour change intervention. This supports previous research in South Africa where CHWs were found to address the recipients' context-related, as well as health and medical needs, thus building greater levels of trust with their clients [74] which may result in better adherence to treatment and outcomes. This work extends these findings by

highlighting that adolescents were receptive to CHWs and expressed the greater trust they felt as compared to their experience at healthcare facilities. Research has reported that an important aspect of recipients' choice to use services, their uptake of advice and continuing care from CHWs has been their trust in the CHWs [75]. This work highlights the views of the adolescents on characteristics CHWs required – being an individual familiar with the context although not from the same community in order to maintain confidentiality and cultivate trust. Thus, interventions must consider where CHWs are from within the context and address those characteristics to ensure trust amongst the adolescents and alleviate concerns of confidentiality that adolescents may have with people from their specific area.

In addition to the positive response to the intervention and the role of CHWs as implementers of the intervention, CHWs also present an opportunity to extend the delivery of health services. The recent COVID-19 pandemic highlighted the importance of their role when providing communities with COVID-19 health education and early screening [76,77]. However, there have been general concerns about the use of CHWs. Several challenges related to the rollout of CHWs include poor remuneration, lack of required skills, high attrition rates and lack of supervision and support at local, district and national levels. These have implications for scale-up in the use of CHWs in adolescents and other interventions and would need to be addressed in order for interventions to be implemented successfully. In this study, there were debriefing sessions to ensure CHWs felt supported in the role and adaptations were made as needed to facilitate the intervention. While it required effort, it is not impossible and further work should seek to understand the needs of CHWs in relation to providing community-based services and interventions.

There have been some arguments that CHWs who specialise in adolescent health [18,31] may be able to increase health coverage of adolescents by specifically targeting households with adolescents, in addition to already available, primary healthcare services [31,78]. While this study's focus was on adolescents only, it did not compare specialised (adolescent-focused) and general CHWs. However, there were positive responses to CHWs engaging adolescents both in the group sessions at the school venues and at their homes where the consenting occurred with guardians and adolescents. There are implications regarding the choice of general versus specialised CHWs around policy, supervision and resources which all have implications for sustained service and need to be explored further in the local and national context.

Previous research with adolescents has suggested that they are typically averse to traditional health education approaches such as lectures or printed material and are therefore more likely to respond to educational strategies that involve more interactive methods or encourage physical activity [57,60,73]. It, therefore, seems appropriate to use CHWs in community-based interventions as a means to promote healthy lifestyle choices among adolescents. The findings from the current research support this as CHWs are outside the traditional approach to education. This study was not designed to examine the effectiveness of the intervention and further research is warranted.

Health promotion interventions on behaviour change

The impact of health-promoting interventions on behaviour change has often been unclear and often varied in outcomes [34,79]. Some studies have collected quantitative and qualitative outcomes post-intervention to determine the adoption and effectiveness of an intervention [80,81]. There have been studies on behaviour change in various contexts; however, there are limited studies exploring health promotion interventions on behaviour change in sub-Saharan Africa and South Africa in particular amongst adolescents [36,59,82]. This study contributes by extending knowledge on the acceptability of community-based interventions implemented by CHWs focusing on adolescents. This work supports the use of specialised adolescent CHWs to increase coverage of households with adolescents and increase awareness and while the study did not test the uptake of adolescent-friendly health services, the specialised CHWs could potentially increase awareness and uptake. This study provides evidence for the inclusion of adolescent-focused CHWs as part of the primary healthcare system, especially in the rural context where accessibility to health facilities remains a concern.

An important finding from this study is that adolescents can be part of knowledge extension to parents and other household members. Furthermore, parents who are open to discussion and who support the intervention can lead to changes in behaviour and positive choices amongst adolescents [70,82]. This study, like previous studies where adolescents receive their information from multiple sources, shows the importance of reinforcing positive messages within the home to impact improvements such as changes in diet and/or portion sizes, increased physical activity and even improvement in health-seeking behaviour. As part of the lessons learned from this study, adolescent-targeted interventions must consider where adolescents get information and address the sources of information within the intervention to ensure success. This work suggests that interventions could use those sources of information as part of the

intervention. As an example, the use and the role of the school is potentially a good place where positive messages regarding behavioural interventions can be reinforced.

Evidence for a multi-level intervention

There are studies that suggest the importance of including caregivers in interventions directed at children and adolescents. While this study did not include parents/caregivers in the intervention, adolescent participants shared material from the peer groups with their caregivers, an action that could contribute to wider community awareness of healthier lifestyles. There were parents who reported changing their own behaviours as a result of the adolescent intervention. However, there were also parents who saw no difference in their children's behaviour which may suggest that parents could be involved in future interventions to reinforce the learnt information and support changes that adolescents make. From previous work, CHWs can provide further household-level support [46] .

The implementation of interventions in practice does not always progress as planned, which has implications for the findings of research and intervention outcomes [83,84]. recent implementation science work has emphasised the importance of documenting modifications in the field that refine interventions for their context in order to enhance successful outcomes. Documenting modifications not only supports the refining of interventions, but also supports their reproducibility and further clarifies mechanisms of change. Documenting modifications may limit the impact of the challenges and maintain efficacy as well as increase the impact of the interventions. Our findings lend further weight to calls for process evaluations to examine both the structural and processual aspects of implementation – including interactions with the local context – if they are to fully explain what is delivered and why [85]. Collectively, the practical implementation insights from this study support the idea of context-specific interventions for better outcomes.

Strengths and Limitations

This study offers insight into the acceptability and feasibility of a CHW-led, community-based intervention for rural adolescents. The findings generated several recommendations to consider when designing adolescent-focused interventions. It provided insights into the promotion of healthy behaviour through interactive health literacy material and how that information can move from just the individual (adolescents) to their environment (family and peers).

Qualitative semi-structured interviews and focus group discussions were ideal to explore participants' in-depth lived experiences of the intervention. However, the results were not generalisable to a broader adolescent population. While we explored the acceptability of the intervention, we did not examine the fidelity and did not measure the effectiveness of the intervention or whether the reported behaviour changes were sustained over time. While there was potential for researcher bias, we attempted to mitigate this through the iterative development of the interview guides and independent coding of the transcripts. This contributed to data trustworthiness and ensured that no common themes were missed.

Conclusions

Interventions targeting adolescents should involve the adolescent in the development. The interventions need to be implemented at places where adolescents spend large portions of their time (e.g. schools), with interactive health literacy workbooks by adolescents. Furthermore, CHWs are acceptable to adolescents as implementers of the intervention and adolescents themselves can extend the intervention to other family members. Careful consideration of the way in which the intervention is delivered and the material that adolescents engaged with during the sessions is important. The lessons learned provide important insights for future interventions for adolescents and how CHWs may be deployed and potentially extend the services and reach of the primary healthcare system as it relates to adolescent health and the promotion of healthy lifestyles.

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Author contributions

TS carried out the analysis with input from RW and CA. TS, RW, CA and KK reviewed the results. TS wrote the first draft of the manuscript. All authors conceptualised the research, helped to revise the manuscript, and read and approved the final version of the manuscript submitted for publication.

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Chapter 7: Discussion

This thesis documents the continued anthropometric changes underway in rural South African adolescents and documents the feasibility and acceptability of a community-based, CHW-led intervention to reduce unhealthy BMI amongst adolescents. Building on earlier work by Kimani and colleagues, [46] the study provides evidence of a continuing double burden of malnutrition over ten years, characterised by the co-occurrence of stunting and underweight and an increasing prevalence of overweight and obesity in adolescents, particularly among females. This ongoing double burden of malnutrition (DBM) is a major risk factor for developing noncommunicable diseases (NCDs) later in life [32,46]. In documenting the persistent double burden, this study further sought to investigate how adolescents in rural South Africa understand the health risks associated with obesity. While adolescents are generally aware that there are multiple contributing causes to obesity, this research found – as frequently documented in the literature – that knowledge of the health risks associated with increased BMI does not translate into changes in behaviour or attitudes. Adolescents in this context do not see themselves as agents of behaviour change or as directly influencing their behaviour as it relates to obesity. Instead, they view the solutions to obesity as being external.

Finally, and in an effort to address the double burden of malnutrition, this study explored the feasibility and acceptability of a community health worker (CHW)-led community-based health promotion intervention, including necessary modifications, through the lens of adolescent recipients of the intervention, their parents and the CHW implementers.

This chapter places the results of this thesis into context, drawing on national and international literature to better understand the findings and highlighting potential limitations. The chapter links the results back to the conceptual framework discussed in Chapter 1 and is then divided into three sections: 1.) Trends of patterns of malnutrition; 2.) Adolescent obesity, views and understanding; and 3.) Community-based interventions in the context of Adolescent Health Promotion.

Link to Conceptual Framework

This study has substantiated that associations between individual (adolescent), household, and community/societal factors impact an adolescent's health behaviours as proposed by the conceptual framework for this thesis (Figures 1.0.1-1.0.2). Individual factors include adolescents' dietary choices, physical activity levels, and body image perceptions. Household factors include SES and the family's cultural beliefs and practices related to food and nutrition. Community/societal factors include access to healthcare, education, and infrastructure such as clean water and sanitation facilities, although not directly investigated in this study. Additionally, societal and cultural norms related to food and body image can also influence an adolescent's nutritional status. Societal and cultural norms around traditional food preferences and eating practices can also impact the types and quantities of food consumed by adolescents. Additionally, the beliefs about body size and shape may affect body image perception, which in turn can influence dietary choices and overall nutritional well-being.

It is crucial to consider the interconnectedness of various factors that influence the decision-making and health behaviours of adolescents when developing interventions to address their nutrition. To create comprehensive, effective and holistic programs, it is important to understand how these factors interact. The study employed a community-based intervention to examine behavioural aspects related to adolescent health, facilitated by Community Health Workers (CHWs) to promote the utilisation of appropriate healthcare services.

The findings in this study as related to the socioecological model highlight the necessity for targeted interventions that take into account the interplay between different factors in shaping health outcomes for adolescents, i.e. how adolescents as individuals interact with their households/families and peers as well as factoring in community views. The study emphasised that adolescents who participated in the intervention learned valuable lessons, and these lessons were also observed and influenced caregivers/guardians who were not directly involved in the intervention.

By recognising the complexity of these interactions, interventions can be better tailored to meet the specific needs of this population and achieve improved health outcomes.

Trends of malnutrition

This study documented, in Paper 1, presented in chapter 4, the phenomenon of the double burden of malnutrition documented in this study, marked by continuing levels of stunting and underweight and increasing levels of overweight and obesity is increasingly common in other LMICs undergoing the nutrition transition [18,22]. This study found a substantial prevalence of adolescent stunting and underweight: 19-25% and 7.9%, respectively. The levels of stunting have not changed significantly between 2007 and 2018, although the peak increased from 13 years in 2007 to 15 years in 2018. Levels of underweight have decreased particularly in younger adolescent males in this rural community, corresponding with levels seen in South Africa at similar ages [8,48,112]. The prevalence of persistent stunting and underweight in South Africa and other countries has been well-documented [238,239]. Surveys such as the Global School-Based Student Health and Health Behaviour in School-Aged Children indicate that during the early 2000s, approximately 10.2% of adolescents aged 12-15 years in low- and middle-income countries (LMICs) were found to be stunted [174,240]. The study found a persisting higher prevalence of stunting and underweight amongst adolescent males compared to females in both 2007 and ten years later in 2018. Whilst this trend was found in national South African studies [174,238,239], several international studies produced mixed results [122,174,238,241].

Concurrent with the levels of stunting and underweight, this study found substantial levels of overweight and obesity among adolescents in the same community over the ten-year period, from an overall prevalence overweight and obesity of about 11% in 2007 to 18% in 2018. Similar findings have been documented elsewhere in South Africa [32,49,174,238]. The levels documented in this rural area, though marked, were lower in 2007 than those recorded in national surveys and comparable in 2018 [23,115,118,155,242,243], showing that rural areas are ‘catching up’ with urban areas. Previous surveys undertaken in the early 2000s documented a combined prevalence of overweight and obesity of 21% among adolescents 13-19 years nationally- 7% in boys and 25% in girls [34].

In 2007, Kimani and colleagues found 10.9% of rural 13-19-year-olds were either overweight or obese; 16% in females [8]. By 2018, this increased to 17.8% overall; 21% in females and 7% in males [32,35,46]. At both time point, rates were notably more pronounced among

females. The increasing levels of overweight and obesity over the ten year period indicate changes in the rural context related to environmental transitions including increased access to high-caloric foods. These and other changes are discussed below.

As in other South African studies, our study reported a higher prevalence of overweight and obesity among adolescent females and much lower levels in adolescent males in 2007 and 2018 [32,34,49,239,244–246]. The increasing overweight and obesity in South African females over the ten-year period, and the gender discrepancy, is comparable to that found in several upper-middle- and higher-income countries [239].

This nutritional transition is marked by a shift in dietary patterns and nutrient intake that occurs as populations undergo economic, social, and demographic changes affecting lifestyles. This double burden of malnutrition is linked to increased risk for NCDs later in life, with studies indicating that exposure to stunting and underweight in early life leads to short stature later in life, particularly in women; while short stature in later life has been associated with a higher risk of obesity and other non-communicable diseases [30,247,248]. The literature highlights the association between early-life stunting and underweight during childhood and adolescence and the potential long-term consequences of these conditions. It is suggested that such early-life factors may increase the risk of overweight and obesity. These weight-related issues, in turn, can contribute to the development of non-communicable diseases, including type 2 diabetes, later in life. Additionally, for females, these effects can extend to their offspring, potentially influencing their health outcomes as well [148,249–252]. This research is based in Agincourt which is located in the rural northeast South Africa has found that there has been an epidemiological shift with increased risk factors for non-communicable diseases [253,254]. The research reveals an elevated risk of cardiometabolic diseases throughout the lifespan. This risk is associated with early childhood stunting, affecting approximately one-third of 1-year-olds, as well as a high prevalence of overweight and obesity among adolescents, particularly in older female adolescents and later in life older women [219]. This coupled with complex social and behavioural changes will negatively influence the ongoing progress to reduce preventable mortality and enhance overall health throughout the lifespan in the rural context.

Adolescent obesity, views and understanding

This study has identified risk factors such as sex and age for adolescent overweight and obesity at individual and household levels, as well as explored adolescents' views of obesity. At the individual level, adolescent's age, sex and blood pressure were found to be associated with overweight and obesity. Consistent with other studies, obesity increased with an increase in age and was positively associated with being female and having higher blood pressure. This may reflect the effect of increased sedentary behaviour and decreased physical activity with age and pubertal onset related to subsequent physical, social and emotional changes [255,256]. While the recent Covid-19 pandemic occurred after data collection for this study was completed, Covid-19 has been documented to have impacted changes in eating habits, sedentary behaviour and physical activities amongst adolescents [257,258]. Pubertal onset was not measured in 2018, a limitation of this work, and needs to be included in future studies. The rise in obesity prevalence among Agincourt adolescents from 2007 to 2018 may be attributed to the timing of pubertal onset. This period, characterised by rapid growth and development, is influenced by a combination of genetic, nutritional, and environmental factors. Similar to this study, higher levels of obesity in females have been found in other studies in other LMICs [245,259–261], including elsewhere in South Africa [8,34,36,37,49,239,262,263]. Several factors may explain the sex difference in our study, including individual (adolescent), household and social factors.

Individual (Adolescent) level

Biologically, energy needs of males and females differ. Further, the timing of pubertal maturation differs by sex [264]. While the causal relationship between blood pressure and sex was not studied here, the association was documented, supporting previous studies finding overweight and obesity to be associated with higher blood pressure [265–267].

Behavioural factors are also important in explaining sex differences. Adolescent males are generally more physically active, participate more in sports (such as soccer) and are physically fitter compared to females, especially during adolescence [255,264,268–270]. Qualitative findings from this research support these documented gender differences. Group discussions revealed that females tend to be viewed as less physically active than males; while males play soccer after school, females have fewer options for physical activity and are often required to do household chores (reflected in chapter 5).

The observed trend of larger body sizes among females may be attributed to a variety of factors. These factors include societal and cultural preferences that favour larger bodies in females, as well as the influence of sedentary behaviours and limited physical activity due to cultural norms, gender roles, and safety concerns [271]. During the focus group discussions conducted as part of this study, adolescents consistently highlighted and provided insights into the societal/cultural factors that influenced body size preferences and behaviours. They discussed how these norms dictated the perception of an ideal body size, which often leaned towards larger bodies. These preferences were shaped by community perceptions that bigger signifies happiness and lack of disease and therefore health. Furthermore, adolescents emphasised that sedentary behaviours and limited physical activity among females were not only influenced by societal norms but also by gender roles and safety concerns. Included in the discussion are the hormonal or genetic factors contributing to overweight and obesity [48,272] that adolescents cited in the discussions. The surveys and focus group discussions shed light on the complex interplay between various factors and behaviours among adolescents.

Household/Family level

At the household level, socio-economic status (SES) was associated with overweight and obesity among adolescents. In 2007, there was a significant association between SES and overweight/obesity although this was no longer significant in 2018. Globally, the relationship between socioeconomic status and obesity is found to vary depending on economic development [273]. The significant association between BMI and SES found in this study is in keeping with other studies in LMICs [274–276]. The area where this study was conducted is low-income, located in a province with one of the highest poverty rates in South Africa [224]. Socio-economic status (SES) has been reported in some cases to be associated with a sedentary lifestyle and lower physical activity, with the rich more likely to afford sedentary lifestyles including television viewing and less strenuous jobs and leisure activities. while in other cases associated, low SES may be a result in work involving high physical labour, or walking very long distances to school.

SES may influence food choices with wealthier individuals able to purchase processed foods. Those of lower SES may rely on starch-based foods that are more affordable, can be bought in bulk, are considered more filling, and for Agincourt may include the use of limited farm

products (although farming is decreasing in the area). Over time there has been a change in household diet, with a shift from more traditional diets to more Westernised diets marked by increased consumption of processed and convenience foods, higher intake of added sugars and unhealthy fats, and a decrease in the consumption of whole grains, fruits, and vegetables. This has resulted in increased access to processed and packaged foods, and changes in agricultural practices within communities. While this study did not focus directly on the household/family dynamics and how they may influence adolescents' decision making related to nutrition, studies have further highlighted the significant role of household environments and parental influence on adolescent nutrition. This research underscores the complexity of adolescent nutrition decision-making within the household context, showing that family support and household food environment are crucial in shaping adolescents' dietary behaviours [277–279]. Findings in this study show that the shift at the household level contributes to what adolescents' eat with regard to the food they access to on a daily basis, highlights the importance the interaction of individual and household/family levels in the behaviour and consideration in future interventions.

Community/Societal

Concerns and societal perceptions regarding body image, specifically among female adolescents, can contribute to the development of problematic eating behaviours. These behaviours may manifest as irregular meal patterns, which can subsequently lead to fluctuations in weight, either through increased weight loss or weight gain [30–32]. Problematic body image and eating behaviours have been documented amongst female adolescents particularly in South Africa [53–55,280,281]. The present study found that bigger bodies are preferred as they signal happiness, findings supported in many African countries, particularly from rural areas with low socio-economic status [54,282]. This may contribute to the higher levels of obesity observed among female adolescents. While this study did not investigate the influences of social media, more investigation is needed to establish how perceptions of body image among adolescents in the study area are changing through influences of social media and post the Covid-19 pandemic [283–286]. In recent years, the Covid-19 pandemic has had a profound impact on various aspects of daily life. Although data collection for this study preceded the pandemic, it has resulted in significant changes in social behaviour and a notable increase in the use of digital media platforms. These changes might have influenced body image perceptions and behaviours among adolescents in the study area through exposure to a wider range of images and social influences through online platforms.

During the focus groups discussions, adolescents expressed both positive and negative views regarding obesity (detailed in Chapter 5). While they were aware of the long-term health effects of obesity, such as type 2 diabetes, they did not appear overly concerned about these in their current behaviours. However, given the Covid-19 pandemic and growing concerns about the severity of disease and mortality related to obesity, non-communicable diseases and co-morbidities, it is possible that perceptions regarding body image and the importance of maintaining a healthy weight may have shifted among adolescents.

Additionally, there is growing concern about the impact of social media on body image and self-esteem among adolescents, particularly among girls. There has been increased access to social media platforms and with the pandemic, more time is spent on those platforms even in rural South Africa. This study did not explore the use of social media platforms. Social media platforms can present an unrealistic and heavily filtered version of reality, which can contribute to body dissatisfaction and negative self-image among users, and may need to be addressed in interventions.

Socio-cultural context

Rural adolescents are gaining increasing access to energy-dense processed foods and are, at the same time, increasing their sedentary lifestyles. High levels of labour migration, increasing particularly in women since 1994 [224,287–289], introduces urban habits to rural settings, altering rural diets and lifestyles. While unemployment is still high in this context, there are women entering employment in the area [224,290], has an impact on food supply and diet and has been linked to higher consumption of processed meals made outside the home [17,22]. Research conducted in other parts of South Africa has shown that urbanisation has led to a drop in the consumption of staple foods like maize meal while leading to an increase in calorie-dense foods such as foods with added fats and oils and foods originating from animals. In rural area, there is greater access to fast food outlets (both formal and informal vendors) [92,135,267]. Similar dietary changes in other LMICs going through a nutrition shift have been recorded [17,40,89–91]. In recent years, the study area is defined by limited local food production (food gardens) and an overreliance on purchased food, with energy-dense processed foods becoming inevitable as access to shops increases. Consumption of high-caloric food, which is sold in the community, especially near schools,

has been identified as one of the potential causes contributing to obesity, according to adolescents in the focus groups (Chapter 5).

The rising prevalence of overweight and obesity among rural adolescents can be attributed to broader socio-cultural transitions within these communities. These transitions are associated with environmental changes brought about by rural development and modernisation, such as increased availability of motorised transportation, greater use of electronic devices, and the proliferation of fast food outlets. They are also linked to commercial marketing strategies, particularly targeting children through television advertisements and in-store product placements. While this was not the focus of the study, studies have shown that exposure to food marketing increases the likelihood of adolescents developing preferences for unhealthy foods, contributing to poor dietary habits and subsequent health issues like overweight and obesity [292–294]. This is a recommendation of future work to consider commercial marketing on television and social media in interventions as this study found rural adolescents adopting more sedentary lifestyles and increased screentime. The environmental shift to modernisation, adolescents in rural areas still face limitations in accessing safe and suitable spaces for physical activity, which contributes to a more sedentary lifestyle. Adolescents have reported inadequate access to gym facilities, insufficient grounds for safe sports activities, and a lack of appropriate recreational spaces [153,295,296] in South Africa. Despite this, they should still be able to meet the weekly target of 150 minutes of walking [297]. Additionally, factors like extended school hours and increased screen time from smartphone use have further reduced physical activity levels among adolescents. Research suggests that excessive screen time, particularly television viewing, is associated with increased consumption of unhealthy foods and fewer fruits and vegetables, potentially contributing to the rise in overweight and obesity among children and adolescents [298–301]. While this study did not analyse the direct relationship between screen time, physical activity, and overweight, it is worth considering the impact of screen time on eating habits and behaviour for future interventions targeting obesity in this context. In in-depth interviews and focus groups discussions, adolescents generally did not prioritise physical activity and tended to engage in gender-specific activities such as soccer or labour-intensive work for males and household chores for females. Overall, the complex interplay between environmental factors, limited access to physical activity spaces, sedentary behaviours including screen time, and gender-specific activity preferences contribute to the increasing prevalence of overweight and obesity among rural adolescents. Addressing these factors through targeted interventions and

promoting a culture of physical activity may be crucial in combating malnutrition in this population.

Addressing malnutrition among rural adolescents requires a comprehensive and multilevel approach that takes into account the complex interaction of multiple factors influencing behaviour. Simply focusing on a single aspect, such as promoting healthy eating or increasing physical activity, may not be sufficient to tackle the issue effectively. Instead, interventions need to consider the broader socio-cultural context, environmental influences, access to resources, and individual motivations and preferences.

To effectively address the complex issue of malnutrition among rural adolescents, a multilevel approach must be adopted, involving interventions at different levels such as individual, family, community, and policy levels. Findings from the qualitative research conducted in this study revealed that adolescents emphasised the importance of health education regarding diet and physical health, and believed that such education should be targeted not only at themselves but also at their family members. This is in line with a multilevel approach to addressing malnutrition. Health education can play a crucial role on the nutritional status of adolescents by increasing their knowledge about better dietary practices and raising awareness about the detrimental effects of overnutrition, as well as including encouraging physical activity. Understanding the local context is also vital, particularly in areas experiencing environmental and nutrition transitions. This includes the transition from traditional food production practices such as farming, the ability to afford purchased food, and increased access to fast food outlets [92,135,169,276–278]. Food security was not studied, however further research should be done as part of addressing obesity [301,305–310]. Food security is defined as the state of having access to enough food to meet basic nutritional needs, while also ensuring that the food is safe, culturally appropriate, and socially acceptable. In many rural areas, food security is a major concern due to a variety of factors, including poverty, limited access to resources, and environmental factors such as drought and climate change. This is important to understand not only for health education purposes but to effectively tailor interventions to address malnutrition.

To effectively promote healthy eating habits among adolescents and their families and provide context-specific education on diet to adolescents and households, it is important to understand the factors that contribute to food insecurity in the context of the rural South

African community and tailor interventions accordingly. In understanding the specific factors contributing to food insecurity such as challenges in the community i.e. unemployment, cultural perceptions, and availability of resources, interventions can be tailored to address those factors directly. This ensures that resources and efforts are focused on the most relevant and impactful areas, leading to more effective outcomes. While this study did not address food security, adolescents and caregivers highlighted the important lessons on diets, portion sizes and healthy eating plates from the information4 my life activity book as useful as part of the intervention and the need to learn more.

Community-based interventions to promote adolescent health

As of 2019, there are over 10 million adolescents aged 10 to 19 years living in South Africa [77]. Since the country's transition to democracy in 1994, the South African government has introduced a number of reforms and programmes to address the negative effects of apartheid policies on various aspects of life, including healthcare. The South African Constitution, enacted in 1996, grants its inhabitants the right to obtain healthcare services, including sexual and reproductive healthcare [311–313]. Most importantly, it formally and publicly acknowledges that the health requirements of adolescents, who make up over 18% of the population of South Africa, are unique [311,314]. To address this, a number of policy-oriented programmes, like the National Adolescent-Friendly Clinic Initiative (NAFCI) and Youth Friendly Services (YFS), have been established. The Youth and Adolescent Health Policy also aims to improve young South Africans' access to healthcare and long-term health outcomes [311–313].

The National Adolescent Friendly Clinic Initiative (NAFCI) was launched in 1999 as South Africa's first formal effort to improve healthcare services for children and adolescents. Its objective was to enhance the responsiveness of publicly funded primary healthcare (PHC) clinics to the needs of young people. PHC clinics in South Africa offer a wide range of medical services to patients of all ages, and efforts to improve the quality of care, specifically for young people, are integrated into the standard treatment protocols. These clinics are primarily led by nurses, with only a limited number having permanent or visiting doctors [315–317]. This is highlighted by adolescents in the study as they mention their interactions in the health facilities mainly being with nurses [109]. The National Adolescent and Youth Health Policy was later reviewed and extended to include adolescents between the ages of 10

and 24 [57]. Several qualitative studies conducted in urban and rural areas of South Africa explored the experiences of young people regarding the youth-friendliness of the healthcare services they received. Studies also provided insights into the accessibility and appropriateness of the healthcare services provided to adolescents [226,227,318]. It was reported that adolescents were generally dissatisfied with healthcare due to lengthy wait times, unwelcoming and judgmental healthcare professionals, insufficient staff, a lack of equipment and medications, a lack of privacy and confidentiality, and inadequate information [226,227,318–327]. These findings are supported by this study where adolescents expressed similar sentiments on accessing health facilities and their interactions with health professionals. Lack of knowledge of youth-friendly programmes added to the discontent [318,328,329] for healthcare workers as well as adolescents needing to access healthcare. The dissatisfaction with health services by adolescents as reported in this study and other previous work is a barrier to accessing healthcare, and led to their reported preference for discussing their health with CHWs [232,330–332].

This work extends findings of positive experiences with CHWs by highlighting that adolescents were receptive to CHWs and expressed the greater trust they felt as compared to their experience at healthcare facilities [124–127]. The positive reception and expressed trust (around privacy and confidentiality) of CHWs mirror what was found in the current study where adolescents mentioned the positives of having CHWs leading the intervention as it allowed for adolescents to access health education and to positive interactions on health through the CHWs that they previously didn't access [113,124,125]. This is an important finding on encouraging adolescents to access basic health services and further services by the CHWs should be explored including the potential use of CHWs in adolescent-targeted interventions. The findings from this study further highlight the importance of providing adolescent services in areas/places where adolescents spend most of their time in order to facilitate access.

CHWs have been used for a variety of services and are seen as a link between health facilities and the community. They are viewed as an extension of healthcare services and are an effort by governments to increase access to care and address some of the challenges reported at PHC facilities such as staffing shortages, inadequate facilities, limited medical equipment, and shortages of essential supplies and medications as well as high patient volumes, leading to long waiting times and overcrowding. CHWs have been utilised globally to extend

healthcare services and address various health concerns [212,333,334], reducing undernutrition and increasing access to healthcare facilities in LMICs [211] through their extension into the community. Research has demonstrated the positive impact of CHWs on reducing under-5 mortality, enhancing women's health, combating the spread of HIV/AIDS, promoting treatment adherence, and addressing malaria, tuberculosis, and diabetes in diverse communities [128,131–134]. Given their effectiveness, CHWs in South Africa, predominantly women, have been [132] employed to target specific diseases in rural communities [186,209–212].

In this study, rural South African adolescents were receptive to CHWs within the intervention. This supports previous research in South Africa where CHWs were found to address the recipients' context-related, as well as health and medical needs, thus building greater levels of trust with their clients [330], which resulted in better adherence to treatment and greater positive outcomes. In this study, adolescents adopted health education and reported making changes. Research has reported that an important aspect of recipients' choice to use services, and their uptake of advice and continuing care, has been their trust in their healthcare provider [335]. This work highlights the views of adolescents on the most important characteristics of CHWs – being an individual familiar with the context although not from the same community in order to maintain confidentiality and cultivate trust. Interventions should consider where CHWs are from to ensure trust and alleviate concerns regarding confidentiality that adolescents may have with people from their specific area. This is an important consideration for interventions that need to create safe, supportive environments both within health facilities and in the broader community. This may involve creating private and confidential spaces for adolescents to receive care, training healthcare professionals to provide youth-friendly services, and building trust with adolescents through open communication and community engagement.

This study found that CHWs present an opportunity to extend the delivery of health services and may play a vital role in facilitating a link between health services, adolescents and households. The recent Covid-19 pandemic highlighted the importance of this role when providing communities with Covid-19 health education and early screening [336,337], a role that can be extended to other health education to adolescents and their caregivers as highlighted by the adolescents interviewed as important (highlighted in chapter 5 and chapter 6).

Previous research with adolescents has suggested that they are typically averse to traditional health education approaches such as lectures or printed material and are therefore more likely to respond to educational strategies that involve more interactive methods [190,333,338]. Adolescents in this study reported enjoying the interactive sessions that included group discussions, hands-on activities such as weight and height measurements with calculation of BMI, as well as writing or mapping goals, and participatory learning. The intervention created a space that intended to foster a sense of urgency among adolescents regarding their health through peer discussions and interactions. Through these interactive methods, adolescents not only received important health information but also actively engaged in diverse discussions. They were encouraged to share their thoughts, concerns, and experiences, creating a supportive and inclusive environment. This enabled them to explore and reflect on their own health behaviours, ultimately empowering them to take ownership of their well-being. The adolescents in the study reported changes as a result of the intervention. They also reflected on aspects they felt were missing and should be included in future interventions. This study was designed to examine the feasibility and acceptability of the intervention, was not designed to examine the effectiveness of the intervention and further research is warranted.

There have been arguments that CHWs who specialise in adolescent health [78,214] may be able to augment primary healthcare services and increase health coverage of adolescents by specifically targeting households with adolescents [78,161]. This study did not compare specialised (adolescent-focused) and general CHWs. However, there was support for CHWs engaging adolescents both in the group sessions at the school venues and at their homes where consenting occurred. General CHWs are trained to provide a wide range of basic healthcare services to the community. They have a broad understanding of various health issues and can address common health concerns, perform health promotion activities, and provide basic preventive and curative care. The advantage of general CHWs is their versatility and ability to serve as the first point of contact for primary healthcare needs in underserved rural areas. They play a crucial role in bridging the gap between the community and formal healthcare facilities. Specialised CHWs focus on specific health conditions or interventions and receive in-depth training in a particular area, such as HIV/AIDS, maternal and child health, or chronic disease management. These specialised CHWs possess more advanced knowledge and skills in their respective fields, allowing them to provide targeted

and specialised care to individuals with specific health needs. They may be involved in disease-specific programs, health campaigns, and outreach initiatives [78,214,232]. While this study did not focus on distinguishing between specialised and general CHWs, the work that they did was around health promotion amongst adolescents. Specialised CHWs focused on adolescent health promotion may be important in the rural context to extend coverage to adolescents and their families. Further work is needed to understand the relative trade-offs of specialised vs generalised CHWs. Ultimately, the choice of type of CHWs will be influenced by supervision and resources which both have implications for sustained service and need to be explored further in the local and national context.

Challenges related to the rollout of CHWs have included poor remuneration, lack of necessary skills, high attrition rates and lack of supervision and support at local, district and national levels [208,215,331,339,340]. Despite these, there have been studies that have trialled the use of CHWs with adolescents [341,342] and found this approach to be feasible. In this study, the community-based intervention led by CHWs was acceptable to adolescents and to CHWs leading the intervention, and was found to be feasible with modifications. The implementation of interventions in practice does not always progress as planned, with implications for intervention outcomes [343,344]. However, refining interventions for their context can enhance successful outcomes. These modifications in the field must be documented to support their reproducibility and further clarify mechanisms of change.

In this study, the modifications made were the day, time and location of meeting adolescents (discussed fully in Chapter 6). The modifications and their documentation reduced the challenge of adolescents getting to the venue on the agreed day and time, helped maintain efficacy, and increased the impact of the interventions. As shown in Chapter 6, by changing the venue, a greater number of adolescents attended the health promotion sessions provided by CHWs, and returned for the second session. Our findings reinforce the importance of conducting process evaluations that thoroughly examine the structural and process elements of implementation. These evaluations should also consider the interactions between the intervention and the local context in order to provide a comprehensive understanding of what is delivered and why [345]. Collectively, the practical implementation insights from this study support the need for context-specific interventions for better outcomes. These have implications not only for interventions in the rural context, but emphasise the need to further explore the implications of scale-up of CHWs in adolescent health locally and nationally.

Challenges are supervision, ongoing training and support of CHWs. In this study, there were debriefing sessions to ensure CHWs felt supported in their role and to ensure adaptations were effectively made as needed to facilitate the intervention. While it required effort in terms of resources such as a supervisor to be present for debrief and time to provide ongoing support which this project provided, it is not impossible. Scaling up this intervention would necessitate the allocation of resources, including supervision, ongoing support, and trained personnel. While it requires effort, with the provision of adequate resources and support, it is feasible to implement and expand this program in public health facilities and local governments. Further work should seek to understand the needs of CHWs in relation to providing community-based services and interventions.

Overall, addressing malnutrition and promoting healthy lifestyles among adolescents requires comprehensive and targeted interventions that consider the specific needs of this population. Integrating the lessons learnt on trends of malnutrition and associated risk factors, adolescent views and use of CHWs adolescent health promotion interventions can help make significant progress in improving the health and well-being of adolescents.

Strengths and Limitations

Strengths and limitations are detailed in chapters 4 to 6 and summarised here.

Strengths

The study extends earlier work and documents the ongoing nutritional transition underway among adolescents in rural South Africa. This transition is marked by the continuing double burden of malnutrition. The investigation of both underweight and overweight / obesity among adolescents in the same community offers insights into the changes over time and provides justification for exploring targeted interventions. Health and demographic surveillance platforms have proven valuable in conducting nested studies within communities, facilitating the exploration of changes at different time points. These platform collects household information, providing a valuable tool to understand the evolving determinants over time and potentially measure long term effects of interventions.

One noteworthy strength of the study was the robust research methods employed in the projects that generated the data used in this thesis. The findings of this thesis relied on two rigorously undertaken population-based studies collected within the same well-established rural research site roughly a decade apart. The same scientific team was involved in conducting both studies, which utilised standardised measures and the same standard operating procedures. The interviews and focus group discussions provided further insights into adolescent views on obesity as well as causes of obesity and ways in which obesity can be addressed. Post-intervention, mixed methods including tracking the number of adolescents consenting and attending together with qualitative approaches, allowed us to understand the feasibility of the intervention as well as the acceptability from multiple perspectives. Additionally, full participation of the PhD candidate in fieldwork as project manager, and comparative coding of qualitative interviews with other colleagues, ensured high quality data collection and interpretation of results, particularly the qualitative data.

Through the use of CHWs as implementers, the study was able to pilot the specifics of a community-based intervention with CHWS for adolescents. This was a strength as it provided important lessons on developing a feasible intervention, and contributed to

establishing the acceptability of using CHWs and thus bridging access for adolescents to health services in a community setting.

Limitations

The limitations of the study are presented below:

Measurements

Malnutrition is complex and likely a result of complex interactions on multiple levels. While this study explored several variables, it was in no way exhaustive of the determinants of health. Data collected in 2007 and 2018 was not matched, thus cannot be compared.

Data on some important distal measures including the occupation of the mother, education status of father and mother, and receipt of support grants were not included. Also missing was household food security which has an impact on nutrition. Thus the study did not measure changing trends in food security over time, which would have been important in this study. Additionally, receipt of social grants – such as the child support grant or pension for older adults – may well play an important role in the nutritional status of children in this low-resource setting. Mental health assessments, including depression and anxiety, would add valuable information. Sugary beverage intake and physical activity measurements were collected in 2018 but not in 2007, and so could not be included in the analyses.

Measures of central obesity and data on pubertal status were not collected. Given the latter, stunting figures may be inflated in males compared to females due to known differences in pubertal development.

Furthermore, BMI is recognised as a somewhat crude measure of health status and does not take into consideration body composition (body fat or body lean mass), which can be collected through more intensive measuring, such as through Dual-Energy X-ray Absorptiometry (DXA). Whilst DXA may offer more accuracy, this technology is not readily available in many rural contexts and BMI continues to serve as a well-published, albeit limited, measure of health status. Further research is to explore how pubertal development and central obesity have changed over time as it has implications for interventions.

Chapter 8: Recommendations for future research and Conclusion

A large amount of research has been conducted on the double burden of malnutrition globally and this study adds a rural South African perspective to this research. Furthermore, little work on health promotion interventions among rural South African adolescents exists and, as documented in this PhD study, must take a holistic view of how individual, household and societal factors contribute to the double burden.

Based on the findings of this study, several recommendations can be made for future research to expand our understanding of the double burden of malnutrition among rural adolescents, as well as appropriate interventions to address it within a rural context:

1. Analysis of additional factors with potential to have an impact on malnutrition that were not explored in this study, including food security, sedentary behaviour and physical activity, and mental health (which includes cognitive assessment). The analysis of pubertal maturation and changes over time in connection to understanding the double burden of malnutrition. The impact of social media, screen time, and other commercial determinants of health as well as Covid-19 on body image, eating habits and behaviours. Understanding these factors will provide a more comprehensive picture of the underlying determinants of malnutrition and better guide the design of multifaceted interventions.
2. Further evaluation of CHW-led interventions to promote adolescent health will require additional full-scale interventions targeting the double burden of malnutrition among rural adolescents to assess their effectiveness, sustainability, and scalability. Outcomes can include changes in dietary behaviours and nutritional status, health outcomes such as anaemia, as well as the cost-effectiveness of interventions. Further testing of interventions should include the feasibility of different approaches such as targeting adolescents (such as females who are underweight and obese), cash transfer to promote balanced diets, and the use of nutritional supplements. Cohort follow-up over an extended period would be beneficial to better understand effectiveness over a longer period of time post-intervention. Included in the future research is interventions that are multilevel and

include household members that may strengthen engagement and further facilitate behaviour change, and sustaining interventions in rural settings.

3. Examine the policy landscape and assess the impact of existing policies on addressing the double burden of malnutrition among rural adolescents. Identify gaps and opportunities for policy interventions at the national, regional, and local levels to support comprehensive approaches that address both undernutrition and overweight/obesity.
4. Explore the use of technology and digital platforms in delivering interventions to rural adolescents. Mobile health (mHealth) applications, telehealth services, or interactive educational tools can enhance the accessibility, engagement, and effectiveness of interventions, particularly in rural areas and in general given the reluctance of adolescents to access health facilities.

By addressing these research recommendations, we can enhance our knowledge base, develop evidence-based interventions, and ultimately improve the health outcomes and well-being of rural adolescents affected by the double burden of malnutrition.

Conclusion

This study highlights the persistent double burden of malnutrition among rural adolescents, with a concerning increase in overweight and obesity and a decrease in underweight observed over an 11-year period. The prevalence of stunting and underweight, especially among males, remains substantial but has shown some reduction in recent years. These trends highlight the importance of addressing malnutrition during adolescence as a risk factor for developing non-communicable diseases (NCDs) later in life. The understanding of adolescent malnutrition is multifaceted, with multiple risk factors such as age and sex contributing to its development. The conflicting views expressed by adolescents regarding obesity indicate the need for comprehensive health promotion and lifestyle interventions with strong aspects on nutrition education and that address both the physical and psychological aspects of malnutrition with the aim to impact behaviour.

The community-based approach led by CHWs demonstrated promise in engaging rural adolescents and received favourable feedback from participants. However, modifications to the intervention strategy, such as adjusting the timing and location, was necessary to ensure optimal participant uptake. Participant acceptance of dietary and portion-size changes as a result of the intervention further supports the feasibility and potential effectiveness of the intervention.

The findings of this study serve as a valuable foundation for the development of tailored context-specific health promotion interventions that address the specific needs and circumstances of rural adolescents, considering both undernutrition and overweight/obesity concerns. Adolescents proposed a multilevel intervention that involved themselves as individuals and their households, delivered outside the clinic by CHWs. By integrating educational components that are interactive, engaging local resources, and addressing sociocultural factors, it appears possible to make significant progress in combating the double burden of malnutrition in the adolescent population. Importantly, adolescents should be involved in the co-creation of interventions involving them. Adolescents' interactive health literacy activity books should be used in settings where they spend a lot of time (such as schools), as part of these interventions.

However, it is important to acknowledge that further research is needed to assess the long-term impact and sustainability of these interventions. Additionally, exploring other contributing factors to the double burden of malnutrition in rural areas will provide a more comprehensive understanding and enable the development of more targeted interventions. As it relates to adolescent health and the promotion of healthy lifestyles, the lessons learned offer crucial insights for future interventions for adolescents and how CHWs may be used to potentially expand the services and reach of the primary healthcare system. Collaborative efforts of rural adolescents, their families, schools, healthcare providers and policymakers are needed to implement evidence-based interventions to mitigate the effects of malnutrition and improve the overall health outcomes of rural adolescent populations. Future research can offer further evidence for the design of interventions and yet more insights into the sustainability of health and nutrition outcomes.

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Appendix 1: Ethics applications

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

R14/49 Pettifor

CLEARANCE CERTIFICATE

PROTOCOL NUMBER M070244

PROJECT

Cross-Sectional Growth and Pubertal Study
(0-20 years of age) in Agincourt Dikgale

INVESTIGATORS

Prof J Pettifor

DEPARTMENT

Paediatrics & Child Health

DATE CONSIDERED

07.03.02

DECISION OF THE COMMITTEE*

Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 07.03.05

CHAIRPERSON



(Professors PE Cleaton-Jones, A Dhai, M Vorster,
C Feldman, A Woodiwiss)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Prof K Kahn

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. I agree to a completion of a yearly progress report.

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES



Office of the Deputy Vice-Chancellor (Research & Post Graduate Affairs)

TO: Professor SA Norris et al
School of Clinical Medicine
Department of Paediatrics and Child Health
Developmental Pathways to Health Research Unit
Chris Hani Baragwanath Academic Hospital

E-mail: Ryan.Wagner@wits.ac.za

CC: Supervisor: <san@global.co.za>
and <HREC-Medical.ResearchOffice@wits.ac.za>

FROM: Iain Burns
Human Research Ethics Committee (Medical)
Tel: 011 717 1252

E-mail: Iain.Burns@wits.ac.za

DATE: 06/04/2018

REF: R14/49

PROTOCOL NO: M1711103 *(This is your ethics application study reference number. Please quote this reference number in all correspondence relating to this study)*

PROJECT TITLE: *Health of adolescents living in rural Mpumalanga:
formative work for an intervention to optimize
adolescent health (baseline cross-sectional survey)*

Please find attached the Clearance Certificate for the above project. I hope it goes well and that an article in a recognized publication comes out of it. This will reflect well on your professional standing and contribute to the Government funding of the University.

MSWorks2000/Iain0007/Clearscan.wps



R14/49 Professor SA Norris et al

**HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M1711103**

NAME: Professor SA Norris et al
(Principal Investigator)
DEPARTMENT: School of Clinical Medicine
Department of Paediatrics and Child Health
Developmental Pathways to Health Research Unit
Chris Hani Baragwanath Academic Hospital

PROJECT TITLE: Health of adolescents living in rural Mpumalanga:
formative work for an intervention to optimize
adolescent health (baseline cross-sectional survey)

DATE CONSIDERED: 24/11/2017

DECISION: Approved unconditionally

CONDITIONS:

SUPERVISOR: Not applicable

APPROVED BY: 
Professor CB Penny, Chairperson, HREC (Medical)

DATE OF APPROVAL: 06/04/2018

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and ONE COPY returned to the Research Office Secretary on 3rd floor, Phillip V Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.
I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to resubmit to the Committee. I agree to submit a yearly progress report. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed, in this case, the study was initially reviewed in November and will therefore be due in the month of November each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Shane A Norris

Principal Investigator Signature

Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

UNIVERSITY OF THE
WITWATERSRAND
JOHANNESBURG



HUMAN RESEARCH ETHICS
COMMITTEE (MEDICAL)

24 October 2018

Professor SA Norris et al
School of Clinical Medicine
Department of Paediatrics and Child Health
Developmental Pathways to Health Research Unit
Chris Hani Baragwanath Academic Hospital

Sent by e-mail to: Kathleen.Kahn@wits.ac.za

Dear Professor Kahn

Re: Protocol Ref No: M1711103

Protocol Title: *Health of adolescents living in rural Mpumalanga: formative work for an intervention to optimize adolescent health (baseline cross-sectional survey)*

Principal Investigator: Professor SA Norris et al

Thank you for your letter of 12 October 2018.

I confirm that the proposed amendments to your study have been noted and approved.
For the record, the amendments are:

1. back-extending the entry age of participants from 14 to 12
2. adding six new testing instruments to the interview process with the adolescents

Thank you for keeping us informed and updated.

Yours Sincerely



.....
Mr I Burns
For the Human Research Ethics Committee (Medical)

cc Professor SA Norris



R14/49 Ms Seabi Tshegofatso

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M180873

NAME: Ms Seabi Tshegofatso
(Principal Investigator)
DEPARTMENT: Public Health
MRC/Wits-Agincourt Health
Socio-Demographic Surveillance System Site
Bushbuckridge, Mpumalanga Province

PROJECT TITLE: Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa

DATE CONSIDERED: Ad hoc

DECISION: Approved unconditionally

CONDITIONS: A substudy under the primary study M1711103
Prof SA Norris et al

SUPERVISOR: Kathleen Kahn and Ryan Wagner

APPROVED BY: 
Professor CB Penny, Chairperson, HREC (Medical)

DATE OF APPROVAL: 28/08/2018

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report.** The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **August** and will therefore be due in the month of **August** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).


Principal Investigator Signature

Date _____

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 2: Quantitative information sheets and consent forms

PARTICIPANT INFORMATION SHEET For those 18 years and older

Health of Adolescents living in rural Mpumalanga: Formative work for an intervention to optimize adolescent health (Baseline Survey)

Invitation

Hello, my name is _ from the University of the Witwatersrand and working with researchers from Agincourt Health and Socio-Demographic Surveillance System.

I would like to invite you to participate in the research study entitled: **Health of Adolescents living in rural Mpumalanga: Formative work for an intervention to optimize adolescent health (Baseline cross-sectional survey)**. Before, agreeing to participate, it is important that you understand the purpose of the study, the study procedures, benefits and risks as well as your right to withdraw from the study at any time. If you have any questions, do not hesitate to ask me. You should not agree to take part unless you are satisfied with all the procedures involved. If you decide to take part in this study, you will be asked to sign this document to confirm that you understand the study. You and your child will also be given a copy to keep.

Why is the study being done?

The study aims to: (i) understand the willingness of adolescents to consent to be part of a study; (ii) understand health behaviours of adolescent boys and girls.

Who can participate?

We will be selecting all adolescents living in your village who are 12 to 19 years of age

What will happen if you decide to take part in the study?

If you consent to take part in the study, you will be required to complete one interview session at home.

You are under no obligation to take part in the study and are not required to give a reason if you do not wish to participate. If you decide to take part in the study, you are free to withdraw at any time and without giving a reason and without prejudice. If you decide to withdraw from the study, we will discuss with you what will happen to any information that you have provided. If the incomplete information can usefully contribute to the study, we will ask your permission to use the data in our analysis. Alternatively, on your request all your information will be destroyed.

During the Interview:

You will be requested to complete questions about yourself (time spent walking; time spent watching TV and sitting; sugar sweetened beverage intake and some questions about your future) with an interviewer, and your height, weight and waist circumference will be measured. This will take no longer than 60 minutes. Further details of these procedures are provided below:

Beverage frequency questionnaire (BQ)

You will also be asked to fill in a beverage frequency questionnaire to measure your usual intake (what you normally drink). This questionnaire will give us a sense of what and how much you have consumed over the last week

Hope questionnaire (BQ)

You will also be asked to fill in a questionnaire about your future and your hope for success.

Mental Health Screening Tool & Cognitive Assessment

We are interested in understanding more about your mental health and the way that you make decisions. We will ask you a few questions on how you are feeling and also ask you to participate in an exercise on a computer that might seem like a computer game.

Height and weight, blood pressure and waist circumference measurements

We will determine your height by you standing next to a height board with no shoes on and we will ask you to stand on an electronic scale to determine your weight. We will also measure your waist circumference with a tape measure and measure your blood pressure using a blood pressure cuff.

What are the risks and discomforts of this study?

There are no risks or discomforts associated with the administration of the questionnaires. Strict confidentiality of results will be maintained. Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Are there any benefits to you for being in the study?

There are no direct benefits to you for being part of the study.

Who will see the information that is collected about you during the study?

Strict confidentiality of results will be maintained. Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Who do I contact if I have any questions about the study?

If you have any questions or you experience any problems during or after the sessions, please contact Professor Shane Norris, or a representative of the Human Research Ethics Committee. **Professor Shane Norris (PhD)**

Principal Investigator

MRC/Wits Developmental Pathways for Health Research Unit Chris Hani Baragwanath Hospital

Soweto Johannesburg Tel: 011-9331122

Email : shane.norris@wits.ac.za

Human Research Ethics Committee contact details:

Prof P Cleaton-Jones, Tel 011 717 2301, email peter.cleaton-jones1@wits.ac.za or Ms Zanele Ndlovu/ Mr Rhulani Mkansi/ Mr Lebo Moeng Administrative Officers 011 717 2700/2656/1234/1252

zanele.ndlovu@wits.ac.za; Rhulani.mkansi@wits.ac.za; and Lebo.moeng@wits.ac.za

INFORMED CONSENT

Health of Adolescents living in rural Mpumalanga: Formative work for an intervention to optimize adolescent health (Baseline survey)

PARTICIPANT:

I, _____, hereby give consent to participate in this research at the University of Witwatersrand.

Signature or Thumbprint of Participant ____

Date ____

I understand that the study will involve completion of questionnaires by interview. The purpose and all the details of this study have been explained to me.

I have read and have had explained to me the procedures described. I have had an opportunity to ask questions and my questions have been answered in a satisfactory way.

I understand that all the information collected during the study will be treated with the strictest confidentiality and will only be used for scientific research purposes. All records will be kept in a locked room and in a secure computer database in the research unit. My name will not be used in any publication of the results. I understand that for data verification and quality control purposes regulatory authorities and/or members of the Wits Human Research Ethics Committee (Medical) may be allowed access to my personal data under conditions of strict confidentiality.

I understand that I may be contacted for a follow-up study.

I agree to participation and participation of my child in the study on the condition that:

I can withdraw voluntarily from the study at any time and that no adverse consequences will follow on withdrawal from the study.

I have the right not to answer any or all questions posed in the questionnaire.

The University of the Witwatersrand's Human Research Ethics committee has approved the study protocol and procedures.

All results will be treated with the strictest confidentiality.

Only group results, and not my individual results, will be published in scientific journals and in the media.

The study scientific team is committed to treating participants with respect and privacy through interviews conducted in private and follow-up counseling available on request.

I will receive a referral note to psychological services if I experience any psychological distress during the study.

I have read the information, or it has been read to me. I have had the opportunity to ask questions about it and my questions have been answered to my satisfaction. I consent voluntarily and understand that I have the right to withdraw my ascent without this affecting the current research study or my medical care.

I have accurately read or witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

RESEARCH ASSISTANT:

Printed Name Signature

Date and Time

Copy provided to participant__ (initialed by researcher)

PARTICIPANT INFORMATION SHEET

For Caregivers/Parents

Health of Adolescents living in rural Mpumalanga: Formative work for an intervention to optimize adolescent health (Baseline survey)

Invitation

Hello, my name is ___ from the University of the Witwatersrand and working with researchers from Agincourt Health and Socio-Demographic Surveillance System.

I would like to invite your child to participate in the research study entitled: **Health of Adolescents living in rural Mpumalanga: Formative work for an intervention to optimize adolescent health (Baseline survey)**. Before, agreeing to allow your child to participate, it is important that you understand the purpose of the study, the study procedures, benefits and risks as well as your child's right to withdraw from the study at any time. If you have any questions, do not hesitate to ask me. You should not agree to take part unless you are satisfied with all the procedures involved. If you decide to take part in this study, you will be asked to sign this document to confirm that you understand the study. You and your child will also be given a copy to keep.

We will need both you and your child to agree to participate in this study.

Why is the study being done?

The study aims to: (i) understand the willingness of adolescents to consent to be part of a study; (ii) understand health behaviours of adolescent boys and girls.

Who can participate?

We will be selecting all adolescents living in your village who are 12 to 19 years of age

What will happen if you decide to take part in the study?

If you consent for your child to take part in the study, your child will be required to complete an interview at a data collection site in your village.

You and your child are under no obligation to take part in the study and are not required to give a reason if you do not wish to participate. If you decide to take part in the study, you are free to withdraw at any time and without giving a reason and without prejudice. If you decide to withdraw from the study, we will discuss with you what will happen to any information that you have provided. If the incomplete information can usefully contribute to the study, we will ask your permission to use the data in our analysis. Alternatively, on your request all your information will be destroyed.

What are the risks and discomforts of this study?

There are no risks or discomforts associated with the administration of the questionnaires. Strict confidentiality of results will be maintained. Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Are there any benefits to you for being in the study?

There are no direct benefits to you for being part of the study.

Who will see the information that is collected about you during the study?

Strict confidentiality of results will be maintained. Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Who do I contact if I have any questions about the study?

If you have any questions or you experience any problems during or after the sessions, please contact Professor Shane Norris, or a representative of the Human Research Ethics Committee.

Professor Shane Norris (PhD)

Principal Investigator

MRC/Wits Developmental Pathways for Health Research Unit Chris Hani Baragwanath Hospital

Soweto Johannesburg Tel: 011-9331122

Email : shane.norris@wits.ac.za

Human Research Ethics Committee contact details:

Prof P Cleaton-Jones, Tel 011 717 2301, email peter.cleaton-jones1@wits.ac.za or Ms Zanele Ndlovu/ Mr

Rhulani Mkansi/ Mr Lebo Moeng Administrative Officers 011 717 2700/2656/1234/1252

zanele.ndlovu@wits.ac.za; Rhulani.mkansi@wits.ac.za; and Lebo.moeng@wits.ac.za

INFORMED CONSENT

Health of Adolescents living in rural Mpumalanga: Formative work for an intervention to optimize adolescent health (Baseline survey)

PARENT/Caregiver:

I, _____, hereby give consent for my child
_____ to participate in this research at the University of Witwatersrand.

Print Name of Participant _____

Signature of Participant _____

Date ____

I understand that the study will involve my child completing a questionnaire by interview. The purpose and all the details of this study have been explained to me.

I have read and have had explained to me the procedures described. I have had an opportunity to ask questions and my questions have been answered in a satisfactory way.

I understand that all the information collected during the study will be treated with the strictest confidentiality and will only be used for scientific research purposes. All records will be kept in a locked room and in a secure computer database in the research unit. My name and my child's name will not be used in any publication of the results. I understand that for data verification and quality control purposes regulatory authorities and/or members of the Wits Human Research Ethics Committee (Medical) may be allowed access to my personal data under conditions of strict confidentiality.

I understand that I may be contacted for a follow-up study.

I agree to participation and participation of my child in the study on the condition that:

I can withdraw voluntarily from the study at any time and that no adverse consequences will follow on withdrawal from the study.

I have the right not to answer any or all questions posed in the questionnaire.

The University of the Witwatersrand's Human Research Ethics committee has approved the study protocol and procedures.

All results will be treated with the strictest confidentiality.

Only group results, and not my individual results, will be published in scientific journals and in the media.

The study scientific team is committed to treating participants with respect and privacy through interviews conducted in private and follow-up counseling available on request.

I will receive a referral note to psychological services if I experience any psychological distress during the study.

I have read the information, or it has been read to me. I have had the opportunity to ask questions about it and my questions have been answered to my satisfaction. I consent voluntarily and understand that I have the right to withdraw my ascent without this affecting the current research study or my medical care.

I have accurately read or witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

RESEARCH ASSISTANT:

Printed Name Signature _____

Date and Time

Copy provided to participant__ (initialed by researcher)

PARTICIPANT INFORMATION SHEET
For those under the age of 18 years

Health of Adolescents living in rural Mpumalanga: Formative work for an intervention to optimize adolescent health (Baseline Survey)

Invitation

Hello, my name is ____ from the University of the Witwatersrand and working with researchers from Agincourt Health and Socio-Demographic Surveillance System.

I would like to invite you to participate in the research study entitled: **Health of Adolescents living in rural Mpumalanga: Formative work for an intervention to optimize adolescent health (Baseline survey).**

Before, agreeing to participate, it is important that you understand the purpose of the study, the study procedures, benefits and risks as well as your right to withdraw from the study at any time. If you have any questions, do not hesitate to ask me. You should not agree to take part unless you are satisfied with all the procedures involved. If you decide to take part in this study, you will be asked to sign this document to confirm that you understand the study. You and your child will also be given a copy to keep.

We will need both you and your caregiver/parent to agree to participate in this study.

Why is the study being done?

The study aims to: (i) understand the willingness of adolescents to consent to be part of a study; (ii) understand health behaviours of adolescent boys and girls.

Who can participate?

We will be selecting all adolescents living in your village who are 12 to 19 years of age

What will happen if you decide to take part in the study?

If you consent to take part in the study, you will be required to complete one interview session at home.

You are under no obligation to take part in the study and are not required to give a reason if you do not wish to participate. If you decide to take part in the study, you are free to withdraw at any time and without giving a reason and without prejudice. If you decide to withdraw from the study, we will discuss with you what will happen to any information that you have provided. If the incomplete information can usefully contribute to the study, we will ask your permission to use the data in our analysis. Alternatively, on your request all your information will be destroyed.

During the Interview:

You will be requested to complete questions about yourself (time spent walking; time spent watching TV and sitting; sugar sweetened beverage intake and some questions about your future) with an interviewer, and your height, weight and waist circumference will be measured. This will take no longer than 60 minutes. Further details of these procedures are provided below:

Beverage frequency questionnaire (BQ)

You will also be asked to fill in a beverage frequency questionnaire to measure your usual intake (what you normally drink). This questionnaire will give us a sense of what and how much you have consumed over the last week

Hope questionnaire (BQ)

You will also be asked to fill in a questionnaire about your future and your hope for success.

Mental Health Screening Tool & Cognitive Assessment

We are interested in understanding more about your mental health and the way that you make decisions. We will ask you a few questions on how you are feeling and also ask you to participate in an exercise on a computer that might some like a game.

Height and weight, blood pressure and waist circumference measurements

We will determine your height by you standing next to a height board with no shoes on and we will ask you to stand on an electronic scale to determine your weight. We will also measure your waist circumference with a tape measure and measure your blood pressure using a blood pressure cuff.

What are the risks and discomforts of this study?

There are no risks or discomforts associated with the administration of the questionnaires. Strict confidentiality of results will be maintained. Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Are there any benefits to you for being in the study?

There are no direct benefits to you for being part of the study.

Who will see the information that is collected about you during the study?

Strict confidentiality of results will be maintained. Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Who do I contact if I have any questions about the study?

If you have any questions or you experience any problems during or after the sessions, please contact Professor Shane Norris, or a representative of the Human Research Ethics Committee. **Professor Shane Norris (PhD)**

Principal Investigator

MRC/Wits Developmental Pathways for Health Research Unit Chris Hani Baragwanath Hospital

Soweto Johannesburg Tel: 011-9331122

Email : shane.norris@wits.ac.za

Human Research Ethics Committee contact details:

Prof P Cleaton-Jones, Tel 011 717 2301, email peter.cleaton-jones1@wits.ac.za or Ms Zanele Ndlovu/ Mr

Rhulani Mkansi/ Mr Lebo Moeng Administrative Officers 011 717 2700/2656/1234/1252

zanele.ndlovu@wits.ac.za; Rhulani.mkansi@wits.ac.za; and Lebo.moeng@wits.ac.za

INFORMED ASSENT

Health of Adolescents living in rural Mpumalanga: Formative work for an intervention to optimize adolescent health (Baseline survey)

PARTICIPANT:

I, _____, hereby give assent to participate in this research at the University of Witwatersrand.

Signature or thumbprint of Participant _____

Date __

I understand that the study will involve completion of questionnaires by interview. The purpose and all the details of this study have been explained to me.

I have read and have had explained to me the procedures described. I have had an opportunity to ask questions and my questions have been answered in a satisfactory way.

I understand that all the information collected during the study will be treated with the strictest confidentiality and will only be used for scientific research purposes. All records will be kept in a locked room and in a secure computer database in the research unit. My name will not be used in any publication of the results. I understand that for data verification and quality control purposes regulatory authorities and/or members of the Wits Human Research Ethics Committee (Medical) may be allowed access to my personal data under conditions of strict confidentiality.

I understand that I may be contacted for a follow-up study. I agree to participation in the study on the condition that:

I can withdraw voluntarily from the study at any time and that no adverse consequences will follow on withdrawal from the study.

I have the right not to answer any or all questions posed in the questionnaire.

The University of the Witwatersrand's Human Research Ethics committee has approved the study protocol and procedures.

All results will be treated with the strictest confidentiality.

Only group results, and not my individual results, will be published in scientific journals and in the media. The study scientific team is committed to treating participants with respect and privacy through interviews conducted in private and follow-up counseling available on request.

I will receive a referral note to psychological services if I experience any psychological distress during the study.

I have read the information, or it has been read to me. I have had the opportunity to ask questions about it and my questions have been answered to my satisfaction. I consent voluntarily and understand that I have the right to withdraw my ascent without this affecting the current research study or my medical care.

I have accurately read or witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

RESEARCH ASSISTANT:

Printed Name Signature

Date and Time

Copy provided to participant__ (initialed by researcher)

Appendix 3: Quantitative data collection tools

Ntshembo Research Data collection

Participant ID:

--	--	--	--	--	--	--	--	--	--	--	--

Date:

D	D		M	M		Y	Y
---	---	--	---	---	--	---	---

Height

--	--	--

 .

--

 cm

Weight

--	--	--

 .

--

 kg

Waist circumference .

--

 cm

Blood Pressure	sys(mmHg)	dia(mmHg)						
	<table border="1"><tr><td></td><td></td><td></td></tr></table>				<table border="1"><tr><td></td><td></td><td></td></tr></table>			
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Time spent walking for transport

--

In a usual week, how many days do you walk for at least 10 minutes to get to and from places?

--

DaysOn a usual day, how much time do you spend walking for travel? Hours minutes

Sedentary behaviours

--

“On school days (Monday through Friday), how many hours do you spend watching television per day?”,

--

“On weekends (Saturday and Sunday), how many hours do you spend watching television per day?”

--

“On school days (Monday through Friday), how many hours do you spend on your phone per day?”,

--

“On weekends (Saturday and Sunday), how many hours do you spend on your phone per day?”

--

HOPE SCALE

Interviewer Script: We would like to ask you some questions about your future and your hope for success. Please tell me how much you agree with the following statements about yourself on a scale of one to four, where 1=I totally disagree, 2=I disagree, 3=I agree, and 4=I totally agree.

1. I can achieve my dreams if I focus on them.
2. I trust that I will achieve the goals that I set for myself.
3. It is easy for me to reach my goals.
4. I trust that I will be able to do everything I want to do in my future.
5. I have more confidence in my future success than others my age.
6. I believe that the things I am doing now are preparing me for what I want in the future.
7. I know that my life will be better in the future.
8. I believe that I will be successful even when there are difficulties in my life now.
9. I have faith that I will be successful.
10. The important people in my life tell me that I will have a successful life.
11. I will be successful because I know other people like me whom have been successful.
12. There are people who can help me when I need guidance to achieve something important to me.
13. When I feel discouraged my religious beliefs help me the most.

CENTER FOR EPIDEMIOLOGIC STUDIES DEPRESSION SCALE – CES-D

Below is a list of some of the ways you may have felt or behaved. Please indicate how often you have felt this way during the past week

1.	I was bothered by things that usually don't bother me	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
2.	I did not feel like eating. My appetite was poor	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
3.	I felt that I could not shake off the blues even with help from my family	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
4.	I felt that I was just as good as other people	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
5.	I had trouble keeping my mind on what I was doing	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
6.	I felt depressed	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
7.	I felt that everything I did was an effort	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
8.	I felt hopeful about the future	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
9.	I thought my life had been a failure	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
10.	I felt fearful	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)

11.	My sleep was restless	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
12.	I was happy	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days)

	4 = All of the time (5-7 days)
--	--------------------------------

13.	I talked less than usual	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
14.	I felt lonely	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
15.	People were unfriendly	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
16.	I enjoyed life	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
17.	I had crying spells	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
18.	I felt sad	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
19.	felt that people disliked me	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)
20.	I could not "get going"	1 = Rarely or none of the time (less than 1 day) 2 = Some of a little of the time (1-2 days) 3 = Occasionally or a moderate amount of time (3-4 days) 4 = All of the time (5-7 days)

REVISED CHILDREN'S MANIFEST ANXIETY SCALE

Interviewer Script: *Many kids and teenagers feel nervous or anxious at times. Please say which of these is true for you.*

1.	I worry a lot of the time	1 = Yes 0 = No
2.	I worry about what my carers will say to me.	1 = Yes 0 = No
3.	I feel that others do not like the way I do things.	1 = Yes 0 = No
4.	It is hard for me to get to sleep at night.	1 = Yes 0 = No
5.	I worry about what other people think about me	1 = Yes 0 = No
6.	I feel alone even when there are people with me.	1 = Yes 0 = No
7.	I worry about what is going to happen.	1 = Yes 0 = No
8.	Other children/teenagers are happier than I.	1 = Yes 0 = No
9.	I have bad dreams.	1 = Yes 0 = No
10.	I wake up scared some of the time.	1 = Yes 0 = No
11.	I worry when I go to bed at night.	1 = Yes 0 = No
12.	I am nervous.	1 = Yes 0 = No
13.	A lot of people are against me.	1 = Yes 0 = No
14.	I often worry about something bad happening to me.	1 = Yes 0 = No

CHILDREN'S DEPRESSION INDEX

This part of the questionnaire looks at sadness and other difficulties which many people experience at some point in their lives. This questionnaire is arranged in groups of 3 statements. Please listen to each group carefully. Then pick out ONLY ONE statement from each group which best describes the way you have been feeling during the past 2 weeks.

1.	1 = I am sad once in a while 2 = I am sad many times 3 = I am sad all the time
2.	1 = Nothing will ever work out for me 2 = I am not sure if things will work out for me 3 = Things will work out for me ok
3.	1 = I do most things ok 2 = I do many things wrong 3 = I do everything wrong
4.	1 = I hate myself 2 = I do not like myself 3 = I like myself
5.	1 = I feel like crying every day 2 = I feel like crying many days 3 = I feel like crying once in awhile
6.	1 = Things bother me all the time 2 = Things bother me many times 3 = Things bother me once in awhile
7.	1 = I look ok 2 = There are some bad things about my looks 3 = I look ugly
8.	1 = I do not feel alone 2 = I feel alone many times 3 = I feel alone all the time
9.	1 = I have plenty of friends 2 = I have some friends but I wish I had more 3 = I don't have any friends
10.	1 = Nobody really loves me 2 = I am not sure if anybody loves me 3 = I am sure that somebody loves me

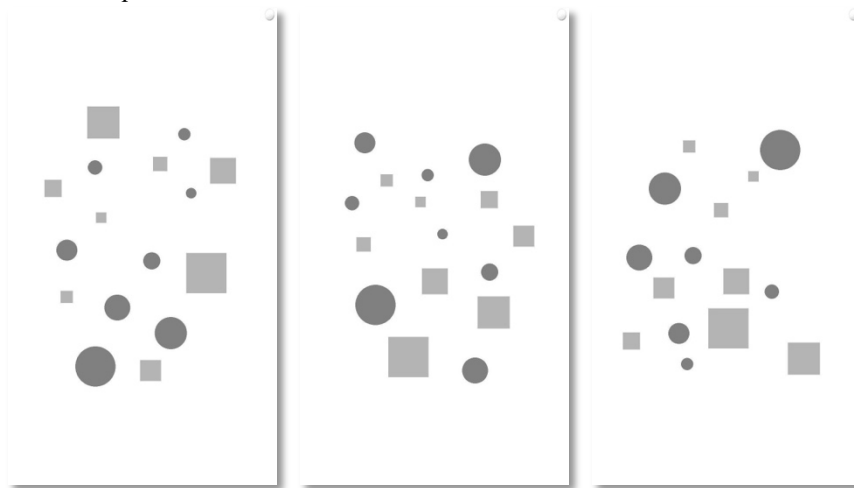
Cognitive testing in adolescents and young adults - description of tasks

A series of cognitive tests of memory, processing speed, inhibitory control, attention, executive function, risk taking and decision-making will be administered on a tablet device to all respondents using a subset of the OCS-Plus (Oxford Cognitive Screen Plus), a variation of the IOWA gambling task, and a go/nogo task - all designed to minimize literacy and numeracy. The OCS-Plus has previously been used in studies of the MRC/Wits Agincourt Research Unit. The user manual for the tasks is included. These together should take no more than 45 minutes. We have included both the English and Shangaan translations of the instructions for these tasks (attached) and a short description of each below.

OCS-Plus subset

OCS-Plus comprises a series of short tests of domain-specific and domain-general cognitive performance of which we are including a subset to assess memory, attention, executive functioning and praxis. OCS-Plus runs as a stand-alone application on Windows Surface Pro tablets. OCS-Plus's graphical user interface – used in conjunction with trained fieldworkers and instructions translated into Shangaan – provides full scripts for each task, ensuring standardized administration. Timing of tasks is automatically recorded. For most tasks, accuracy of response is also automatically scored, except for interpretation of the figure drawing task which is done manually.

Trails. Respondents will be presented with an arrangement of dark grey circles and light grey squares of different sizes and asked to draw lines on the screen with the stylus to connect them in a particular order: for example to connect circles from small to large, to connect squares from large to small, and to alternate connections between squares and circles.



Rule Finding. Respondents will be presented with a set of 12 squares and 12 triangles randomly arranged in an 8-by-3 grid. All shapes will be light grey, with the exception of one per

row that will be dark grey. During the task, a red dot will move across the shapes following certain rules. Current and previous positions of the dot will always be marked. At each move, respondents will be asked to use the stylus to tap the position they predict the dot will assume next. There will be five rules in total, and transitions from one rule to the next will not be signalled.

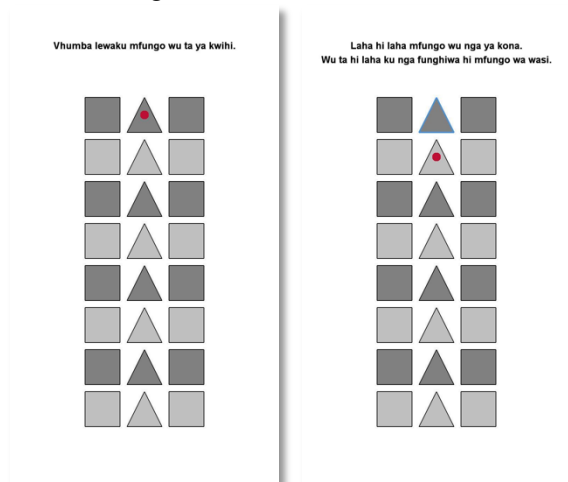
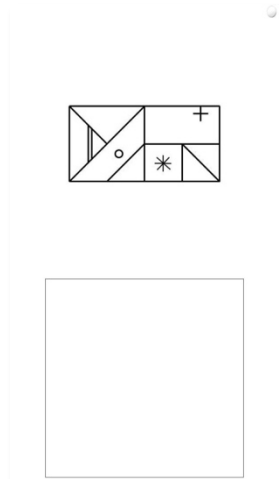


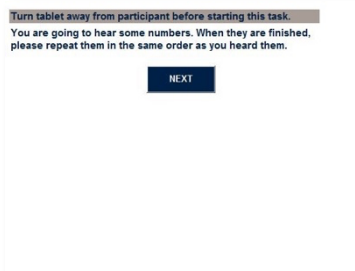
Figure Copy. The participant will be asked to copy a composite image of geometric shapes, with the image to be copied initially present at the top of the page for the duration of the copying. Immediately after this, the participant is asked to draw the same composite figure once more, this time from memory. Drawings will be completed in a box underneath where the figure has been shown. Currently the drawings are scored manually.



Selection. The participant will be presented with a distribution of black-and-white drawings of three vegetables and three fruits and asked to use the pen to select the fruits. There are two variations of the task, one in which each selected item is highlighted and the marking remains on the screen to the end of the task, and one in which the highlighting is only visible for a short while and then disappears.

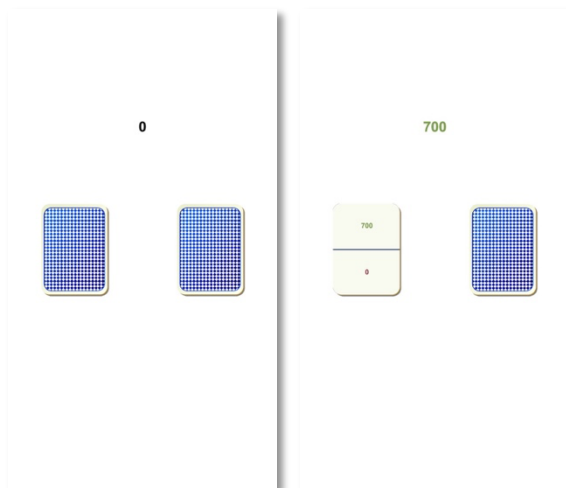


Digit Span. The participant will be read out loud sequences of digits and asked to repeat them. There are two variations of the task, one in which the sequence has to be repeated in the same order, and one in which the sequence has to be repeated backwards. The length of the digit sequences will incrementally increase from 2 to 9.



Extensions

Modified IOWA gambling task. The participant will select cards from one of two packs during 50 trials. Each card will have both a reward and a penalty. Sometimes the reward will be higher than the penalty and vice versa. One pack has an overall net reward while the other has an overall net loss. Participants will have to infer which of the two packs was better in terms of long-term reward in order to maximise long-term reward.



Go/Nogo task. The participant will complete a go/nogo task with neutral faces as targets and either fearful or happy as non-targets across 144 trials split in 4 blocks of 36 trials. In two blocks the fearful faces will act as non-targets, while for the other two blocks the non-targets will be the happy faces. The participant has to use the pen to tap the screen only when a neutral face appears. Speed and accuracy of responses will be scored. Below are examples of fearful and neutral expressions similar to the ones we will use in our task. Our faces will reflect the local population, but due to copyright on the faces images we cannot include those here.



Appendix 4: Pre-intervention FGDs information sheet and consents

Study information sheet (Adolescent) Focus Group

Hello, my name is _____ from the University of the Witwatersrand and working with researchers from MRC/Wits-Agincourt Research Unit.

I would like to invite you to participate in the research study entitled: **Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa** Before, agreeing to participate, it is important that you understand the purpose of the study, the study procedures, benefits and risks as well as your right to withdraw from the study at any time. If you have any questions, do not hesitate to ask me. You should not agree to take part unless you are satisfied with all the procedures involved. If you decide to take part in this study, you will be asked to sign this document to confirm that you understand the study. You will also be given a copy to keep.

Why is the study being done?

To define young people's understanding of overweight and obesity, and establish the practicality, suitability /tolerability and the experience of a community based intervention to change behaviour for healthier lifestyles in rural South African young people.

Who can participate?

We will be selecting all adolescents living in your village who are 12 to 19 years of age

What will happen if you decide to take part in the study?

If you agree to take part in the study, you will be asked to participate in a Focus Group Discussion with about 5 other people. The discussion will be about your experiences during the Saturday camps and the use of the Information 4 My Life book. It will take about 45-60 minutes, and will be audio-recorded with your consent along with other participants in the group. If you do not want to be audio-recorded, you may refuse. The focus group will take place at a time and place arranged between you and the researcher.

You do not have to take part in the study and are not required to give a reason if you do not wish to participate. If you and your child decide to take part in the study, you are free to withdraw at any time and without giving a reason and without prejudice.

What are the risks and discomforts of this study?

We cannot ensure complete confidentiality in a focus group discussion; however, we will encourage all focus group participants to keep the discussions and the identities of other participants confidential outside the focus group. Your name will be removed from all information, and you will be assigned a number, which will be used to identify information relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Are there any benefits to you for being in the study?

There are no direct benefits to you for being part of the study.

Who will see the information that is collected about you during the study?

Your name will be removed from all information, and you will be given a study number which will be used to identify information relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Who do I contact if I have any questions about the study?

If you have any questions or you experience any problems during or after the sessions, please contact Tshegofatso Seabi, or a representative of the Human Research Ethics Committee.

Tshegofatso Seabi

PhD Candidate

MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt)

Wits University, School of Public Health

Cell : 0833202097

Email : tshegofatso.seabi@wits.ac.za

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg (“Committee”). A principal function of this Committee is to safeguard the rights and dignity of all human subjects who agree to participate in a research project and the integrity of the research.

If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Thank you for reading this Study Information Sheet.

Informed Consent_ Adolescent Focus Group Discussion

To be completed by participant

- The information sheet has been read out loud to me or I have read the information sheet. I have been given the opportunity to ask questions, and received satisfactory answers.
- I understand that this project has been reviewed by, and received ethics clearance through the University of the Witwatersrand Human Research Ethics Committee
- I understand that my participation is voluntary, and that I can withdraw my consent at any time without further explanation, and without any adverse consequences.
- I understand that this study involves a focus group about my experiences and participation in the Adolescent Saturday camps.
- I understand that since it is a focus group, confidentiality cannot be ensured; however, all participant will be encouraged to keep confidentiality of identity.
- I understand that only group results, and not my individual results, will be used for scientific and public health purposes.
- I understand that there is no direct benefit for me from being in the study.
- I understand how to raise concerns or make a complaint.
- I agree to take part in the study.

Name of participant:

Date (dd/mm/yyyy):...../...../20..... Signature:

To be completed by field worker

- I declare that I have explained the study and its implications to the participant. He/she has understood the explanation, and provided his/her consent to participate.

Name of researcher:

Date (dd/mm/yyyy):/...../20.....

Signature:.....

Participant study code:_..... [study site]

Consent Form: Recording

I consent to being audio-recorded in the Focus Group discussion

I understand that:

- The tapes and transcripts will only be seen or heard by the researcher and her supervisor.
- My real name will not be used in the transcripts or the research report, only group results will be reported.
- Recordings of the interviews will not be destroyed, unless participants request that the recordings of their focus group be destroyed.
- Recordings will be stored secure in a locked cupboard or on a computer protected by a password.

Name of participant:

Date (dd/mm/yyyy):/...../20..... Signature:

Study information sheet (Adolescent <18 years) Focus Group

Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa

Hello, my name is _____ from the University of the Witwatersrand and working with researchers from Agincourt Health and Socio-Demographic Surveillance System.

I would like to invite you and your child to participate in the research study entitled:

Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa

Before, agreeing to participate, it is important that you and your child to understand the purpose of the study, the study procedures, benefits and risks as well as your right to withdraw from the study at any time. If you and/or your child have any questions, do not hesitate to ask me. You should not agree to take part unless you are satisfied with all the procedures involved. If you and your child decide to take part in this study, you will be asked to sign this document to confirm that you and your child understand the study. You will also be given a copy to keep.

Why is the study being done?

To define young people's understanding of overweight and obesity, and determined whether a community-based intervention to change behaviour for healthier lifestyles in rural South African young people is feasible and acceptable.

Who can participate?

We will be selecting all adolescents living in your village who are 12 to 19 years of age, and parents/guardians

What will happen if you decide to take part in the study?

If you and your child agree to take part in the study, you will be invited to complete a focus group. The Focus Group will be about your child's experience in taking part in the Saturday camps and the use of the Information 4 my Life book. The focus group discussion will take about 45-60 minutes, and will be audio-recorded with your consent along with other participants in the group. If you do not want to be audio-recorded, you may refuse. The focus group will take place at your convenience at a time and place arranged between you and the researcher.

You and your child do not have to take part in the study and are not required to give a reason if you do not wish to participate. If you and your child decide to take part in the study, you are free to withdraw at any time and without giving a reason and without prejudice.

What are the risks and discomforts of this study?

We cannot ensure complete confidentiality in a focus group discussion; however, we will encourage all focus group participants to keep the discussions and the identities of other participants confidential outside the focus group. Your child's name will be removed from all data, and will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Are there any benefits to you for being in the study?

There are no direct benefits to you for being part of the study.

Who will see the information that is collected about you during the study?

Participants' name will be removed from all data, and will be assigned a number, which will be used to identify data relating to your child. All records will be kept in a locked room and in a secure computer database in the research unit. You and your child's names will not be used in any publication of the results.

Who do I contact if I have any questions about the study?

If you have any questions or you experience any problems during or after the sessions, please contact Tshegofatso Seabi, or a representative of the Human Research Ethics Committee.

Tshegofatso Seabi

PhD Candidate

MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt)

University of the Witwatersrand, School of Public Health

Cell: 0833202097

Email: tshegofatso.seabi@wits.ac.za

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg ("Committee"). A principal function of this Committee is to safeguard the rights and dignity of all human subjects who agree to participate in a research project and the integrity of the research.

If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Thank you for reading this Study Information Sheet.

Informed Consent_ Adolescent <18 Years old (Parent/Guardian) _ Focus Group

To be completed by Parent/Guardian

- The information sheet has been read out loud to me or I have read the information sheet. I have been given the opportunity to ask questions, and received satisfactory answers.
- I understand that this project has been reviewed by, and received ethics clearance through the University of the Witwatersrand Human Research Ethics Committee
- I understand that my participation is voluntary, and that I can withdraw my consent at any time without further explanation, and without any adverse consequences.
- I understand that this study involves a focus group about my experiences and participation in the Adolescent Saturday camps.
- I understand that since it is a focus group, confidentiality cannot be ensured; however, all participant will be encouraged to keep confidentiality of identity.
- I understand that only group results, and not my individual results, will be used for scientific and public health purposes.
- I understand that there is no direct benefit for me and my child from being in the study.
- I understand how to raise concerns or make a complaint.
- I agree for my child to take part in the study.

Name of Parent/Guardian:

Name of Child:

Date (dd/mm/yyyy):/...../20..... Signature:

.....

To be completed by field worker

- I declare that I have explained the study and its implications to the participant. He/she has understood the explanation, and provided his/her consent to participate.

Name of researcher:

Date (dd/mm/yyyy):/...../20.....

Signature:.....

Participant study code:_..... [study site]

Informed Assent_ Adolescent <18 Years old_Focus Group

To be completed by participant

- The information sheet has been read out loud to me or I have read the information sheet. I have been given the opportunity to ask questions, and received satisfactory answers.
- I understand that this project has been reviewed by, and received ethics clearance through the University of the Witwatersrand Human Research Ethics Committee
- I understand that my participation is voluntary, and that I can withdraw my consent at any time without further explanation, and without any adverse consequences.
- I understand that this study involves a focus group about my experiences and participation in the Adolescent Saturday camps.
- I understand that since it is a focus group, confidentiality cannot be ensured; however, all participant will be encouraged to keep confidentiality of identity.
- I understand that only group results, and not my individual results, will be used for scientific and public health purposes.
- I understand that there is no direct benefit for me from being in the study.
- I understand how to raise concerns or make a complaint.
- I agree to take part in the study.

Name of Child:

Date (dd/mm/yyyy):/...../20..... Signature:

.....

To be completed by field worker

- I declare that I have explained the study and its implications to the participant. He/she has understood the explanation, and provided his/her consent to participate.

Name of researcher:

Date (dd/mm/yyyy):/...../20.....

Signature:.....

Consent Form: Recording

I consent to being audio-recorded in the Focus Group discussion.

I understand that:

- The tapes and transcripts will only be seen or heard by the researcher and her supervisor.
- My real name will not be used in the transcripts or the research report, only group results will be reported.
- Recordings of the interviews will not be destroyed, unless participants request that the recordings of their focus group be destroyed.
- Recordings will be stored secure in a locked cupboard or on a computer protected by a password.

Name of participant:

Date (dd/mm/yyyy):/...../20..... Signature:

Appendix 5: Pre-intervention FGDs guides

Thank you for taking the time to meet with me today.

Today we are going to talk about your experience of being part of the project as it has been explained to you in the informed consent process. Your participation in this group discussion will be extremely helpful for us to develop an intervention that is appropriate for young people in the Agincourt setting. Through this we hope to improve the health and wellbeing of adolescents in your community. Please remember that there are no ‘right’ or ‘wrong’ answers to any of the questions and you should feel free to discuss your thoughts and views openly.

Informant data to be collected:

Participant number	Age	Sex	Highest level of education completed

Materials to be used: These will be used to start and facilitate the conversation within the group around body shapes and sizes and food.

- Pictures from magazines showing (i) different body shapes and sizes, and (ii) different foods.

Questions	Probes
1. Sometime, people refer to others as “obese”. What do you understand by this?	
2. What are your thoughts and feelings about food?	a. Preferences for different food b. What are healthy foods? c. What foods do young people actually eat and what they would like to eat d. How much food they eat with family and then with peers? e. What foods they eat with family and with peers? f. What food are sold near schools in the community or provided at school?
3. What are your thoughts and feelings around exercise?	a. Do young people exercise? b. What exercises do they do? c. What do they think of exercise – is it fashionable to exercise? d. Is it the same or different for boys and girls?
4. We are interested in factors that lead to people being light or heavy. What do you think are reasons that some people are heavy, and others are light?	a. Are young people emotional eaters? b. Do they eat late at night? c. What it means to be light or heavy, in the community, and at school? d. Factors associated with being heavy or light?
5. In your views, what do you think the best size and shape is for young people? And why?	a. What they think of body shape and its association b. Which is good or bad or acceptable and unacceptable c. What do they think is the nicest body shape?

	<i>d. Are people dissatisfied or satisfied (at your home, at school, and community) as far as you know?</i>
6. What are some things that you have heard or seen about obesity in young people?	<i>a. If your mom is obese, do you think you have greater chance of being obese?</i> <i>b. What do you think causes obesity in general? (as an opening question)</i> <i>c. Emotional state and how it affects what they eat (mental health)</i>
7. What are some of the consequences of obesity that you have heard about?	<i>a. What do you think happens to young people's health? now and as they grow up?</i> <i>b. When do these issues start?</i> <i>c. Are people happy or sad? Tell more</i> <i>d. What do you think other people say about them at your age?</i>

Appendix 6: Post-intervention FGDs and IDIs information sheets and consent forms with guides

Study information sheet (Adolescent) Focus Group

Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa

Hello, my name is _____ from the University of the Witwatersrand and working with researchers from MRC/Wits-Agincourt Research Unit.

I would like to invite you to participate in the research study entitled: **Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa** Before, agreeing to participate, it is important that you understand the purpose of the study, the study procedures, benefits and risks as well as your right to withdraw from the study at any time. If you have any questions, do not hesitate to ask me. You should not agree to take part unless you are satisfied with all the procedures involved. If you decide to take part in this study, you will be asked to sign this document to confirm that you understand the study. You will also be given a copy to keep.

Why is the study being done?

To define young people's understanding of overweight and obesity, and determined whether a community-based intervention to change behaviour for healthier lifestyles in rural South African young people is feasible and acceptable.

Who can participate?

We will be selecting all adolescents living in your village who are 12 to 19 years of age

What will happen if you decide to take part in the study?

If you agree to take part in the study, you will be asked to participate in a Focus Group Discussion with about 5 other people. The discussion will be about your experiences during the Saturday camps and the use of the Information 4 My Life book. It will take about 45-60 minutes, and will be audio-recorded with your consent along with other participants in the group. If you do not want to be audio-recorded, you may refuse. The focus group will take place at a time and place arranged between you and the researcher.

You do not have to take part in the study and are not required to give a reason if you do not wish to participate. If you decide to take part in the study, you are free to withdraw at any time and without giving a reason and without anything bad happening to you. If you decide to withdraw from the study, we will discuss with you what will happen to any information that you have provided. If the incomplete information can usefully contribute to the study, we will ask your permission to use the data in our analysis. Alternatively, on your request all your information will be destroyed.

What are the risks and discomforts of this study?

We cannot ensure complete confidentiality in a focus group discussion, however, we will encourage all focus group participants to keep the discussions and the identities of other participants confidential outside the focus group. Your name will be removed from all information, and you will be assigned a number, which will be used to identify information relating to you. All records will be kept in a locked

room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Are there any benefits to you for being in the study?

In the intervention camps, adolescents will learn about all the topics in the information 4my life activity workbook that can benefit their health through changing health behaviours.

Who will see the information that is collected about you during the study?

Your name will be removed from all information, and you will be given a study number which will be used to identify information relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Who do I contact if I have any questions about the study?

If you have any questions or you experience any problems during or after the sessions, please contact Tshegofatso Seabi, or a representative of the Human Research Ethics Committee.

Tshegofatso Seabi

PhD Candidate

MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt)

Wits University, School of Public Health

Cell : 0833202097

Email : tshegofatso.seabi@wits.ac.za

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg ("Committee"). A principal function of this Committee is to safeguard the rights and dignity of all human subjects who agree to participate in a research project and the integrity of the research.

If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Thank you for reading this Study Information Sheet.

Informed Consent_ Adolescent Focus Group Discussion-Intervention

To be completed by participant

- The information sheet has been read out loud to me or I have read the information sheet. I have been given the opportunity to ask questions, and received satisfactory answers.
- I understand that this project has been reviewed by, and received ethics clearance through the University of the Witwatersrand Human Research Ethics Committee
- I understand that my participation is voluntary, and that I can withdraw my consent at any time without further explanation, and without any adverse consequences.
- I understand that this study involves a focus group about my experiences and participation in the Adolescent Saturday camps.
- I understand that since it is a focus group, confidentiality cannot be ensured; however, all participant will be encouraged to keep confidentiality of identity.
- I understand that only group results, and not my individual results, will be used for scientific and public health purposes.
- I understand that there is no direct benefit for me from being in the study.
- I understand how to raise concerns or make a complaint.
- I agree to take part in the study.

Name of participant:

Date (dd/mm/yyyy):...../...../20..... Signature:

To be completed by field worker

- I declare that I have explained the study and its implications to the participant. He/she has understood the explanation, and provided his/her consent to participate.

Name of researcher:

Date (dd/mm/yyyy):/...../20.....

Signature:.....

Participant study code: [study site]

Consent Form: Recording

I consent to being audio-recorded in the Focus Group discussion

I understand that:

- The tapes and transcripts will only be seen or heard by the researcher and her supervisor.
- My real name will not be used in the transcripts or the research report, only group results will be reported.
- Recordings of the interviews will not be destroyed, unless participants request that the recordings of their focus group be destroyed.
- Recordings will be stored secure in a locked cupboard or on a computer protected by a password.

Name of participant:

Date (dd/mm/yyyy):/...../20..... Signature:

Adolescent Focus Group Guide (Post- Intervention)

Thank you for taking the time to meet with me today.

Today we are going to talk about your experience of being part of the project as it has been explained to you in the informed consent process. Your participation in this group discussion will be extremely helpful for us to develop an intervention that is appropriate for young people in the Agincourt setting, and we hope to ultimately improve the health and wellbeing of adolescents in your community. Please remember that there are no 'right' or 'wrong' answers to any of the questions and you should feel free to discuss your thoughts and views openly.

Informant data to be collected:

Participant number	Age	Sex	Highest level of education completed

Questions	Probes
1. Let's talk about your experience in the study - how did you find the different aspects?	a. <i>Coming to the Saturday workshops</i> b. <i>Using the activity book</i>
2. What are your thoughts and feelings about the workshops	a. <i>Working through the activity</i> b. <i>Did you feel you had enough time to cover the topics</i> c. <i>Experience to discuss the topics with peers both male and female</i>
3. What are your thoughts, feelings and attitudes on healthy choices	a. <i>Do you feel that you are able to implement some of the things that you learned ?</i> b. <i>Some highlights and challenges of making choices</i>
4. Do you feel you learned things from participating in the camps? What are some things that you have learned??	a. <i>Food choices</i> b. <i>Exercising</i> c. <i>Factors associated with obesity (financial, social and emotional)</i> d. <i>Community perceptions</i> e. <i>From the home visits with AHWs and parents/caregivers</i> f. <i>From the individual sessions</i> g. <i>Interactions with peers</i>
5. Are there some issues you feel should be discussed in terms of adolescent health in your community that were not included?	a. <i>From their experiences in general and understanding from the community</i>
6. How did you find interacting with an Adolescent Community Health Worker? Is discussing health issues and healthy behaviour with an CHW the same or different to talking to nurses or	

other community health workers in the community?	
7. Do you have any other comments or suggestions for me?	<i>a. For the activity book</i> <i>b. Workshops</i> <i>c. Overall experience</i>

Study information sheet (Adolescent) In-depth Interview

Hello, my name is _____ from the University of the Witwatersrand and working with researchers from Agincourt Health and Socio-Demographic Surveillance System.

I would like to invite you to participate in the research study entitled: **Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa.**

Before, agreeing to participate, it is important that you understand the purpose of the study, the study procedures, benefits and risks as well as your right to withdraw from the study at any time. If you have any questions, do not hesitate to ask me. You should not agree to take part unless you are satisfied with all the procedures involved. If you decide to take part in this study, you will be asked to sign this document to confirm that you understand the study. You will also be given a copy to keep.

Why is the study being done?

To define young people's understanding of overweight and obesity, and determined whether a community-based intervention to change behaviour for healthier lifestyles in rural South African young people is feasible and acceptable.

Who can participate?

We will be selecting all adolescents living in your village who are 12 to 19 years of age

What will happen if you decide to take part in the study?

If you agree to take part in the study, you will be asked to complete one interview. The in-depth interview will be about your experience in taking part in the Saturday camps and the use of the Information 4 my Life book. This book covers information making right choices, choosing health foods, choosing to be healthy and active and choosing healthy sexual behaviour, as well as support for health goals.

The interview will take about 45-60 minutes and will be audio-recorded with your consent. If you do not want the interview audio-recorded, you may refuse and yet still participate in the Saturday camps. The interview will take place at your convenience in private, with time and place arranged between you and the researcher.

You do not have to take part in the study and are not required to give a reason if you do not wish to participate. If you decide to take part in the study, you are free to withdraw at any time and without giving a reason and without prejudice.

What are the risks and discomforts of this study?

There are no risks or discomforts associated with the participation in the Interview.

Are there any benefits to you for being in the study?

There are no risks or discomforts associated with the participation in the interview.

Who will see the information that is collected about you during the study?

Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Who do I contact if I have any questions about the study?

If you have any questions or you experience any problems during or after the sessions, please contact Tshegofatso Seabi, or a representative of the Human Research Ethics Committee.

Tshegofatso Seabi

PhD Candidate

MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt)

Wits University, School of Public Health

Cell : 0833202097

Email : tshegofatso.seabi@wits.ac.za

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg (“Committee”). A principal function of this Committee is to safeguard the rights and dignity of all human subjects who agree to participate in a research project and the integrity of the research.

If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Thank you for reading this Study Information Sheet.

Informed Consent_ Adolescent _ In-depth Interview

Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa

To be completed by participant

- The information sheet has been read out loud to me or I have read the information sheet. I have been given the opportunity to ask questions, and received satisfactory answers.
- I understand that this project has been reviewed by, and received ethics clearance through the University of the Witwatersrand Human Research Ethics Committee
- I understand that my participation is voluntary, and that I can withdraw my consent at any time without further explanation, and without any adverse consequences.
- I understand that this study involves an interview about my experiences and participation in the Adolescent Saturday camps.
- I understand that the interview will not be identified with me. My information will be held strictly confidential, will not be shared with people outside the research group, will be stored safely, and will be destroyed 6 years after the interview.
- I understand that only group results, and not my individual results, will be used for scientific and public health purposes.
- I understand that there is no direct benefit for me from being in the study.
- I understand how to raise concerns or make a complaint.
- I agree to take part in the study.

Name of participant:

Date (dd/mm/yyyy):/...../20.....
.....

Signature:

To be completed by field worker

- I declare that I have explained the study and its implications to the participant. He/she has understood the explanation, and provided his/her consent to participate.

Name of researcher:

Date (dd/mm/yyyy):/...../20.....
Signature:.....

Participant study code:_..... [study site]

Consent Form: Recording

I consent to being audio-recorded in the in-depth Interview

I understand that:

- The tapes and transcripts will only be seen or heard by the researcher and her supervisor.
- My real name will not be used in the transcripts or the research report, only group results will be reported.
- Recordings of the interviews will not be destroyed, unless participants request that the recordings of their in-depth interview be destroyed.
- Recordings will be stored secure in a locked cupboard or on a computer protected by a password.

Name of participant:

Date (dd/mm/yyyy):/...../20..... Signature:

Adolescent In-depth Interview Guide (Post Intervention)

Thank you for taking the time to meet with me today.

Today we are going to talk about your experience of being part of the project as it has been explained to you in the informed consent process. Your participation in this discussion will be extremely helpful for us to develop an intervention that is appropriate for young people in the Agincourt setting, and we hope to ultimately improve the health and wellbeing of adolescents in your community. Please remember that there are no 'right' or 'wrong' answers to any of the questions and you should feel free to discuss your thoughts and views openly.

Informant data to be collected: Age, sex, level of education, village of residence

Participant number	Age	Sex	Highest level of education completed

Questions	Probes
1. How did you find the workshops and having discussions with your peers?	a. <i>Were the workshops enjoyable?</i> b. <i>Did the adolescents feel that they were learning from the discussions?</i> c. <i>Did the adolescents feel their knowledge changed in the discussions and workshops?</i>
2. How did you find using the activity book?	a. <i>Which activities they enjoyed and did not enjoy?</i> b. <i>Did they feel they understood the material?</i> c. <i>Was there any information they didn't know and was new to them?</i> d. <i>What the adolescents feel should be added to the activity book that's important – or left out because boring?</i>
3. How did you find the topics that were covered in the activity book?	a. <i>Did they feel were important to them?</i> b. <i>Did they feel they had enough time to go through the material?</i> c. <i>Which aspects did the adolescents enjoy?</i>
4. How did you find interacting with an Adolescent Health Worker? Is discussing health issues and healthy behaviour with a CHW the same or different to talking to nurses or other community health workers in the community?	a. <i>Did they feel they could talk about anything?</i> b. <i>Did they find it helpful to engage with an adolescent health worker in the community or not helpful?</i> c. <i>Do they feel the CHWs should be kept in the community?</i>
5. What do think about the prospect of having the adolescent community health worker doing a home visit?	a. <i>Would it be helpful to have a discussion with parents/guardians and CHWs?</i> b. <i>Do the young people feel it would be beneficial or not? Or would it be this awkward and embarrassing?</i> c. <i>What they feel would change in their communication with parents/guardians after the visit? – if anything</i>
6. Are there parts of all the levels of the intervention process that you enjoyed or least enjoyed?	a. <i>what parts are those?</i> b. <i>what they feel would make the process better?</i>

7. Is there anything else that you can think is important for us to know about your experience?	a. <i>About the activity book</i> b. <i>Group discussions in the workshop</i>
8. What are your thoughts and feelings about the workshops	a. <i>Easily accessible?</i> b. <i>Did the young people look forward to coming to the workshops?</i> c. <i>Did the young people find the time spent sufficient?</i> d. <i>Did the young people feel it was a good experience?</i> e. <i>Would young people do it again?</i> f. <i>Would young people recommend it to their friends?</i>

Study information sheet (Adolescent <18 years) In-depth Interview

Hello, my name is _____ from the University of the Witwatersrand and working with researchers from Agincourt Health and Socio-Demographic Surveillance System.

I would like to invite you and your child to participate in the research study entitled: **Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa** Before, agreeing to participate, it is important that you and your child to understand the purpose of the study, the study procedures, benefits and risks as well as your right to withdraw from the study at any time. If you and/or your child have any questions, do not hesitate to ask me. You should not agree to take part unless you are satisfied with all the procedures involved. If you and your child decide to take part in this study, you will be asked to sign this document to confirm that you and your child understand the study. You will also be given a copy to keep.

Why is the study being done?

To define young people's understanding of overweight and obesity, and determined whether a community-based intervention to change behaviour for healthier lifestyles in rural South African young people is feasible and acceptable.

Who can participate?

We will be selecting all adolescents living in your village who are 12 to 19 years of age, and their parents/guardians.

What will happen if you decide to take part in the study?

If you and your child consent to take part in the study, you will be invited to complete one interview. The in-depth interview will be about your child's experience in taking part in the Saturday camps and the use of the Information 4 my Life book. This book covers information making right choices, choosing health foods, choosing to be healthy and active and choosing healthy sexual behaviour, as well as support for health goals.

The interview will take about 45-60 minutes, and will be audio-recorded with your consent. If you do not want the interview audio-recorded, you may refuse and yet still participate in the Saturday camps. The interview will take place at your convenience in private, with time and place arranged between you and the researcher.

You and your child do not have to take part in the study and are not required to give a reason if you do not wish to participate. If you and your child decide to take part in the study, you are free to withdraw at any time and without giving a reason and without prejudice.

What are the risks and discomforts of this study?

There are no risks or discomforts associated with the participation in the interview.

Are there any benefits to you for being in the study?

There are no direct benefits to you for being part of the study.

Who will see the information that is collected about you during the study?

You and your child's name will be removed from all data, and assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your and your child's name will not be used in any publication of the results.

Who do I contact if I have any questions about the study?

If you have any questions or you experience any problems during or after the sessions, please contact Tshegofatso Seabi, or a representative of the Human Research Ethics Committee.

Tshegofatso Seabi

PhD Candidate

MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt)

University of the Witwatersrand, School of Public Health

Cell : 0833202097

Email : tshegofatso.seabi@wits.ac.za

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg (“Committee”). A principal function of this Committee is to safeguard the rights and dignity of all human subjects who agree to participate in a research project and the integrity of the research.

If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Thank you for reading this Study Information Sheet.

Informed Consent_ Adolescent <18 Years old (Parent/Guardian) In-depth Interview

To be completed by Parent/Guardian

- The information sheet has been read out loud to me or I have read the information sheet. I have been given the opportunity to ask questions, and received satisfactory answers.
- I understand that this project has been reviewed by, and received ethics clearance through the University of the Witwatersrand Human Research Ethics Committee
- I understand that my and my child's participation is voluntary, and that I can withdraw consent at any time without further explanation, and without any adverse consequences.
- I understand that this study involves an interview about my Child's experiences and participation in the Adolescent Saturday camps.
- I understand that the interview will not be identified with my child. My Child's information will be held strictly confidential, will not be shared with people outside the research group, will be stored safely, and will be destroyed 6 years after the interview.
- I understand that only group results, and not my child's individual results, will be used for scientific and public health purposes.
- I understand that there is no direct benefit for me and my child from being in the study.
- I understand how to raise concerns or make a complaint.
- I agree for my child to take part in the study.

Name of Parent/Guardian:

Name of Child:

Date (dd/mm/yyyy):/...../20..... Signature:

.....

To be completed by field worker

- I declare that I have explained the study and its implications to the participant. He/she has understood the explanation and provided his/her consent to participate.

Name of researcher:

Date (dd/mm/yyyy):/...../20.....

Signature:.....

Informed Assent _ Adolescent <18 Years old _In-depth Interview

To be completed by participant

- The information sheet has been read out loud to me or I have read the information sheet. I have been given the opportunity to ask questions, and received satisfactory answers.
- I understand that this project has been reviewed by, and received ethics clearance through the University of the Witwatersrand Human Research Ethics Committee
- I understand that my participation is voluntary, and that I can withdraw my consent at any time without further explanation, and without any adverse consequences.
- I understand that this study involves an interview about my experiences and participation in the Adolescent Saturday camps.
- I understand that the interview will not be identified with me. My information will be held strictly confidential, will not be shared with people outside the research group, will be stored safely, and will be destroyed 6 years after the interview.
- I understand that only group results, and not my individual results, will be used for scientific and public health purposes.
- I understand that there is no direct benefit for me from being in the study.
- I understand how to raise concerns or make a complaint.
- I agree to take part in the study.

Name of Child:

Date (dd/mm/yyyy):/...../20..... Signature:

.....

To be completed by field worker

- I declare that I have explained the study and its implications to the participant. He/she has understood the explanation, and provided his/her consent to participate.

Name of researcher:

Date (dd/mm/yyyy):/...../20.....

Signature:.....

Consent Form: Recording

I consent to being audio-recorded in the in-depth Interview

I understand that:

- The tapes and transcripts will only be seen or heard by the researcher and her supervisor.
- My real name will not be used in the transcripts or the research report, only group results will be reported.
- Recordings of the interviews will not be destroyed, unless participants request that the recordings of their In-depth Interview be destroyed.
- Recordings will be stored secure in a locked cupboard or on a computer protected by a password.

Name of participant:

Date (dd/mm/yyyy):/...../20..... Signature:

Adolescent (<18 years) In-depth Interview Guide (Post Intervention)

Thank you for taking the time to meet with me today.

Today we are going to talk about your experience of being part of the project as it has been explained to you in the informed consent process. Your participation in this discussion will be extremely helpful for us to develop an intervention that is appropriate for young people in the Agincourt setting, and we hope to ultimately improve the health and wellbeing of adolescents in your community. Please remember that there are no ‘right’ or ‘wrong’ answers to any of the questions and you should feel free to discuss your thoughts and views openly.

Informant data to be collected: Age, sex, level of education, village of residence

Participant number	Age	Sex	Highest level of education completed

Questions	Probes
1. How did you find the workshops and having discussions with your peers?	a. <i>Were the workshops enjoyable?</i> b. <i>Did the adolescents feel that they were learning from the discussions?</i> c. <i>Did the adolescents feel their knowledge changed in the discussions and workshops?</i>
2. How did you find using the activity book?	a. <i>Which activities they enjoyed and did not enjoy?</i> b. <i>Did they feel they understood the material?</i> c. <i>Was there any information they didn't know and was new to them?</i> d. <i>What the adolescents feel should be added to the activity book that's important – or left out because boring?</i>
3. How did you find the topics that were covered in the activity book?	a. <i>Did they feel were important to them?</i> b. <i>Did they feel they had enough time to go through the material?</i> c. <i>Which aspects did the adolescents enjoy?</i>
4. How did you find interacting with an Adolescent Health Worker? Is discussing health issues and healthy behaviour with a CHW the same or different to talking to nurses or other community health workers in the community?	a. <i>Did they feel they could talk about anything?</i> b. <i>Did they find it helpful to engage with an adolescent health worker in the community or not helpful?</i> c. <i>Do they feel the CHWs should be kept in the community?</i>
5. What do think about the prospect of having the adolescent community health worker doing a home visit?	a. <i>Would it be helpful to have a discussion with parents/guardians and CHWs?</i> b. <i>Do the young people feel it would be beneficial or not? Or would it be this awkward and embarrassing?</i> c. <i>What they feel would change in their communication with parents/guardians after the visit? – if anything</i>
6. Are there parts of all the levels of the intervention process that you enjoyed or least enjoyed?	a. <i>what parts are those?</i> b. <i>what they feel would make the process better?</i>

7. Is there anything else that you can think is important for us to know about your experience?	c. <i>About the activity book</i> d. <i>Group discussions in the workshop</i>
8. What are your thoughts and feelings about the workshops	a. <i>Easily accessible?</i> b. <i>Did the young people look forward to coming to the workshops?</i> c. <i>Did the young people find the time spent sufficient?</i> d. <i>Did the young people feel it was a good experience?</i> e. <i>Would young people do it again?</i> f. <i>Would young people recommend it to their friends?</i>

Study information sheet (Parent/Guardian) In-depth Interview

Hello, my name is _____ from the University of the Witwatersrand and working with researchers from Agincourt Health and Socio-Demographic Surveillance System.

I would like to invite you to participate in the research study entitled: **Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa** Before, agreeing to participate, it is important that you understand the purpose of the study, the study procedures, benefits and risks as well as your right to withdraw from the study at any time. If you have any questions, do not hesitate to ask me. You should not agree to take part unless you are satisfied with all the procedures involved. If you decide to take part in this study, you will be asked to sign this document to confirm that you understand the study. You will also be given a copy to keep.

Why is the study being done?

To define young people's understanding of overweight and obesity, and establish the practicality, suitability /tolerability and the experience of a community based intervention to change behaviour for healthier lifestyles in rural South African young people.

Who can participate?

We will be selecting all adolescents living in your village who are 12 to 19 years of age and parents/guardians.

What will happen if you decide to take part in the study?

If you agree to take part in the study, you will be asked to participate in an interview. The discussion will be about your thoughts and perceptions of an adolescent health worker and your child's experiences during the Saturday camps and the use of the Information 4 My Life book. It will take about 45-60 minutes, and will be audio-recorded with your consent. If you do not want to be audio-recorded, you may refuse. The interview will take place at a time and place arranged between you and the researcher.

You do not have to take part in the study and are not required to give a reason if you do not wish to participate. If you decide to take part in the study, you are free to withdraw at any time and without giving a reason and without anything bad happening to you. If you decide to withdraw from the study, we will discuss with you what will happen to any information that you have provided. If the incomplete information can usefully contribute to the study, we will ask your permission to use the data in our analysis. Alternatively, on your request all your information will be destroyed.

What are the risks and discomforts of this study?

There are no risks or discomforts associated with the participation in the Interview. Strict confidentiality of results will be maintained. Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Are there any benefits to you for being in the study?

There are no direct benefits to you for being part of the study.

Who will see the information that is collected about you during the study?

Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Who do I contact if I have any questions about the study?

If you have any questions or you experience any problems during or after the sessions, please contact Tshegofatso Seabi, or a representative of the Human Research Ethics Committee.

Tshegofatso Seabi

PhD Candidate

MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt)

Wits University, School of Public Health

Cell : 0833202097

Email : tshegofatso.seabi@wits.ac.za

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg (“Committee”). A principal function of this Committee is to safeguard the rights and dignity of all human subjects who agree to participate in a research project and the integrity of the research.

If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Thank you for reading this Study Information Sheet.

Informed Consent_ Parents/Guardians_ In-depth Interview

Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa

To be completed by participant

- The information sheet has been read out loud to me or I have read the information sheet. I have been given the opportunity to ask questions, and received satisfactory answers.
- I understand that this project has been reviewed by, and received ethics clearance through the University of the Witwatersrand Human Research Ethics Committee
- I understand that my participation is voluntary, and that I can withdraw my consent at any time without further explanation, and without any adverse consequences. Without my child being removed from the study.
- I understand that this study involves an interview about my child's experiences and participation in the Adolescent Saturday camps with an Adolescent Health worker and using the information 4 my Life book as part of the Ntshembo study. My perceptions of having an adolescent health worker.
- I understand that the interview will not be identified with me. My information will be held strictly confidential, will not be shared with people outside the research group, will be stored safely, and will be destroyed 6 years after the interview.
- I understand that only group results, and not my individual results, will be used for scientific and public health purposes.
- I understand that there is no direct benefit for me from being in the study.
- I understand how to raise concerns or make a complaint.
- I agree to take part in the study.

Name of participant:

Date (dd/mm/yyyy):/...../20..... Signature:
.....

To be completed by field worker

- I declare that I have explained the study and its implications to the participant. He/she has understood the explanation, and provided his/her consent to participate.

Name of researcher:

Date (dd/mm/yyyy):/...../20.....

Signature:.....

Participant study code:_..... [study site]

Consent Form: Recording

I consent to being audio-recorded in the Interview

I understand that:

- The tapes and transcripts will only be seen or heard by the researcher and her supervisor.
- My real name will not be used in the transcripts or the research report, only group results will be reported.
- Recordings of the interviews will not be destroyed, unless participants request that the recordings of their focus group be destroyed.
- Recordings will be stored secure in a locked cupboard or on a computer protected by a password.

Name of participant:

Date (dd/mm/yyyy):/...../20..... Signature:

Parents/Guardians In-depth Interview Guide

Thank you for taking the time to meet with me today.

Today we are going to talk about your experience of being part of the project as it has been explained to you in the informed consent process. Your participation in this group discussion will be extremely helpful for us to develop an intervention that is appropriate for young people in the Agincourt setting, and we hope to ultimately improve the health and wellbeing of adolescents in your community. Please remember that there are no 'right' or 'wrong' answers to any of the questions and you should feel free to discuss your thoughts and views openly.

Informant data to be collected: Age, sex, level of education, village of residence

Participant number	Age	Sex	Highest level of education completed

Questions	Probes
1. When you were approached for your child to participate in the study, what were your expectations of the program?	
2. What are some of the things your child has expressed to have learned from the study?	a. From the workshop b. The materials that were discussed
3. To what extent have you managed to implement or maintain some of the things your child has learned from the study?	a. Did they mention anything that they have learned b. Do you feel that they have started to implement some of the lessons they have learned
4. What is your perception of your own weight as well as of your child?	a. Body shape and body size b. Have you discussed body size and shape with your child? c. How do you and child's view compared?
5. What foods do you eat at home and have there been any changes as a result of your child participating in the study?	a. how they describe the foods they ate before and eat now? b. what factors that play a role in the decision for those foods c. from the home visits have there been changes in food decisions?
6. What do you think about interventions involving Adolescent Community Health Workers? What can or can't help improve the health behaviour of adolescents in your community? How would you find it if an adolescent health worker come to speak to you about health issues?	
7. What do you think are some of the causes of overweight/obesity?	a. In the community b. The different factors c. Activities
8. What are your thoughts on food and choices for foods?	a. The factors that make them choose the foods b. Emotions around foods

	<i>c. Social catalyst</i>
9. What are your thoughts on exercise and choices to exercise or not to exercise?	<i>a. Do they exercise</i> <i>b. Understanding of exercise</i> <i>c. Factors that are involved in the choices</i>
10. Would you encourage your child to go and see an CHW, why or why not?	<i>a. What factors are involved in your decision</i>
11. Would you be prepared to attend some sessions, exercise or cook healthy foods with your child, why or why not?	<i>a. Would it be feasible in terms of time and resources</i>
12. Do you think there is value in having CHWs to discuss health issues and healthy behaviour as opposed to nurses or other community health workers in the community?	
13. Do you have any other comments or suggestions for me?	<i>a. Adolescent health in your community</i>

Study information sheet (Community Health Worker) In-depth Interview

Dear Sir/Madam

Hello, my name is _____ from the University of the Witwatersrand and working with researchers from Agincourt Health and Socio-Demographic Surveillance System.

I would like to invite you to participate in the research study entitled: **Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa** Before, agreeing to participate, it is important that you understand the purpose of the study, the study procedures, benefits and risks as well as your right to withdraw from the study at any time. If you have any questions, do not hesitate to ask me. You should not agree to take part unless you are satisfied with all the procedures involved. If you decide to take part in this study, you will be asked to sign this document to confirm that you understand the study. You will also be given a copy to keep.

Why is the study being done?

To evaluate the changing prevalence of overweight and obesity, describe adolescents' understanding of overweight and obesity, and determine the feasibility, acceptability and the experience of a complex intervention to change behaviour for healthier lifestyles in rural South African adolescents.

Who can participate?

We will be selecting all adolescents living in your village who are 12 to 19 years of age, parents/guardians and Adolescent health workers.

What will happen if you decide to take part in the study?

If you consent to take part in the study, you will be invited to complete one interview. The in-depth interview will be about your experience in facilitating the Saturday camps and the use of the Information 4 my Life book. The interview will take about 60 minutes, and will be audio-recorded with your consent. If you do not want the interview audio-recorded, you may refuse and get to still participate in the intervention. The interview will take place at your convenience in private, with time and place arranged between you and the researcher.

You are under no obligation to take part in the study and are not required to give a reason if you do not wish to participate. If you decide to take part in the study, you are free to withdraw at any time and without giving a reason and without prejudice. If you decide to withdraw from the study, we will discuss with you what will happen to any information that you have provided. If the incomplete information can usefully contribute to the study, we will ask your permission to use the data in our analysis. Alternatively, on your request all your information will be destroyed.

What are the risks and discomforts of this study?

There are no risks or discomforts associated with the interview. Strict confidentiality of results will be maintained. Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Are there any benefits to you for being in the study?

There are no direct benefits to you for being part of the study.

Who will see the information that is collected about you during the study?

Strict confidentiality of results will be maintained. Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Who do I contact if I have any questions about the study?

If you have any questions or you experience any problems during or after the sessions, please contact Professor Shane Norris, or a representative of the Human Research Ethics Committee.

Professor Shane Norris (PhD)

Principal Investigator
MRC/Wits Developmental Pathways for Health Research Unit
Chris Hani Baragwanath Hospital
Soweto Johannesburg
Tel: 011-9331122
Email : shane.norris@wits.ac.za

Tshegofatso Seabi

PhD Candidate
MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt)
Wits University, School of Public Health
Cell : 0833202097
Email : tshegofatso.seabi@wits.ac.za

Human Research Ethics Committee contact details:

Prof P Cleaton-Jones, Tel 011 717 2301, email peter.cleaton-jones1@wits.ac.za or Ms Zanele Ndlovu/
Mr Rhulani Mkansi/ Mr Lebo Moeng Administrative Officers 011 717 2700/2656/1234/1252
zanele.ndlovu@wits.ac.za; Rhulani.mkansi@wits.ac.za; and Lebo.moeng@wits.ac.za

Informed Consent_ Community Health Worker_In-depth Interview

To evaluate the changing prevalence of overweight and obesity, describe adolescents' understanding of overweight and obesity, and determine the feasibility, acceptability and the experience of a complex intervention to change behaviour for healthier lifestyles in rural South African adolescents.

To be completed by participant

- The information sheet has been read out loud to me or I have read the information sheet. I have been given the opportunity to ask questions, and received satisfactory answers.
- I understand that this project has been reviewed by, and received ethics clearance through the University of the Witwatersrand Human Research Ethics Committee
- I understand that my participation is voluntary, and that I can withdraw my consent at any time without further explanation, and without any adverse consequences.
- I understand that this study involves an interview about my experiences as an Adolescent health worker facilitating participation in the Adolescent Saturday camps and the use of the information 4 my Life book as part of the Ntshembo study.
- I understand that the interview will not be identified with me. My information will be held strictly confidential, will not be shared with people outside the research group, will be stored safely, and will be destroyed 6 years after the interview.
- I understand that only group results, and not my individual results, will be used for scientific and public health purposes.
- I understand that there is no direct benefit for me from being in the study.
- I understand how to raise concerns or make a complaint.
- I agree to take part in the study.
- I consent with audio recording (*tick as applies*): ☐ Yes ☐ No

Name of participant:

Date (dd/mm/yyyy): /...../20..... Signature:
.....

To be completed by field worker

- I declare that I have explained the study and its implications to the participant. He/she has understood the explanation, and provided his/her consent to participate.

Name of researcher:

Date (dd/mm/yyyy): /...../20.....

Signature:.....

Participant study code:_..... [study site]

Consent Form: Recording

I consent to being audio-recorded in the in-depth Interview

I understand that:

- The tapes and transcripts will only be seen or heard by the researcher and her supervisor.
- My real name will not be used in the transcripts or the research report, only group results will be reported.
- Recordings of the interviews will not be destroyed, unless participants request that the recordings of their focus group be destroyed.
- Recordings will be stored secure in a locked cupboard or on a computer protected by a password.

Name of participant:

Date (dd/mm/yyyy):/...../20..... Signature:

Community Health Worker In-depth Interview Guide

Thank you for taking the time to meet with me today.

Today we are going to talk about your experience of being part of the project as it has been explained to you in the informed consent process. Your participation in this group discussion will be extremely helpful for us to develop an intervention that is appropriate for young people in the Agincourt setting, and we hope to ultimately improve the health and wellbeing of adolescents in your community. Please remember that there are no 'right' or 'wrong' answers to any of the questions and you should feel free to discuss your thoughts and views openly.

Questions	Probes
1. What was it like working with the Adolescents?	a. <i>In the workshops</i> <i>Were they engaged in the workshops?</i> <i>How were their interactions with each other and with you as a CHWs?</i> b. <i>In the individual session</i> c. <i>Were the adolescents engaged?</i> d. <i>Was the material easy to understand and facilitate?</i> e. <i>Did they seem to enjoy the workshops</i> f. <i>Was the number of adolescents easy to facilitate and continue discussions</i>
2. How was it facilitating the workshops with the adolescents?	a. <i>Did you feel there was enough time to cover the activities in the topic</i> b. <i>Did you enjoy facilitating</i>
3. Tell me about your experience going to the households to speak to parents/caregivers?	a. <i>Did you find the parents/caregivers engaged in the discussion</i> b. <i>Describe some of the highlights of visiting homes</i> c. <i>Describe some of the difficult/challenging aspects of visiting the homes?</i> d. <i>Some of your observations around the parents and adolescent interaction?</i>
4. What were some of the highlights and challenges you faced working with the adolescents and with the material?	a. <i>Did you feel adequately prepared to facilitate the process with adolescents? What was most helpful? What else would have helped?</i> b. <i>Confidence to deliver and facilitate discussions in the activity book</i> c. <i>Did they feel they were prepared for the individual sessions and able to handle discussions with adolescent health issues</i>
5. What would you do differently to improve the experience?	a. <i>For yourself as an CHW</i> b. <i>For the adolescents in the workshops and individual sessions</i> c. <i>For the home visits</i>
6. Do you feel there is value in having Adolescent Community Health Workers to discuss health issues and healthy behaviour as opposed to nurses or other community health workers in the community?	a. <i>General information about their role and what was valuable. Also what was not of value</i>
7. Any more comments that you would like to make on the process?	a. <i>About the activity book</i> b. <i>Group discussions in the workshop</i> c. <i>The home visits</i> d. <i>The individual sessions</i>

Appendix 7: Information sheets and consent to participate in the intervention

PARTICIPANT INFORMATION SHEET For those 18 years and older

Invitation

Hello, my name is _____ from the University of the Witwatersrand and working with researchers from Agincourt Health and Socio-Demographic Surveillance System.

I would like to invite you to participate in the research study entitled: **Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa** Before, agreeing to participate, it is important that you understand the purpose of the study, the study procedures, benefits and risks as well as your right to withdraw from the study at any time. If you have any questions, do not hesitate to ask me. You should not agree to take part unless you are satisfied with all the procedures involved. If you decide to take part in this study, you will be asked to sign this document to confirm that you understand the study. You will also be given a copy to keep.

Why is the study being done?

To define young people's understanding of overweight and obesity, and determined whether a community-based intervention to change behaviour for healthier lifestyles in rural South African young people is feasible and acceptable.

Who can participate?

We will be selecting all adolescents living in your village who are 12 to 19 years of age

What will happen if you decide to take part in the study?

If you consent to take part in the study, you will be required to attend two Saturday camps.

You do not have to take part in the study and are not required to give a reason if you do not wish to participate. If you decide to take part in the study, you are free to withdraw at any time and without giving a reason and without prejudice.

During the Intervention:

You will be asked to attend two Saturday camps. The camp sessions will be run for four (4) hours each Saturday. You may be invited to further participate in interviews and focus groups about the intervention.

What will the Saturday camps entail?

If you do decide to participate, you will be divided into two groups at village level. You will participate in two Saturday camps in your village with the following topics:

In one village, the camps will focus on good decision making for healthy behaviour. The topics that will be covered include information and knowledge about making right choices, choosing healthy foods,

choosing to be healthy and active, and choosing healthy sexual behaviour as well as where to get support for healthy goals. This will be through group activities such as drawing, games, group discussions and homework activities.

In the other village, the Saturday camp sessions will cover non-health related issues, with the exception of HIV/AIDS, such as goals, empowerment, managing stress, financial education, sex/gender, peer pressure, and empowerment. You will be encouraged to engage with the material and discussions in the camps. This will be through group activities such as drawing, games, group discussions and homework activities.

What are the risks and discomforts of this study?

There are no risks or discomforts associated with participating in the Saturday camps. Strict confidentiality of results will be maintained. Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Are there any benefits to you for being in the study?

Young people will gain knowledge of the various topics that are covered in the camps as they participate.

Who will see the information that is collected about you during the study?

Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Who do I contact if I have any questions about the study?

If you have any questions or you experience any problems during or after the sessions, please contact Tshegofatso Seabi, or a representative of the Human Research Ethics Committee.

Tshegofatso Seabi

PhD Candidate

MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt)

University of the Witwatersrand, School of Public Health

Cell: 0833202097

Email: tshegofatso.seabi@wits.ac.za

INFORMED CONSENT

PARTICIPANT:

I, _____, hereby give consent to participate in this research at the University of Witwatersrand.

Signature or Thumbprint of Participant _____

Date _____

I understand that the study will involve attending of two (2) Saturday camps. The purpose and all the details of this study have been explained to me.

I have read and have had explained to me the procedures described. I have had an opportunity to ask questions and my questions have been answered in a satisfactory way.

I understand that all the information collected during the study will be treated with confidentiality and will only be used for scientific research purposes. All records will be kept in a locked room and in a secure computer database in the research unit. My name will not be used in any publication of the results. I understand that for data verification and quality control purposes regulatory authorities and/or members of the Wits Human Research Ethics Committee (Medical) may be allowed access to my personal data under conditions of strict confidentiality.

I understand that I may be contacted for a follow-up study.

I agree to participate in the study on the condition that:

1. I can withdraw voluntarily from the study at any time and that no adverse consequences will follow on withdrawal from the study.
2. I have the right not to answer any or all questions posed in the questionnaire.
3. The University of the Witwatersrand's Human Research Ethics committee has approved the study protocol and procedures.
4. All results will be treated with the strictest confidentiality.
5. Only group results, and not my individual results, will be published in scientific journals and in the media.
6. The study scientific team is committed to treating participants with respect and privacy through interviews conducted in private and follow-up counselling available on request.
7. I will receive a referral note to psychological services if I experience any psychological distress during the study.

I have read the information, or it has been read to me. I have had the opportunity to ask questions about it and my questions have been answered to my satisfaction. I consent voluntarily and understand that I have the right to withdraw my consent without this affecting the current research study or my medical care.

I have accurately read or witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

RESEARCH ASSISTANT:

Printed Name

Signature

Date and Time

Copy provided to participant _____ (initialed by researcher)

PARTICIPANT INFORMATION SHEET

For those under the age of 18 years

Invitation

Hello, my name is _____ from the University of the Witwatersrand and working with researchers from Agincourt Health and Socio-Demographic Surveillance System.

I would like to invite you to participate in the research study entitled: **Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa** Before, agreeing to participate, it is important that you understand the purpose of the study, the study procedures, benefits and risks as well as your right to withdraw from the study at any time. If you have any questions, do not hesitate to ask me. You should not agree to take part unless you are satisfied with all the procedures involved. If you decide to take part in this study, you will be asked to sign this document to confirm that you understand the study. You will also be given a copy to keep.

Why is the study being done?

To define young people's understanding of overweight and obesity, and determined whether a community-based intervention to change behaviour for healthier lifestyles in rural South African young people is feasible and acceptable.

Who can participate?

We will be selecting all adolescents living in your village who are 12 to 19 years of age

What will happen if you decide to take part in the study?

If you consent to take part in the study, you will be required to attend two Saturday camps.

You do not have to take part in the study and are not required to give a reason if you do not wish to participate. If you decide to take part in the study, you are free to withdraw at any time and without giving a reason and without prejudice.

During the Intervention:

You will be asked to attend two Saturday camps. The camp sessions will be run for four (4) hours each Saturday. You may be invited to further participate in interviews and focus groups about the intervention.

What will the Saturday camps entail?

If you do decide to participate, you will be divided into two groups at village level. You will participate in two Saturday camps in your village with the following topics:

In one village, the camps will focus on good decision making for healthy behaviour. The topics that will be covered include information and knowledge about making right choices, choosing healthy foods, choosing to be healthy and active, and choosing healthy sexual behaviour as well as where to get support for healthy goals. This will be through group activities such as drawing, games, group discussions and homework activities.

In the other village, the Saturday camp sessions will cover non-health related issues, with the exception of HIV/AIDS, such as goals, empowerment, managing stress, financial education, sex/gender, peer pressure, and empowerment. You will be encouraged to engage with the material and discussions in the camps. This will be through group activities such as drawing, games, group discussions and homework activities.

What are the risks and discomforts of this study?

There are no risks or discomforts associated with participating in the Saturday camps. Strict confidentiality of results will be maintained. Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Are there any benefits to you for being in the study?

Young people will gain knowledge of the various topics that are covered in the camps as they participate.

Who will see the information that is collected about you during the study?

Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Who do I contact if I have any questions about the study?

If you have any questions or you experience any problems during or after the sessions, please contact Tshegofatso Seabi, or a representative of the Human Research Ethics Committee.

Tshegofatso Seabi

PhD Candidate

MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt)

University of the Witwatersrand, School of Public Health

Cell: 0833202097

Email: tshegofatso.seabi@wits.ac.za

INFORMED CONSENT

PARTICIPANT:

I, _____, hereby give consent to participate in this research at the University of Witwatersrand.

Signature or Thumbprint of Participant _____

Date _____

I understand that the study will involve attending of two (2) Saturday camps. The purpose and all the details of this study have been explained to me.

I have read and have had explained to me the procedures described. I have had an opportunity to ask questions and my questions have been answered in a satisfactory way.

I understand that all the information collected during the study will be treated with confidentiality and will only be used for scientific research purposes. All records will be kept in a locked room and in a secure computer database in the research unit. My name will not be used in any publication of the results. I understand that for data verification and quality control purposes regulatory authorities and/or members of the Wits Human Research Ethics Committee (Medical) may be allowed access to my personal data under conditions of strict confidentiality.

I understand that I may be contacted for a follow-up study.

I agree to participate in the study on the condition that:

1. I can withdraw voluntarily from the study at any time and that no adverse consequences will follow on withdrawal from the study.
2. I have the right not to answer any or all questions posed in the questionnaire.
3. The University of the Witwatersrand's Human Research Ethics committee has approved the study protocol and procedures.
4. All results will be treated with the strictest confidentiality.
5. Only group results, and not my individual results, will be published in scientific journals and in the media.
6. The study scientific team is committed to treating participants with respect and privacy through interviews conducted in private and follow-up counseling available on request.
7. I will receive a referral note to psychological services if I experience any psychological distress during the study.

I have read the information, or it has been read to me. I have had the opportunity to ask questions about it and my questions have been answered to my satisfaction. I consent voluntarily and understand that I have the right to withdraw my consent without this affecting the current research study or my medical care.

I have accurately read or witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

RESEARCH ASSISTANT:

Printed Name

Signature

Date and Time

Copy provided to participant _____ (initialed by researcher)

PARTICIPANT INFORMATION SHEET

For Parents/Guardians

Invitation

Hello, my name is _____ from the University of the Witwatersrand and working with researchers from Agincourt Health and Socio-Demographic Surveillance System.

I would like to invite your child to participate in the research study entitled: **Promoting adolescent health: Feasibility, acceptability and experiences of a behaviour change intervention for healthier lifestyles in rural South Africa** Before, agreeing to allow your child to participate, it is important that you understand the purpose of the study, the study procedures, benefits and risks as well as your child's right to withdraw from the study at any time. If you have any questions, do not hesitate to ask me. You should not agree to take part unless you are satisfied with all the procedures involved. If you decide to take part in this study, you will be asked to sign this document to confirm that you understand the study. You and your child will also be given a copy to keep.

We will need both you and your child to agree to participate in this study.

Why is the study being done?

To define young people's understanding of overweight and obesity, and determined whether a community-based intervention to change behaviour for healthier lifestyles in rural South African young people is feasible and acceptable.

Who can participate?

We will be selecting all adolescents living in your village who are 12 to 19 years of age

What will happen if you decide to take part in the study?

If you and your child consent to take part in the study, your child will be required to attend two Saturday camps facilitated by the Adolescent Community health worker (CHW).

You and your child do not have to take part in the study and are not required to give a reason if you do not wish to participate. If you decide to take part in the study, you are free to withdraw at any time.

During the Intervention:

Your child will be asked to attend two Saturday camps. The camp sessions will be run for four (4) hours each Saturday. You may be invited to further participate in interviews and focus groups about the intervention.

What will the Saturday camps entail?

If you do decide to participate, the young people will be divided into two groups at village level. Your child will participate in two Saturday camps in your village with the following topics:

In one village, the camps will focus on good decision making for healthy behaviour. The topics that will be covered include information and knowledge about making right choices, choosing healthy foods, choosing to be healthy and active, and choosing healthy sexual behaviour as well as where to get support

for healthy goals. This will be through group activities such as drawing, games, group discussions and homework activities.

In the other village, the Saturday camp sessions will cover non-health related issues, with the exception of HIV/AIDS, such as goals, empowerment, managing stress, financial education, sex/gender, peer pressure, and empowerment. You will be encouraged to engage with the material and discussions in the camps. This will be through group activities such as drawing, games, group discussions and homework activities.

What are the risks and discomforts of this study?

There are no risks or discomforts associated with participating in the Saturday camps. Strict confidentiality of results will be maintained. Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Are there any benefits to you for being in the study?

Young people will gain knowledge of the various topics that are covered in the camps as they participate.

Who will see the information that is collected about you during the study?

Your name will be removed from all data, and you will be assigned a number, which will be used to identify data relating to you. All records will be kept in a locked room and in a secure computer database in the research unit. Your name will not be used in any publication of the results.

Who do I contact if I have any questions about the study?

If you have any questions or you experience any problems during or after the sessions, please contact Tshgofatso Seabi, or a representative of the Human Research Ethics Committee.

Tshgofatso Seabi

PhD Candidate

MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt)

University of the Witwatersrand, School of Public Health

Cell: 0833202097

Email: tshgofatso.seabi@wits.ac.za

INFORMED CONSENT

Parent/Guardian:

I, _____, hereby give consent for my child _____ to participate in this research at the University of Witwatersrand.

Print Name of Participant _____

Signature of Participant _____

Date _____

I understand that the study will involve attending two (2) Saturday camps. The purpose and all the details of this study have been explained to me.

I have read and have had explained to me the procedures described. I have had an opportunity to ask questions and my questions have been answered in a satisfactory way.

I understand that all the information collected during the study will be treated with the strictest confidentiality and will only be used for scientific research purposes. All records will be kept in a locked room and in a secure computer database in the research unit. My name and my Child's name will not be used in any publication of the results. I understand that for data verification and quality control purposes regulatory authorities and/or members of the Wits Human Research Ethics Committee (Medical) may be allowed access to my personal data under conditions of strict confidentiality.

I understand that I may be contacted for a follow-up study.

I agree to participation and participation of my child in the study on the condition that:

1. I can withdraw voluntarily from the study at any time and that no adverse consequences will follow on withdrawal from the study.
2. I have the right not to answer any or all questions posed in the questionnaire.
3. The University of the Witwatersrand's Human Research Ethics committee has approved the study protocol and procedures.
4. All results will be treated with the strictest confidentiality.
5. Only group results, and not my individual results, will be published in scientific journals and in the media.
6. The study scientific team is committed to treating participants with respect and privacy through interviews conducted in private and follow-up counselling available on request.
7. I will receive a referral note to psychological services if I experience any psychological distress during the study.

I have read the information, or it has been read to me. I have had the opportunity to ask questions about it and my questions have been answered to my satisfaction. I consent voluntarily and understand that I have the right to withdraw my ascent without this affecting the current research study or my medical care.

I have accurately read or witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

RESEARCH ASSISTANT:

Printed Name

Signature

Date and Time

Copy provided to participant _____ (initialed by researcher)

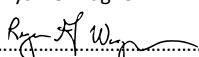
Appendix 8: Student's contribution to article(s) and agreement of co-author(s)

Declaration: Student's contribution to article(s) and agreement of co-author(s)

I, **Tshegofatso Martha Seabi**, student number **449345**, declare that this Thesis/Dissertation/Research Report is my own work and that I contributed adequately towards research findings published in the article(s) stated below which are included in my Thesis/Dissertation/Research Report .

Signature of Student  Date..... **02 June 2023**

Name of Primary Supervisor.....Dr. Ryan G Wagner

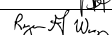
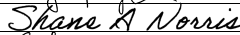
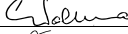
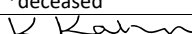
Signature of Primary Supervisor  Date..... **02 June 2023**

Agreement by co-authors: By signing this declaration, the co-authors listed below agree to the use of the article(s) by the student as part of his/her Thesis/Dissertation/Research Report. In cases where the student is not the 1st author of a published article, the primary supervisor must explain (under comments) why the student is entitled to use the paper for his/her degree purposes.

Article 1: Title: Adolescents' understanding of obesity: a qualitative study from rural South Africa

Journal name, year, volume and page numbers: Global Health Action, 14:1, 2021,

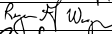
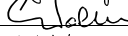
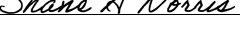
DOI: 10.1080/16549716.2021.1968598

Authors	Name	Signature	Date
1 st author	Tshegofatso M Seabi		2-June-2023
2 nd author	Ryan G Wagner		2-June-2023
3 rd author	Shane A Norris		2 June 2023
4 th author	Stephen M Tollman		2-June-2023
5 th author	Rhian Twine		2-June-2023
6 th author	David B Dunger	*deceased	
7 th author	Kathleen Kahn		2-June-2023

Comments by primary supervisor:

.....

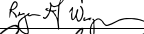
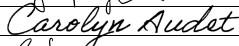
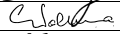
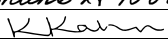
Article 2: Title: Trends in body mass index, blood pressure and associated determinants among rural South African adolescents, 2007 to 2018. Under review at BMC Public Health.

Authors	Name	Signature	Date
1 st author	Tshegofatso M Seabi		2- June 2023
2 nd author	Ryan G Wagner		2-June-2023
3 rd author	Stephen M Tollman		2-June-2023
4 th author	Kathleen Kahn		2-June-2023
5 th author	Shane A Norris		2 June 2023
6 th author			

Comments by primary supervisor:

.....

Article 3: Title: Assessing the feasibility of a community health worker-led, community-based health promotion intervention for rural South African adolescents. Under review at Global Public Health.

Authors	Name	Signature	Date
1 st author	Tshegofatso M Seabi		2-June-2023
2 nd author	Ryan G Wagner		2-June-2023
3 rd author	Carolyn M Audet		2-June-2023
4 th author	Stephen M Tollman		2-June-2023
5 th author	Rhian Twine		2-June-2023
6 th author	Shane A Norris		2 June 2023
7 th author	Kathleen Kahn		2-June-2023

Comments by primary supervisor:

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Appendix 9: Turnitin report

Seabi TM_PhD thesis_TS (2).docx			
ORIGINALITY REPORT			
17 %	16%	9%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS