Title: Cancer-related Lifestyle Risk, Knowledge, Risk Perception, and Intention to Screen in a Socio-economically diverse urban population in South Africa

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Submitted in partial fulfilment of the Master of Public Health degree, School of Public Health, Faculty of Health Sciences, University of the Witwatersrand

2nd November 2022

Declaration

I, Dean Floor, student number 1922946, declare that this research report is my original work. It is submitted in partial fulfilment of the requirements for the degree of Master of Public Health, in the field of Social and Behaviour Change Communication, at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to this or any other university. I have read the sections on referencing and plagiarism in the WITS Plagiarism Policy. I am aware that the plagiarism is wrong and that the University of the Witwatersrand may take disciplinary action should plagiarism be found in this work. I have followed the required conventions in referencing the thoughts and ideas of others. I confirm that all the work submitted in this thesis is my own unaided work except where I have explicitly indicated otherwise.

Signed: 

Date: 2nd November 2022

Acknowledgements

I am immensely grateful to my supervisors Nicola Christofides and Preethi Mistri, for their invaluable advice and motivational support, who were not only integral in helping conceptualise the study, but also its implementation every step of the way. I also want to thank them for their patience in running alongside me through this lengthy process.

I want to acknowledge the central role played by each of my research assistants, namely Lesego Mokgosi, Sipho Hans, and Priscilla Mathibe. Without their enthusiasm, teamwork, and on-the-ground experience, fieldwork would have not been possible. I also want to thank Marcus Mathibe for the short time he was with us.

I am also indebted to all the individuals in Diepkloof, Soweto, who chose to give up time to participate in the study.

Preface

This research report is submitted for examination for a Master's in Public Health degree. It has been written according to the University of the Witwatersrand School of Public Health guidelines for research reports in submissible format. The report also includes a manuscript drafted for submission to the *International Journal of Cancer (IJC)* (see Appendix 1 for author guidelines). For the purposes of this submission, tables and figures were kept in the text for ease of reference. Furthermore, all references, including those for other parts of the research report, are placed at the end before Appendices. The Vancouver referencing style was used throughout. When the manuscript is submitted to the journal, their guidelines for referencing and table/figure placement will be followed. Ariel font was used with 1.5 line spacing.

Table of Contents:

List of figures and tables

Figures

Tables

List of abbreviations

WCRF/AICR	World Cancer Research Fund/American Institute of Cancer Research
AM	Anthropometric measurements
MVPA	Moderate to vigorous physical activity
HHS	Household Hunger Scale
SES	Socio-economic status
BMI	Body Mass Index
WC	Waist circumference
FFQ	Food frequency questionnaire
UPF	Ultra-processed food
SSB	Sweet and sugar beverage
CBE	Clinical Breast Examination
BSE	Breast Self-Examination
PSA	Prostate-Specific Antigen
DRE	Digital Rectal Exam
SD	Standard deviation
IQR	Interquartile range
P	P-value
HREC	Human Research Ethics Committee

Definition of terms

Adherence: For this study, this term refers to how well participants 'scored' with respect to the WCRF/AICR recommendations scoring system, i.e. to what degree they met the guidelines. It does not imply that these guidelines were communicated in any way beforehand to participants or that individuals made a choice whether or not to 'adhere' to these guidelines. It is simply a measure of their current lifestyle patterns.

Abstract

Cancer prevention through lifestyle modification is a cost-effective approach to reducing rising cancer incidence in South Africa. This study aimed to investigate adherence to the 2018 World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) Cancer Prevention Recommendations and the association with socio-economic status (SES) and other health-related factors in a Black African urban population from Soweto, South Africa. A cross-sectional household survey was conducted using a proportionate stratified systematic random sample of 407 men and women. Anthropometric measurements were conducted, and structured questionnaires were used to collect data on socio-demographic characteristics, SES, dietary intake, and other lifestyle factors. To assess adherence to recommendations, a seven-point adherence score was developed, using WCRF/AICR cut-offs and adherence score categories for scoring each recommendation (0, 0·5 and 1) with zero indicating the lowest adherence to the recommendations. Bivariate and multivariate linear regression analyses, with estimated coefficients and 95% CI, were used to assess correlates of adherence. Adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations was low, with a mean score of 3.0 (±SD = 0.86). Lower adherence was associated with younger age (p=0.010), high school education (vs no schooling or primary level) (p = 0.018) and high food security (p = 0.044). Higher adherence was associated with believing cancer is controllable if detected early (p = 0.017) and having been screened for prostate cancer (p = 0.018). In the multivariate model, lower adherence was associated with the 20-29 year age-group versus the 30-39 (β = 0.27, 95% CI = 0.00, 0.54) and 50-55 (β = 0.44, 95% CI = 0.13, 0.76) year age groups, high school education (β = -0.29, 95% CI = -0.53, -0.05), current employment (β = -0.36, 95% CI = -0.66, -0.06), living in moderate-affluence area versus low-affluence area (β = 0.42, 95% CI = 0.08, 0.76), and, for males only, high food security versus moderate food security (β = 0.52, 95% CI = 0.08, 0.95). Higher adherence was associated with having been screened for cancer for both males (β = 0.56, 95% CI = 0.08, 1.04) and females (β = 0.24, 95% CI = 0.00, 0.48). Low adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations is associated with younger age, higher SES, low risk perception, and poor cancer screening behaviour, with patterns differing with sex. Targeted public health efforts that account for sub-group differences are required to improve lifestyle health.

Chapter 1 – Background and Literature review

1.1 Background

Based on recent estimates by the International Agency for Research on Cancer (IARC), the burden of cancer incidence and mortality is expanding rapidly worldwide (1). This expansion is by no means restricted to high-income countries, with 57% of all new cases thought to occur in low and middle-income countries (LMICs), largely exacerbated by lack of awareness and preventive strategies, and increasing life expectancies in these regions (2). In Africa, cancer continues to be given low priority in research and healthcare services, despite cancer death rates having surpassed those of AIDS, malaria, and tuberculosis combined (3), with this expansion in mortality rates being linked to cost of care and absence of care facilities (3).

While the rising cancer burden reflects the aging and growth of populations, it is also driven by changes in the prevalence and distribution of important risk factors, several of which are modifiable and tied to socio-economic development (1,4). There is increasing recognition that cancer prevention through lifestyle and environmental change is a cost-effective approach to reducing the global cancer burden (5). The past few decades have seen marked economic growth and industrialisation in many African countries, including South Africa, accompanied by changes in lifestyles associated with exposure to a variety of carcinogenic factors (2,3). Such changes include increases in urbanisation, pollution exposure, obesity, alcohol and tobacco usage, changes in diets characterised by meat, sugar, and energy-dense processed foods, and reduced physical activity. These environmental and lifestyle associated cancer risk factors increase incidence not only in the elderly, but also in younger age-groups, with a large proportion of patients in sub-Saharan African (SSA) countries being diagnosed at younger ages and with advanced stages of disease (3,6). While these trends are likely driven by hereditary factors, the impact of the environment and lifestyle cannot be ignored.

The growing cancer burden and epidemiological shift occurring in LMICs, coupled with changes in economic transition-associated lifestyle patterns and comparatively low cancer prevention initiatives, makes focusing on prevention a critical aspect to combating cancer in these countries (7,8).

1.2 Literature review

1.2.1 Cancer and lifestyle

It is well established that a variety of lifestyle factors increase risk of developing different cancers, including cancers of the breast, prostate, lung, colon, and cervix – all high incidence cancers in the Southern African region (2,5). Potentially modifiable risk factors, including behavioural, environmental, occupational, and metabolic factors accounted for 44.4% of all cancer deaths globally in 2019, with smoking, alcohol use, and high body mass index (BMI) as the leading risk factors (9). As with other LMICs, the landscape in South Africa is equally troubling and has increasingly begun to mirror and even exceed worldwide non-communicable disease (NCD) trends (10,11), exacerbated by a high prevalence of obesity and other lifestyle and nutrition-related risk behaviours (12–17).

Therefore, addressing problematic lifestyle patterns is of paramount importance. This urgency was highlighted by Dr. Christine Stefan of the Medical Research Counsel in an editorial to the South African Medical Journal (18), stating that cancer as a whole, and particularly cancer prevention, has been largely neglected in South Africa. She pointed to the fact that despite malignant neoplasms being the second most frequent cause of death in 2013, cancer did not appear in the top ten causes of death in the country, published by Statistics South Africa. This is due to how cancer deaths are reported according to the International Statistical Classification of Diseases and Related Health Problems (10th edition) (ICD-10) (19), with total cancer deaths being distributed across 15 anatomical sites, resulting in smaller numbers. This apparent underestimation of the magnitude of the problem is further highlighted in a study that showed a paucity of research into cancer prevention and survivorship across academic institutions in the country (20). Furthermore, inequitable and under-resourced cancer care services, often lacking integrated management of risk factors, continue to hamper progress toward holistic care (10,21). Due to limited data available that might assist with quantifying cancer lifestyle risk (22), assessing modifiable risk, and therefore developing preventive interventions, proves challenging in the South African population. The cancer burden and accompanying burden of unhealthy lifestyles is projected to rise dramatically across LMICs, and South Africa is no exception (2). This in addition to the high cost of adequate cancer treatment, makes addressing the emerging patterns of harmful lifestyle practice a priority.

In 2018, the World Cancer Research Fund (WCRF) and American Institute for Cancer Research (AICR) published the Third Expert Report with updated WCRF/AICR Cancer Prevention Recommendations, an international benchmark for evidence-based guidelines regarding alcohol use, body weight, physical activity, and diet (23). These recommendations form a comprehensive package of modifiable lifestyle behaviours that, taken together,

promote a healthy lifestyle, enhancing the prevention of several cancers, other non-communicable diseases, and obesity. Greater adherence to WCRF/AICR recommendations has been shown to reduce incidence of general and site-specific cancers, as well as all-cause and cancer-related mortality (24). However, until recently no standardised scoring algorithm operationalising the recommendations existed, limiting direct comparability between studies. To address this, a standard scoring system was developed (25).

While the WCRF/AICR guidelines are recognised as an international standard, little is known about their application in African countries, with one study measuring levels of adherence and associated predictors in 18 countries (26). In South Africa, a recent study, using the new standard scoring algorithm, showed that higher adherence was associated with reduced breast cancer incidence in black urban women (27), while another showed that increased access to health care services is linked to greater adherence (28). However, these studies involved either men or women only, or relied on relatively old data. As such, further work among men and women across age-groups might yield additional insights into the current level of adherence, and its predictors, to multiple cancer-related lifestyle recommendations in South African communities.

1.2.2 Lifestyle risk and socio-economic status

Compelling evidence from both high-income countries and LMICs indicate that socio-economic status (SES) is linked to NCD incidence and mortality, including cancer (8,10,29–31). The historical and still widely held view that cancer is a disease of the rich only is simply false, with the brunt of the disease burden rapidly shifting to LMICs (2). Much of this disparity is driven by the influence of social and economic factors on the prevalence and distribution of lifestyle risk factors that contributes to income-related inequalities in cancer health outcomes amongst the poor (4,32).

Lifestyle risk patterns across different SES groups are not uniform and vary according to country and risk factor in question. For instance, data from high-income countries typically show a higher prevalence of several cancer risk factors among low SES groups (33), while in lower-income countries a reverse association is often shown to be the case, with higher rates of some risk factors, including obesity and physical inactivity, concentrating in higher SES groups (32,34). These patterns are often explained by the nutritional transition thought to occur concurrently with demographic and epidemiological shifts taking place in LMICs with the onset of globalisation and industrialisation (35,36). Popkin et al. highlight how this transition is characterised by a general displacement of agrarian lifestyles and traditional diets by typical Western lifestyle patterns of highly refined, energy-dense diets, physical inactivity, and obesity - a pattern also observed in South Africa (35). As LMICs continue to develop, lower SES

groups increasingly begin to adopt these previously unaffordable lifestyles – a shift partly driven by health promotion effects usually manifesting first in higher-income groups, who can afford elements of healthy living that are frequently associated with higher cost, particularly in poorer rural and urban areas. In South Africa, as with other LMICs, there is large variation in cancer risk factor prevalence and distribution across SES strata (4,12,16,38–42). A pattern that consistently emerges in these studies is the heavy burden increasingly experienced in poorer rural and urban contexts, with social and economic gradients in risk factor trends apparent even within these communities.

More local research is needed to better understand the nuances in how different important cancer-related risk factors relate to SES in disadvantaged communities, including poorer urban areas such as 'townships'.

1.2.3 Cancer-related beliefs, perceived risk, and screening behaviour

In addition to multiple lifestyle factors disproportionality affecting lower income groups, there is some indication that low risk perception and/or limited cancer-related awareness partly explains this SES-related disparity (43). Indeed, a study examining smokers' attitudes in poor populations in France demonstrated how risk perceptions surrounding tobacco usage was mediated by present-oriented time preferences, with peoples' environments influencing how they viewed lifestyle (44) . While it has been shown that risk perception is a motivating factor for a variety of cancer preventive behaviours (45,46), personal cancer risk perceptions may not always accurately reflect individuals' actual exposure to lifestyle risk factors (47). Cancer-related knowledge, perceived risk, and actual behaviour do not always correspond (48). This is also illustrated in relation to cancer screening. A study in rural Limpopo, South Africa, showed that despite moderate levels of knowledge of breast cancer symptoms and risk factors, and the importance of early detection, few women reported seeking services, including screening (49). Furthermore, while several studies suggest a link between these factors and cancer screening, the relationship is not well established (50–54). It is worth noting that many of these studies looked at very specific population groups, often conveniently sampled, with few investigating the general public.

High rates of diagnosis of late-stage cancer in cancer patients occur in Africa, including South Africa (9), highlighting the importance of timely detection through screening. The Cancer Association of South Africa (CANSA) recommends that for prostate and breast cancer screening, all men aged 50 years and older (40+ years with first-degree family history of cancer) and all women aged 40-54 years be tested annually, with women aged 55 years and older undergoing biennial mammograms (57,58).

Improving our understanding of how cancer-related risk perception and screening behaviour relate to lifestyle risk in the South African context is important, as engagement in cancer preventive lifestyles may be hindered if individuals' cancer beliefs, risk perception, and screening behaviour are not appropriately targeted.

1.3 Problem statement

The cancer burden in South Africa is a growing concern (18,20). There is little doubt that a high prevalence of cancer risk lifestyle behaviours, exacerbated by socio-economic inequalities, contributes to this burden (10,59). Future initiatives to promote healthy lifestyle behaviour for cancer prevention require understanding how socio-demographics/SES, cancer-related beliefs and risk perception, and screening behaviour relate to adoption of cancer preventive lifestyles. This can better inform current and future intervention efforts.

1.4 Justification for the study

This study has potential to provide important findings on cancer-related lifestyle risk, beliefs, risk perception, and screening behaviour in a socio-economically diverse urban population in South Africa. There is little data currently available in South Africa on the level of adherence to international cancer lifestyle guidelines and its predictors, particularly in lower SES populations. The Cancer Association of South Africa (CANSA) has recently developed an evidence-based tool to help measure risk (60). However, it hasn't been tested in a South African township population. There is need to continue to fill the gap in the current paucity of cancer risk and prevention research in the South African context.

2. Study objectives

2.1 Research question

What is the level of adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations in urban men and women living in Soweto, South Africa, and which demographic, SES, and other health factors, including, cancer-related knowledge, risk perception, and screening are associated with adherence?

2.2 Aim

To measure the level of adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations and identify which demographic, SES, and other health factors, including cancer-related knowledge, risk perception, and screening are associated with adherence in urban men and women from Soweto, South Africa.

2.3 Specific objectives

2.3.1 To assess the level of adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations (overall and individual) in 25-55yr-old males and females living in Soweto, South Africa, from July-October 2021.

2.3.2 To determine which demographic, SES, and other health factors, including cancer-related knowledge, risk perception, and screening, are associated with overall adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations in 25-55yr-old males and females living in Soweto, South Africa, from July-October 2021.

2.3.3 Using multivariable adjusted analysis to determine which demographic, SES, and other health factors, including cancer-related knowledge, risk perception, and screening , are independently associated with overall adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations in 25-55yr-old males and females living in Soweto, South Africa, from July-October 2021.

Chapter 2 - Methods

Methods

2.1 Study design and research setting

A cross-sectional household survey was conducted in Diepkloof, Soweto by the University of Witwatersrand School of Public Health (SPH) and Cancer Association of South Africa (CANSA) from July to October 2021. Diepkloof is a residential area with a population of approximately 95 000 (61), situated on the eastern border of Soweto, comprising a mix of both formal and informal settlements and a range of access to services (62). It is divided into three main areas: the oldest and largest area consisting of six zones, originally made up of basic houses and hostels; the second being the wealthier Extension; and finally, Motsoaledi informal settlement. This study setting was selected for two reasons. First, the residential areas described above are characterised by marked differences in SES, including access to services and housing type (62). This was confirmed through consultations with community ward counsellors prior to study commencement. This allowed for a potentially more socioeconomically diverse sample. Second, there is limited data on disease burden and risk factor patterns for the general population of Soweto and other similar urban settings, particularly in regards to cancer (27,63), with most studies targeting key populations and/or age or sex groups.

2.2 Participants

2.2.1 Sampling strategy and recruitment

A proportionate stratified systematic random sample of households from each of the three main areas was undertaken. The number of households sampled was in relative proportion to the total number for each of the three areas. In each area, and in four randomly sampled zones for the first area, the first household on a randomly selected street was visited, followed by every third household until the appropriate sample size had been reached. A household was defined by members who sleep and eat together regularly in the same dwelling. Upon each visit, research assistants explained the details of the survey to an adult member of the household and an information sheet was provided in the preferred language.

One randomly selected eligible person from the household was invited to participate. If an eligible individual was identified but was not at home during the first visit, two more attempts were made at a rescheduled date. Men and women aged between 25 and 55 years, who were regular members of a sampled household, had never been diagnosed with cancer, and were

free of any illness or condition that prevented them from engaging in their regular dietary consumption or physical activity routines were eligible for participation. The age-range was selected on the basis of assessing cancer lifestyle risk in adults at whose age cancer incidence is lower. Incidence rates for most cancers in South Africa rise markedly in individuals aged 55 years and above (64). In addition, we wanted to include individuals eligible for prostate and breast cancer screening (57,58).

A sample size of 500 was calculated to ensure sufficient statistical power to estimate prevalence of cancer-related lifestyle risk behaviour practice by socio-demographic categories (e.g. males and females). This sample size was deemed adequate to measure difference in knowledge and perceived risk prevalence. The following syntax for STATA was used to calculate the sample size:

sampsi (p_0)(p_1), alpha(.05) power(.8)

A minimum sample size of 450 (n_1=225; n_2=225) was computed to be sufficient to detect differences of ≥12% and to measure the primary objective of the study. The final sample size, adjusted for a 10% non-response rate, was 500.

Data on perceived cancer risk and cancer-related knowledge in South Africa is limited. One study indicated a high level of perceived risk for cervical cancer (>70%) among HIV positive women attending a Johannesburg clinic (65), and another study reported that approximately 33% of women attending a rural clinic in Limpopo had correct knowledge of breast cancer risk factors (66). However, these studies are not representative of the general public and don't measure these factors for other cancers. A general population survey conducted in the USA that reported association between cancer-related risk perception and risk behaviour used a sample of 474 males and females (67). Therefore, it seems that our proposed minimum sample size of 500 may prove adequate to measure difference in knowledge and perceived risk prevalence.

2.2.2 Data collection

Trained research assistants conducted face-to-face interviews with eligible participants who had provided written consent. Interviews were conducted in the preferred language of the participant (isiZulu, Sesotho, or English) by research assistants fluent in the language. Data were captured on a tablet using the REDCap electronic data capture platform hosted at the University of the Witwatersrand. Interviews took around 30 minutes to complete. Participants were invited to undergo weight, height, and waist circumference measurements. However, if participants refused the anthropometric measurements, they could consent to complete the interview. COVID-19 prevention protocols were followed throughout the recruitment and data

collection process. Research assistants were required to attend a five-day training workshop covering all fieldwork standard operating procedures, including recruitment, questionnaire administration, interview skills, and anthropometry.

2.2.3 Questionnaire

The questionnaire covered several domains including socio-demographic characteristics such as age, sex, and ethnicity. Socio-economic status (SES) was measured through household income, educational attainment, employment status, dwelling type, and household food security, which was assessed using a three-item household hunger scale validated for cross-cultural use (68), categorised into little to no, moderate, and severe household hunger. Residential location was also used as a measure of SES given the pronounced differences in SES across the three main areas of Diepkloof (62). The residential areas that comprise Diepkloof are characterised by marked differences in SES, including access to services and housing type.

Dietary intake, physical activity, alcohol consumption, and smoking status were measured using various questionnaire items (outlined in detail below) that together comprised the CANSA Lifestyle Risk Assessment Tool (LRAT) for Cancer based on the 2018 WCRF/AICR Cancer Prevention Recommendations (Table 1) (60). While the LRAT questionnaire has not yet been formally validated, it has been used by CANSA social workers and volunteers in various contexts in South Africa to assist individuals in assessing their personal lifestyle risk. One of the reasons for using this tool for the study was because it had not yet been tested in a 'township' context like Soweto.

Several cancer belief items were adapted from a short scale for cancer knowledge, the Cancer Research UK Cancer Awareness Measure, and the African Women Awareness of Cancer (AWACAN) tool (69–71), which were validated in Australia, UK, and South Africa/Uganda respectively. Internal reliability analysis revealed the items could not be used together as a scale and therefore were used individually in analysis. Participants were asked whether they believed that colon cancer is controllable if detected early, drinking alcohol increases the risk of cancer, and being overweight can help protect against cancer. Two other items assessed the belief that breast cancer is controllable if detected early and that exercise causes cancer to spread faster in the body. No significant associations were found for these latter two items, and it was decided not to report findings due to redundancy and space constraints. Data can be provided upon request. Risk perception was assessed using a scale validated in the Netherlands, which included both cognitive and affective elements (72). Ten items (five

cognitive and five affective) were used to assess participants' perceived risk of developing cancer in their lifetime given a sustained type of lifestyle, with different items pertaining to various lifestyle patterns related to diet, physical activity, alcohol consumption, and smoking. The Cronbach's alpha was 0.8 suggesting good internal consistency. Lastly, two items were used to assess screening behaviour.. Men and women were asked whether they underwent at least one prostate specific antigen (PSA) test or a clinical/self-breast examination (CBE/SBE) over the last 12 months, respectively.

2.3 World Cancer Research Fund/American Institute for Cancer Research lifestyle recommendations, score construction and operationalisation

Seven of the updated 2018 WCRF/AICR Cancer Prevention Recommendations were used in this study, including the recommendations relating to body fatness, moderate- to vigorous-intensity physical activity (MVPA), energy-dense foods, plant foods, meat consumption and alcoholic drinks (25). We did not operationalise the breast-feeding recommendation as it was optional and not relevant to our study population. A summary of the applied WCRF/AICR (sub)recommendations, the study data used and operationalisation of recommendations, and scoring thereof is shown in Table 1. Cut-offs and adherence score categories were based on the official 2018 WCRF/AICR scoring system developed by Shams-White et al. (25), and participants were classified into appropriate adherence score categories accordingly.

To operationalise the body fat recommendation, height (m) and weight (kg) measurements were used to calculate body mass index (BMI) (kg/m^2), with waist circumference (cm) also being measured. Procedures for anthropometric measurement were based on the WHO STEPS Surveillance Guide for Physical Measurements (73).

Self-reported MVPA was assessed using a single recall-based item from the Lifestyle Risk Assessment Tool (LRAT) measuring the number of minutes per week engaged in at least moderate activity, including walking, jogging, cycling, household work, and other forms of manual labour, based on WHO adult guidelines (86). As noted above, score calculation was based on the standard WCRF/AICR scoring system by Shams-White et al. (25). The authors allocate one point to individuals who complete ≥150 min, and 0 points to those performing <75 min of moderate-to-vigorous physical activity per week, in accordance with WHO recommendations. The 0.5 cut-off is based on additional data from the U.S. Physical Activity Guidelines (87), which indicates a significantly decreased risk of all-cause mortality even for those performing 75–<150 min/week of moderate physical activity per week. Due to a

programming error in REDCap detected after completion of fieldwork, the highest level of MVPA we were able to capture for this study was 120 min/week.

Dietary intake was assessed using a semi-quantitative food frequency questionnaire (FFQ) with nine items, which forms the dietary component of the LRAT instrument. Adherence scores were calculated using food composition table data of the South African Food Data System (SAFOODS) and the U.S. Department of Agriculture (USDA) (74–76). Additionally, other sources, including the 2013 South African Dietary Guidelines, were used to verify portion size data for certain food groups (77–83). Research assistants used a standard household cup measure and other visual aids, including palm size and product packaging, to assist participants in estimating portion sizes for amorphous, leafy, and single unit solid foods, while accounting for being in cooked or raw form. Responses were then converted to grams per day during coding. Conversion of food intake data recorded in household measures into grams was not possible for all food groups using South African databases, hence international sources were consulted. The Food Quantities Manual of the South African Medical Research Council (84) can be used for this purpose but was not available for this study.

Fruit and vegetable intake (g/day) was based on the reported number of portion sizes based on standard cup measures eaten daily (approximately 80g per standard portion size). Dietary fibre intake was based on all plant-based food sources as per the WCRF/AICR dietary recommendations. Therefore, our calculated total fibre intake (g/day) was based on the nutrient value from the food composition tables for dietary fibre according to the reported number of portion sizes of fruits, vegetables, wholegrains, and legumes consumed daily (approximately 75g per standard portion size for wholegrain and legume foods). For the legume item, while only frequency of consumption per week is specified in the questionnaire, the same cup measures were used as with the wholegrain item (1/2 cup being a single portion) during interviews, and amount per day was estimated. Red and processed meat intake (g/week) was measured by the reported number of palm-sized portions of red meat and number of slices or units of processed meat eaten per week (approximately 100g and 30g per standard portion size for red and processed meat respectively). Red meat was defined as fresh meat needing preparation (including beef, lamb, pork, and goat), while processed meat included any meat that had been preserved by smoking, curing, salting or addition of chemical preservatives and was ready for consumption without preparation (including cold meats such as polony, ham, and vienna sausages, ‘Russian’ sausages, and meats from poultry sources). The 2018 WCRF/AICR ‘fast food’ recommendation is based on an ultra-processed foods (UPFs) category that is derived from an adapted version of the NOVA classification system (85) which includes foods high in fat, starch, and sugar not accounted for in the sugary drinks and red/processed meat recommendations (25). Hence for this study, the UPFs category

included crisps, bakery foods, desserts, and confectioneries. Intake frequency was calculated as the number of occasions per week items were consumed, with adherence score categories determined by subjective cut-offs based on tertiles, with tertile one representing the lowest frequency, as per the 2018 WCRF/AICR Recommendations score. Amount consumed for this food item was not determined. Sugar-sweetened beverages (SSBs) included drinks with natural sugar, like fruit juices, as well as soft drinks. SSB intake (g/day) was calculated based on the number of cups consumed daily (250ml per drink). A standard cup measure equals approximately 250ml so was used as a reference during interviews. Alcohol intake (g/day) was calculated using the reported number of standard drinks consumed in a week (1 standard drink: 350ml of beer, 1 glass of wine, and 1 tot of spirits). Smoking status and behaviour was measured using three items. While not part of the adherence score, smoking status was used as a covariate in multiple regression analyses.

To finally calculate the WCRF/AICR adherence score, a score of 1 point for complete adherence, 0.5 points for moderate adherence, and 0 points for non-adherence was assigned to each recommendation according to the cut-off values defined by the WCRF/AICR adherence categories. Scores were halved where sub-recommendations were present (see Table 1). An overall adherence score was calculated (score range: 0-7) by summing the scores of the seven operationalised (sub)recommendations, with a higher score indicating higher adherence to lifestyle recommendations. A score without the anthropometric components was also calculated (score range: 0-6), to calculate a score for the sample including participants for which body fatness data were not obtained.

2.4 Statistical analyses

Descriptive analyses of participant socio-demographic and health-related characteristics were performed for the total sample and according to sex. Continuous variables were described as means and standard deviations (medians and interquartile ranges for skewed variables), and categorical variables were described using absolute frequencies and percentages. Means and standard deviations for both the overall adherence score and score excluding anthropometric components were calculated. The proportion of participants according to degree of adherence (low, moderate, high) to individual WCRF/AICR recommendations was calculated for the overall population and stratified by sex. Mean WCRF/AICR adherence scores were compared across different groups according to sociodemographic and psychosocial characteristics and other cancer health-related factors. Cancer belief items were measured individually and reverse coded where applicable, and the overall risk perception score was categorised based on tertiles, with tertile one representing low risk perception. Differences were assessed using independent samples *t* tests or one-way ANOVA for variables with two categories or more

than two categories, respectively. The Bonferroni correction method for multiple comparisons was used to test associations between individual groups when ANOVA revealed at least two groups to be statistically significantly different. Bartlett's test was used to test for equality of variances.

Multivariable linear regression models were run to assess associations between the continuous WCRF/AICR adherence score (overall and without AM) and socio-demographic, psychosocial, and other cancer health-related variables. Explanatory variables included sex, age category, education level, residential area, employment status, household income and hunger, smoking status, family history of cancer, risk perception, cancer beliefs, and cancer screening behaviour. Variables were included in the models based on confounding likelihood and showing association in bivariate analyses (a *P*-value of ≤0.1 was chosen as a cut-off for model inclusion). Models were run separately for total sample and according to sex due to sex-specific differences observed during bivariate analysis (data not shown). Unstandardised regression coefficients (β) and 95% CI were obtained from linear regression models, representing the difference in mean adherence scores between groups when compared to reference group for each explanatory variable while controlling for all other variables in the model. Normality of the WCRF/AICR adherence scores was assessed both by observing their graphical distribution and performing the Shapiro-Wilk test. A two-tailed *P*-value of <0.05 was considered statistically significant for all analyses.

2.5 Ethics

Ethics approval was obtained from the Human Research Ethics Committee (HREC) of University of the Witwatersrand before study commencement. During recruitment, participants were asked to provide informed consent after careful explanation of the purpose of the study and how and what exactly would be measured. A distress protocol was followed in cases where participants experienced any form of distress regarding their health during or after the interview. Research assistants or the principal investigator referred participants to the CANSA counselling service or a local CANSA social worker. All data collected in field were immediately uploaded to a central REDCap database after each interview and signed consent forms were collected by the principal investigator at the end of each day.

Table 1. Operationalisation of lifestyle recommendations for the prevention of cancer by the World Cancer Research Fund and American Institute for Cancer Research (WCRF/AICR).

	WCRF/AICR cancer prevention recommendations	Study data	Adherence	Operationalisation	Lifestyle score
1	Keep your weight within the healthy range and avoid weight gain in adult life	BMI (kg/m^2) (Objective measure)	high moderate Low	18.5–24.9 25–29.9 <18.5 or ≥30	0.5 0.25 0
		WC (cm) (Objective measure)	high moderate low	Men: <94; Women: <80 Men: 94–<102; Women: 80–<88 Men: ≥102; Women: ≥88	0.5 0.25 0
2	Be physically active as part of everyday life – walk more and sit less.	Level of moderate-vigorous physical activity (min/week) (Questionnaire)	high moderate low	≥150 75–<150 <75	1 0.5 0
3	Eat a diet rich in wholegrains, vegetables, fruit, and legumes such as beans and lentils.	Total fruit and vegetable intake (g/day) (FFQ)	high moderate low	≥400 200–<400 <200	0.5 0.25 0
		Total dietary fiber (g/day) [1] (FFQ)	high moderate low	≥30 15–<30 <15	0.5 0.25 0
4	Limit consumption of "fast foods" and other processed foods high in fat, starches, or sugars	UPF intake (times/week) [2] (FFQ)	high moderate low	Tertile 1 Tertile 2 Tertile 3	1 0.5 0
5	Limit consumption of red and processed meat	Total red meat (g/week) and processed meat (g/week) (FFQ)	high moderate low	Red meat <500 and processed meat <21 Red meat <500 and processed meat 21–<100 Red meat >500 or processed meat ≥100	1 0.5 0
6	Limit consumption of sugar-sweetened drinks	Total sugar-sweetened drinks (g/day) (FFQ)	high moderate low	0 >0–≤250 >250	1 0.5 0
7	Limit alcohol consumption	Total ethanol (g/day) (FFQ)	high moderate low	0 >0–≤28 (2 drinks) males and ≤14 (1 drink) females >28 (2 drinks) males and >14 (1 drink) females	1 0.5 0
		Total score range			**0-7**

Abbreviations: MVPA, moderate- to vigorous-intensity physical activity; BMI, body mass index; WC, waist circumference; UPF, ultra-processed food; FFQ, food frequency questionnaire; g, grams

[1] Recommendation for dietary fibre is for food sources so intake was calculated from fruit, vegetable, wholegrain, and legume sources.

[2] The UPF component was based on intake of crisps, bakery foods, desserts, and confectioneries. Intake was calculated as the number of occasions per week items are consumed and tertiles were based on subjective cut-off points.

Chapter 3 – Manuscript

This manuscript has been prepared for submission to the *International Journal of Cancer* (*IJC*). It is formatted according to *IJC* author guidelines (Appendix 1).

Adherence to cancer prevention recommendations and associated factors in a socio-economically diverse urban population in South Africa

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Conflicts of interest and source of funding
None of the authors have any conflicts of interest to declare. This project was funded by the Cancer Association of South Africa (CANSA). The content of the publication is solely the responsibility of the authors and do not necessarily represent the official views of the CANSA.

Novelty and Impact

This population-based study adds to the limited knowledge base in South Africa of levels of adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations and associated factors. It uses the newly updated recommendations and standardised scoring algorithm. Low adherence was found to be associated with younger age, higher SES, low risk perception, and poor cancer screening behaviour, with patterns differing with sex. Targeted public health efforts that account for these sub-group differences could help improve lifestyle health.

Key words: Cancer prevention, World Cancer Research Fund/American Institute for Cancer Research recommendations, Diet, Socio-economic status, Urban, South Africa

Abstract

This study aimed to investigate adherence to the 2018 World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) Cancer Prevention Recommendations and the association with socio-economic status (SES) and other health-related factors. A cross-sectional household survey was conducted in Soweto, Johannesburg, South Africa, using a proportionate stratified systematic random sample of men and women aged 25-55 years (*n* 407). Anthropometric measurements were conducted, and data collected on SES, dietary intake, and other lifestyle factors, using a structured questionnaire. A standard scoring algorithm was used to assess adherence to recommendations. Adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations was low. Multivariate linear regression showed that lower adherence was associated with the 20-29 year age-group versus the 30-39 (β = 0.27, 95% CI = 0.00, 0.54) and 50-55 (β = 0.44, 95% CI = 0.13, 0.76) year age groups, high school education (β = -0.29, 95% CI = -0.53, -0.05), current employment (β = -0.36, 95% CI = -0.66, -0.06), living in moderate-SES area versus low-SES area (β = 0.42, 95% CI = 0.08, 0.76), and, for males only, high food security versus moderate food security (β = 0.52, 95% CI = 0.08, 0.95). Higher adherence was associated with having been screened for cancer for both males (β = 0.56, 95% CI = 0.08, 1.04) and females (β = 0.24, 95% CI = 0.00, 0.48). Low adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations was associated with younger age, higher SES, low risk perception, and poor cancer screening behaviour.

Introduction

South Africa has increasingly begun to mirror and even exceed worldwide trends for non-communicable diseases (NCDs) (10,11), exacerbated by a high prevalence of obesity and other lifestyle and nutrition-related risk behaviours (12–17). The past few decades have seen marked economic growth and industrialisation in many African countries, including South Africa, which has been accompanied by changes in lifestyles associated with exposure to a variety of factors that increase risk for a range of NCDs, including several cancers (2,3). In South Africa, as with other low- and middle-income countries (LMICs), there is large variation in prevalence and distribution of cancer risk factors across socio-economic strata (4,12,16,38–42). A pattern that consistently emerges is the heavy burden increasingly experienced in poor rural and urban contexts, with social and economic gradients in risk factor trends apparent even within these communities (4,12,16,38–42).

The cancer burden and accompanying burden of unhealthy lifestyles is projected to rise dramatically across LMICs, and South Africa is no exception (2). In addition to the high cost of adequate cancer treatment, this makes addressing the emerging patterns of harmful lifestyle practice a priority. There are limited data available to assist with quantifying cancer lifestyle risk in the South African population (19, 21), and therefore developing preventive interventions proves challenging. In 2018, the World Cancer Research Fund (WCRF) and American Institute for Cancer Research (AICR) published the Third Expert Report with updated WCRF/AICR Cancer Prevention Recommendations, an international benchmark for evidence-based guidelines regarding alcohol use, body weight, physical activity, and diet (23). These recommendations form a comprehensive package of modifiable behaviours that, taken together, promote a healthy lifestyle, enhancing the prevention of several cancers, other non-communicable diseases, and obesity. Greater adherence to WCRF/AICR recommendations has been associated with reduced incidence of general and site-specific cancers, as well as all-cause and cancer-related mortality (24). However, until recently no standardised scoring algorithm operationalising the recommendations existed, limiting direct comparability between studies. To address this, a standard scoring system was developed for the WCRF/AICR guidelines (25).

The WCRF/AICR guidelines are recognised as an international standard and there is a small and growing body of knowledge about their application in African countries. A study measured levels of adherence and associated predictors in 18 countries (26), demonstrating an overall connection between lower adherence and residing in a lower SES household. A recent South African study, using the new standard scoring algorithm, showed that higher adherence was associated with reduced breast cancer incidence in Black African, urban women (27), while

another showed that increased access to health care services is linked to greater adherence (28). However, these studies involved either men or women only, or relied on relatively old data. As such, further work among men and women across age-groups might yield additional insights into the current levels of adherence to multiple cancer-related lifestyle recommendations in South African communities. Furthermore, deepening understanding of how adherence to cancer lifestyle guidelines relates to socio-economic status (SES) and other potentially associated factors within disadvantaged communities, such as 'townships', could shed light on potential points of intervention.

High rates of diagnosis of late-stage cancer in cancer patients occur in Africa, including South Africa (9), highlighting the importance of timely detection through screening. The Cancer Association of South Africa (CANSA) recommends that for prostate and breast cancer screening, all men aged 50 years and older (40+ years with first-degree family history of cancer) and all women aged 40-54 years be tested annually, with women aged 55 years and older undergoing biennial mammograms (57,58).

It has been shown that risk perception is a motivating factor for a variety of cancer preventive behaviours (45,46). Furthermore, while several studies suggest a link between these factors and cancer screening, the relationship is not well established (50–54). Improving our understanding of how cancer-related risk perception and screening behaviour relate to lifestyle risk in the South African context is important, as engagement in cancer preventive lifestyles may be hindered if individuals' cancer beliefs, risk perception, and screening behaviour are not appropriately targeted.

Therefore, this study aimed to measure the level of adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations and identify which demographic, SES, and other health factors, including cancer-related knowledge, risk perception, and screening, are associated with adherence in urban men and women from Soweto, South Africa.

Methods

Study design and research setting

A cross-sectional household survey was conducted in South Africa in Diepkloof, Soweto by the University of Witwatersrand School of Public Health (SPH) and Cancer Association of South Africa (CANSA) from July to October 2021. Diepkloof is a residential area with a population of approximately 95 000 (61), situated on the eastern border of Soweto, comprising a mix of both formal and informal settlements and a range of access to services (62). It is divided into three main areas: the oldest and largest area consisting of six zones, originally made up of basic houses and hostels; the second being the wealthier Extension; and finally, Motsoaledi informal settlement. This study setting was selected for two reasons. First, the residential areas described above are characterised by marked differences in SES and access to services (62). This was confirmed through consultations with community ward counsellors prior to study commencement. This allowed for a potentially more socioeconomically diverse sample. Second, there is limited data on disease burden and risk factor patterns for the general population of Soweto and other similar urban settings, particularly in regard to cancer (27,63), with most studies targeting key populations and/or age or sex groups.

Participants

Sampling strategy and recruitment

A proportionate stratified systematic random sample of households from each of the three main areas was undertaken. The number of households sampled was in relative proportion to the total number for each of the three areas. In each area, and in four randomly sampled zones for the first area, the first household on a randomly selected street was visited, followed by every third household until the appropriate sample size had been reached. A household was defined by members who sleep and eat together regularly in the same dwelling. Upon each visit, research assistants explained the details of the survey to an adult member of the household and an information sheet was provided in the preferred language.

One randomly selected eligible person from the household was invited to participate. If an eligible individual was identified but was not at home during the first visit, two more attempts were made at a rescheduled date. Men and women aged between 25 and 55 years, who were regular members of a sampled household, had never been diagnosed with cancer, and were free of any illness or condition that prevented them from engaging in their regular dietary consumption or physical activity routines were eligible for participation. The age-range was selected on the basis of assessing cancer lifestyle risk in adults at whose age cancer incidence

is lower. Incidence rates for most cancers in South Africa rise markedly in individuals aged 55 years and above (64). In addition, we wanted to include individuals eligible for prostate and breast cancer screening (57,58).

A sample size of 500 was calculated to ensure sufficient statistical power to estimate prevalence of cancer-related lifestyle risk behaviour practice by socio-demographic categories (e.g. males and females). This sample size was deemed adequate to measure difference in knowledge and perceived risk prevalence.

Data collection

Trained research assistants conducted face-to-face interviews with eligible participants who had provided written consent. Interviews were conducted in the preferred language of the participant by research assistants fluent in the language. Data were captured on a tablet using the REDCap electronic data capture platform hosted at the University of the Witwatersrand. Interviews took around 30 minutes to complete. Participants were invited to undergo weight, height and waist circumference measurements. However, if participants refused the anthropometric measurements, they could consent to complete the interview. COVID-19 prevention protocols were followed throughout the recruitment and data collection process.

Research assistants were required to attend a five-day training workshop covering all fieldwork standard operating procedures, including recruitment, questionnaire administration, interview skills, and anthropometry.

Questionnaire

The questionnaire covered several domains including socio-demographic characteristics such as age, sex, and ethnicity. Socio-economic status (SES) was measured through household income, educational attainment, employment status, dwelling type, and household food security, which was assessed using a three-item household hunger scale validated for cross-cultural use (68). Residential location was also used as a measure of SES given the pronounced differences in SES across the three main areas of Diepkloof (62). The residential areas that comprise Diepkloof are characterised by marked differences in SES, including access to services and housing type.

Dietary intake, physical activity, alcohol consumption, and smoking status were measured using various questionnaire items (outlined in detail below) that together comprised the CANSA Lifestyle Risk Assessment Tool (LRAT) for Cancer based on the 2018 WCRF/AICR Cancer Prevention Recommendations (Table 1) (60). While the LRAT questionnaire has not yet been formally validated, it has been used in various contexts in South Africa to assist

individuals in assessing their personal lifestyle risk. One reason for using this tool in the study was because it had not yet been tested in a 'township' context like Soweto.

Several items assessing cancer-related beliefs were adapted from a short scale for cancer knowledge, the Cancer Research UK Cancer Awareness Measure, and the African Women Awareness of Cancer (AWACAN) tool (69–71), validated in Australia, UK, and South Africa/Uganda respectively. Internal reliability analysis revealed the items could not be used together as a scale and therefore were used individually in analysis. Risk perception was assessed using a scale validated in the Netherlands, which included both cognitive and affective elements (72). Ten items (five cognitive and five affective) were used to assess participants' perceived risk of developing cancer in their lifetime given a sustained type of lifestyle, with different items pertaining to various lifestyle patterns related to diet, physical activity, alcohol consumption, and smoking. The Cronbach's alpha was 0.8 suggesting good internal consistency. Lastly, two items were used to assess screening behaviour for men and women in the last 12 months. Men and women were asked whether they underwent at least one prostate specific antigen (PSA) test or a clinical/self-breast examination (CBE/SBE) over the last 12 months respectively.

World Cancer Research Fund/American Institute for Cancer Research lifestyle recommendations, score construction and operationalisation

Seven of the updated 2018 WCRF/AICR Cancer Prevention Recommendations were used in this study, including the recommendations relating to body fatness, moderate- to vigorous-intensity physical activity (MVPA), energy-dense foods, plant foods, meat consumption and alcoholic drinks (25). We did not operationalise the breast-feeding recommendation as it was optional and not relevant to our study population. A summary of the applied WCRF/AICR (sub)recommendations, the study data used and operationalisation of recommendations, and scoring thereof is shown in Table 1. Cut-offs and adherence score categories were based on the official 2018 WCRF/AICR scoring system developed by Shams-White et al. (25), and participants were classified into appropriate adherence score categories accordingly.

To operationalise the body fat recommendation, height (m) and weight (kg) measurements were used to calculate body mass index (BMI) (kg/m^2), with waist circumference (cm) also being measured. Procedures for anthropometric measurement were based on the WHO STEPS Surveillance Guide for Physical Measurements (73).

Self-reported MVPA was assessed using a single recall-based item from the Lifestyle Risk Assessment Tool (LRAT) measuring the number of minutes per week engaged in at least moderate activity, including walking, jogging, cycling, household work, and other forms of

manual labour, based on WHO adult guidelines (86). As noted above, score calculation was based on the standard WCRF/AICR scoring system by Shams-White et al. (25). The authors allocate one point to individuals who complete ≥150 min, and 0 points to those performing <75 min of moderate-to-vigorous physical activity per week, in accordance with WHO recommendations. The 0.5 cut-off is based on additional data from the U.S. Physical Activity Guidelines (87), which indicates a significantly decreased risk of all-cause mortality even for those performing 75–<150 min/week of moderate physical activity per week. Due to a programming error in REDCap detected after completion of fieldwork, the highest level of MVPA we were able to capture for this study was 120 min/week.

Dietary intake was assessed using a semi-quantitative food frequency questionnaire (FFQ) with nine items, which forms the dietary component of the LRAT instrument. Adherence scores were calculated using food composition table data of the South African Food Data System (SAFOODS) and the U.S. Department of Agriculture (USDA) (74–76). Additionally, other sources, including the 2013 South African Dietary Guidelines, were used to verify portion size data for certain food groups (77–83). Research assistants used a standard household cup measure and other visual aids, including palm size and product packaging, to assist participants in estimating portion sizes for amorphous, leafy, and single unit solid foods, while accounting for being in cooked or raw form. Responses were then converted to grams per day during coding. Conversion of food intake data recorded in household measures and visual aids into grams was not possible for all food groups using South African databases, hence international sources were consulted. The Food Quantities Manual of the South African Medical Research Council (84) can be used for this purpose but was not available for this study.

Fruit and vegetable intake (g/day) was based on the reported number of portion sizes based on standard cup measures eaten daily (approximately 80g per standard portion size). Dietary fibre intake was based on all plant-based food sources as per the WCRF/AICR dietary recommendations. Therefore, our calculated total fibre intake (g/day) was based on the nutrient value from the food composition tables for dietary fibre according to the reported number of portion sizes of fruits, vegetables, wholegrains, and legumes consumed daily (approximately 75g per standard portion size for wholegrain and legume foods). For the legume item, while only frequency of consumption per week is specified in the questionnaire, the same cup measures were used as with the wholegrain item (1/2 cup being a single portion) during interviews, and amount per day was estimated. Red and processed meat intake (g/week) was measured by the reported number of palm-sized portions of red meat and number of slices or units of processed meat eaten per week (approximately 100g and 30g per standard portion size for red and processed meat, respectively). Standard portion sizes were

approximated by converting palm-sized portions for red meat and serving sizes from product packaging for processed meat into grams using food composition table data of SAFOODS and the USDA, in addition to the 2013 South African Dietary Guidelines. Red meat was defined as fresh meat needing preparation (including beef, lamb, pork, and goat), while processed meat included any meat that had been preserved by smoking, curing, salting or addition of chemical preservatives and was ready for consumption without preparation (including cold meats such as polony, ham, and vienna sausages, 'Russian' sausages, and meats from poultry sources). The 2018 WCRF/AICR 'fast food' recommendation is based on an ultra-processed foods (UPFs) category that is derived from an adapted version of the NOVA classification system (85) which includes foods high in fat, starch, and sugar not accounted for in the sugary drinks and red/processed meat recommendations (25). Hence for this study, the UPFs category included crisps, bakery foods, desserts, and sweets. Intake frequency was calculated as the number of occasions per week items were consumed, with adherence score categories determined by subjective cut-offs based on tertiles, with tertile one representing the lowest frequency, as per the 2018 WCRF/AICR Recommendations score. Amount consumed for this food item was not determined. Sugar-sweetened beverages (SSBs) included drinks with natural sugar, like fruit juices, as well as soft drinks. SSB intake (g/day) was calculated based on the number of cups consumed daily (250ml per drink). A standard cup measure equals approximately 250ml so was used as a reference during interviews. Alcohol intake (g/day) was calculated using the reported number of standard drinks consumed in a week (1 standard drink: 350ml of beer, 1 glass of wine, and 1 tot of spirits). Smoking status and behaviour was measured using three items based on recall. While not part of the adherence score, smoking status was used as a covariate in multiple regression analyses.

To finally calculate the WCRF/AICR adherence score, a score of 1 point for complete adherence, 0.5 points for moderate adherence, and 0 points for non-adherence was assigned to each recommendation according to the cut-off values defined by the WCRF/AICR adherence categories. Scores were halved where sub-recommendations were present (see Table 1). An overall adherence score was calculated (score range: 0-7) by summing the scores of the seven operationalised (sub)recommendations, with a higher score indicating higher adherence to lifestyle recommendations. A score without the anthropometric components was also calculated (score range: 0-6), to calculate a score for the sample including participants for which body fatness data were not obtained.

Table 1. Operationalisation of lifestyle recommendations for the prevention of cancer by the World Cancer Research Fund and American Institute for Cancer Research (WCRF/AICR).

	WCRF/AICR cancer prevention recommendations	Study data	Adherence	Operationalisation	Lifestyle score
1	Keep your weight within the healthy range and avoid weight gain in adult life	BMI (kg/m^2) (Objective measure)	high moderate Low	18.5–24.9 25–29.9 <18.5 or ≥30	0.5 0.25 0
		WC (cm) (Objective measure)	high moderate low	Men: <94; Women: <80 Men: 94–<102; Women: 80–<88 Men: ≥102; Women: ≥88	0.5 0.25 0
2	Be physically active as part of everyday life – walk more and sit less.	Level of moderate-vigorous physical activity (min/week) (Questionnaire)	high moderate low	≥150 75–<150 <75	1 0.5 0
3	Eat a diet rich in wholegrains, vegetables, fruit, and legumes such as beans and lentils.	Total fruit and vegetable intake (g/day) (FFQ)	high moderate low	≥400 200–<400 <200	0.5 0.25 0
		Total dietary fiber (g/day) [1] (FFQ)	high moderate low	≥30 15–<30 <15	0.5 0.25 0
4	Limit consumption of "fast foods" and other processed foods high in fat, starches, or sugars	UPF intake (times/week) [2] (FFQ)	high moderate low	Tertile 1 Tertile 2 Tertile 3	1 0.5 0
5	Limit consumption of red and processed meat	Total red meat (g/week) and processed meat (g/week) (FFQ)	high moderate low	Red meat <500 and processed meat <21 Red meat <500 and processed meat 21–<100 Red meat >500 or processed meat ≥100	1 0.5 0
6	Limit consumption of sugar-sweetened drinks	Total sugar-sweetened drinks (g/day) (FFQ)	high moderate low	0 >0–≤250 >250	1 0.5 0
7	Limit alcohol consumption	Total ethanol (g/day) (FFQ)	high moderate low	0 >0–≤28 (2 drinks) males and ≤14 (1 drink) females >28 (2 drinks) males and >14 (1 drink) females	1 0.5 0
		Total score range			**0-7**

Abbreviations: MVPA, moderate- to vigorous-intensity physical activity ; BMI, body mass index; WC, waist circumference; UPF, ultra-processed food; FFQ, food frequency questionnaire; g, grams

[1] Recommendation for dietary fibre is for food sources so intake was calculated from fruit, vegetable, wholegrain, and legume sources.

[2] The UPF component was based on intake of crisps, bakery foods, desserts, and confectioneries. Intake was calculated as the number of occasions per week items are consumed and tertiles were based on subjective cut-off points.

Statistical analyses

Descriptive analyses of participant socio-demographic and health-related characteristics were performed for the total sample and according to sex. Continuous variables were described as means and standard deviations (medians and interquartile ranges for skewed variables), and categorical variables were described using absolute frequencies and percentages. Means and standard deviations for both the overall adherence score and score excluding anthropometric components were calculated. The proportion of participants according to degree of adherence (low, moderate, high) to individual WCRF/AICR recommendations was calculated for the overall population and stratified by sex. Mean WCRF/AICR adherence scores were compared across different groups according to sociodemographic and psychosocial characteristics and other cancer health-related factors. Cancer belief items were measured individually and reverse coded where applicable, and the overall risk perception score was categorised based on tertiles, with tertile one representing low risk perception. Differences were assessed using independent samples *t* tests or one-way ANOVA for variables with two categories or more than two categories, respectively. The Bonferroni post-hoc test was used to test associations between individual groups when ANOVA revealed at least two groups to be statistically significantly different. Bartlett's test was used to test for equality of variances.

Multivariable linear regression models were run to assess associations between the continuous WCRF/AICR adherence score (overall and without anthropometric measures) and socio-demographic, psychosocial, and other cancer health-related variables. Explanatory variables included sex, age category, education level, residential area, employment status, household income and hunger, smoking status, family history of cancer, risk perception, cancer beliefs, and cancer screening behaviour. Variables were included in the models based on confounding likelihood and showing association in bivariate analyses (a *P*-value of ≤0.1 was chosen as a cut-off for model inclusion). Models were run separately for total sample and according to sex due to sex-specific differences observed during bivariate analysis (data not shown). Unstandardised regression coefficients (β) and 95% CI were obtained from linear regression models, representing the difference in mean adherence scores between groups when compared to reference group for each explanatory variable while controlling for all other variables in the model. Normality of the WCRF/AICR adherence scores was assessed both by observing their graphical distribution and performing the Shapiro-Wilk test. A two-tailed *P*-value of <0.05 was considered statistically significant for all analyses.

Ethics

Ethics approval was obtained from the Human Research Ethics Committee (HREC) of University of the Witwatersrand before study commencement. During recruitment, participants were asked to provide informed consent after careful explanation of the purpose of the study and how and what exactly would be measured. A distress protocol was followed in cases where participants experienced any form of distress regarding their health during or after the interview. Research assistants or the principal investigator referred participants to the CANSA counselling service or a local CANSA social worker. All data collected in field were immediately uploaded to a central REDCap database after each interview and signed consent forms were collected by the principal investigator at the end of each day.

Results

Participant characteristics

In total, 549 eligible individuals were invited to participate in the survey, of whom 416 agreed to take part (75.8% response rate). A further nine were excluded due to missing eligibility screening data that could not be verified, including for age and cancer diagnosis. Of the remaining 407 participants, 107 chose not to have anthropometric measurements taken but completed the rest of the questionnaire. Almost all (99.3%) participants self-classified as Black African.

Participant characteristics for total sample and by sex are shown in Table 2. Around one-third of participants were male (n=160; 39.3%) and 247 (60.7%) females and were on average 39.6 years of age (SD 9.6). Almost half (49.5%) earned less than R5000(US$341) monthly, 30.7% were currently employed, 20.0% had completed tertiary level education, and 36.9% experienced moderate or severe food insecurity. Based on body mass index (BMI), for males and females respectively, 15.0% and 5.7% were underweight, 47.7% and 18.0% were normal weight, 20.6% and 27.8% were overweight, and 16.8% and 48.5% were obese. More than a third (35.5%) of participants were current smokers (male, 53.1%; female, 24.1%), with the median number of cigarettes smoked daily being six and three for males and females respectively. Almost half (48.4%) were current consumers of alcohol (male, 58.8%; female, 41.8%). Regarding family history of cancer, 26.5% had one or more direct family members currently or previously diagnosed with cancer and 44.3% had been for cancer screening in the last 12 months (males,15.7%; females, 62.8%).

Adherence to World Cancer Research Fund/American Institute for Cancer Research recommendations (overall and individual)

The mean WCRF/AICR adherence score was 3.0 (±SD = 0.86), ranging from 0.5 to 5.25 points, while the mean WCRF/AICR adherence score (excluding anthropometric measurements) was 2.61 (±SD = 0.78), ranging from 0.5 to 4.25 points. The level of adherence to the individual recommendations for the overall sample and by sex is shown in Figure 1a and Figure 1b respectively. Overall, almost half of the participants did not adhere to both BMI and waist circumference recommendations, while 36.4% did not adhere to MVPA recommendations. High levels of non-adherence were seen for several dietary recommendations, notably for fruit and vegetables (66.7%), dietary fibre (55.4%), and SSBs (52.3%), while most participants practiced moderate adherence for red and processed meat (85.3%) and two-thirds (66.8%) practiced high adherence for the ultra-processed foods. For alcohol consumption, 21.0% did not adhere to the recommendation. There were several notable differences in the degree of adherence between males and females. A significantly higher proportion of females were overweight or obese, with 54.1% and 62.9% not adhering to BMI and waist circumference recommendations respectively, compared to 31.8% and 18.7% for males (p=0.000). For the alcohol recommendation, significantly more males (28.1%) did not adhere, compared to 16.5% of females (p=0.004). Regarding diet, significantly more males (60.6%) did not adhere to the SSB recommendation, compared to 47.0% of females (p=0.006), while more females (70.9%) did not adhere to the fruit and vegetable recommendation, compared to 60.6% of males (p=0.036). There were no significant differences between males and females in dietary fibre, red and processed meat, and UPF consumption and MVPA levels.

Table 2: Summary WCRF/AICR adherence scores, socio-demographics, and risk behaviours according to sex of residents from Soweto, Jul-Oct 2021

	Male (n=160)		Female (n=247)		Total (n=407)	
	n	%*	n	%*	n	%*
WCRF/AICR adherence score[1] (0-7)						
mean (SD)	3.1 (0.89)		3.0 (0.84)		3.0 (0.86)	
range	0.5-5.25		0.5-5.25		0.5-5.25	
WCRF/AICR) adherence score - no anthropometric (0-6)						
mean (SD)	2.5 (0.77)		2.7 (0.78)		2.6 (0.78)	
range	0.5-4.25		0.5-4.25		0.5-4.25	
Number of people in household						
median (IQR)	4 (3-7)		5 (4-7)		5 (3-7)	
Number of cigarettes daily (n=130)						
median (IQR)	6 (4-10)		3 (1-5)		5 (2-10)	
Age category (years)						
20-29	26	16.2	53	21.3	78	19.3
30-39	51	31.9	87	34.9	138	33.7
40-49	55	34.4	48	19.3	102	25.2
50-55	28	17.5	61	24.5	89	21.8
Residential location						
Moderate affluence	136	85.0	198	79.5	334	81.7
High affluence	12	7.5	17	6.8	29	7.1
Low affluence	12	7.5	34	13.7	46	11.2
Dwelling type						
House/townhouse/duplex	134	83.7	193	77.5	327	80.0
Shack	18	11.3	43	17.3	61	14.9
Room on someone else's property	8	5.0	13	5.2	21	5.1
Education level						
No schooling, primary level, or high school not complete	39	24.4	84	33.7	123	30.1
Secondary complete	77	48.1	127	51.0	204	49.9
Tertiary complete	44	27.5	38	15.3	82	20.0
Employed in the last 12 months						
No	60	37.5	149	60.3	209	51.4
Yes	100	62.5	98	39.7	198	48.7
Currently employed						
No	88	55.0	194	78.5	282	69.3
Yes	72	45.0	53	21.5	125	30.7
Household income						
R1000	61	38.4	136	56.9	197	49.5
R5000	48	30.2	54	22.6	102	25.6
R5001-10000	21	13.2	28	11.7	49	12.3
R10001+	29	18.2	21	8.8	50	12.6
HHS category						
Little to no hunger in the household	119	74.3	139	55.8	258	63.1
Moderate hunger in the household	31	19.4	88	35.4	119	29.1
Severe hunger in the household	10	6.3	22	8.8	32	7.8
MVPA (min/week)						
30	23	14.4	34	13.3	57	13.9
>30-60	38	23.8	54	21.9	92	22.5
90-120	99	61.8	161	64.8	260	63.6
BMI category[2] (kg/m^2)						
<18.5	16	15.0	11	5.7	27	9.0
18.5–24.9	51	47.6	35	18.0	86	28.6
25–29.9	22	20.6	54	27.8	76	25.2
≥30	18	16.8	94	48.5	112	37.2
Waist circumference[3] (cm)						
<94/<80	75	70.1	41	21.1	n/a	n/a
94-<102/80-<88	12	11.2	31	16.0	n/a	n/a
≥102/≥88	20	18.7	122	62.9	n/a	n/a
Currently smoking[4]						
No	75	46.9	189	75.9	264	64.5
Yes	85	53.1	60	24.1	145	35.5
Consumes alcohol						
No	66	41.3	145	58.2	211	51.6
Yes	94	58.7	104	41.8	198	48.4
Family history of cancer						
None	125	78.1	174	70.4	299	73.5
One family member	25	15.6	48	19.4	73	17.9
Two or more family members	10	6.3	25	10.2	35	8.6
Cancer screening in last 12 months[5]						
No	134	84.3	94	37.3	226	55.7
Yes	25	15.7	155	62.7	180	44.3

Abbreviations: WCRF/AICR, World Cancer Research Fund and American Institute for Cancer Research; HHS, Household Hunger Scale; MVPA, moderate-to-vigorous intensity physical activity; SD, standard deviation; IQR, interquartile range

*Column percentages

[1]This score includes anthropometric components and was calculated with n=300

[2]BMI was calculated with n=300

[3]Waist circumference has sex-specific cut-offs. Males: <94, 94-<102, ≥102; Females: <80, 80-<88, ≥88. Data are based on n=300

[4]Includes respondents who smoke non-tobacco products

[5]Prostate specific antigen test for males and clinical or self-breast examination for females.

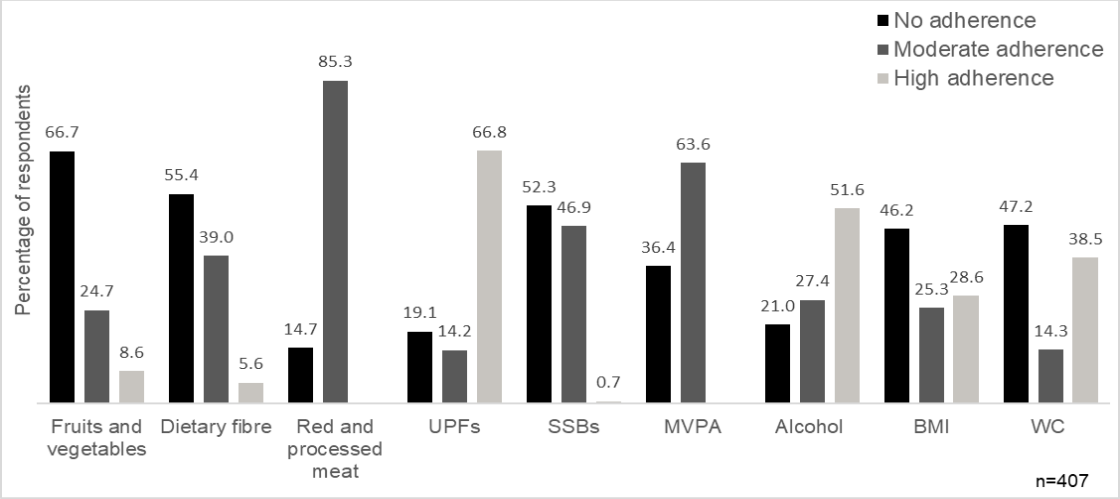

Figure 1a: Adherence to the individual World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) lifestyle recommendations. Abbreviations: UPFs, Ultra Processed Foods; SSBs, Sweet and Sugar Beverages; MVPA, moderate-to-vigorous intensity physical activity; BMI, Body Mass Index; WC, Waist circumference. Anthropometric measurements are based on n=300.

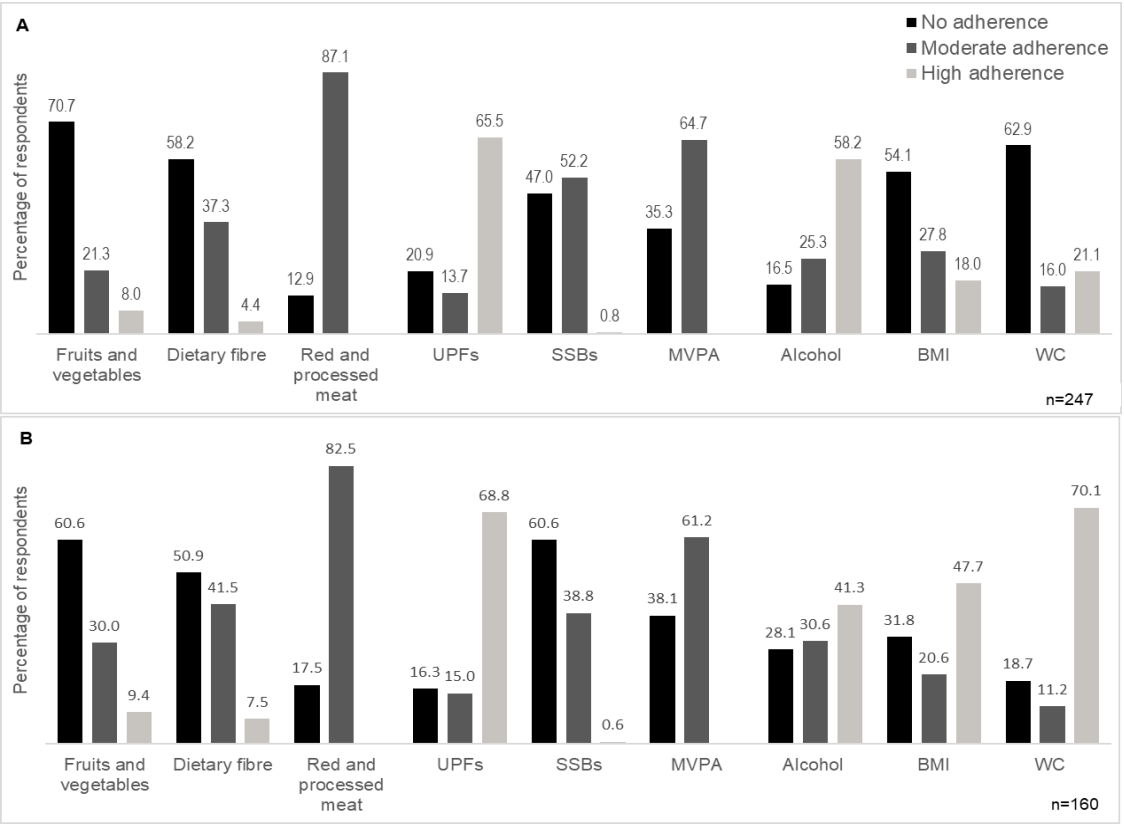

Figure 1b: Adherence to the individual World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) lifestyle recommendations according to sex. A) Females; B) Males. Abbreviations: UPFs, Ultra Processed Foods; SSBs, Sweet and Sugar Beverages; MVPA, moderate-to-vigorous intensity physical activity; BMI, Body Mass Index; WC, Waist circumference. Anthropometric measurements are based on n=300 (f=193, m=107).

Associations of World Cancer Research Fund/American Institute for Cancer Research adherence score with demographics, SES, smoking, cancer-related beliefs, risk perception, and screening

Table 3 presents the differences in adherence score (including and excluding anthropometric components) according to demographics, SES, cancer-related beliefs, risk perception, and other cancer-related health behaviours including screening. Independent two-sample t-tests revealed significant differences in mean adherence scores (excluding anthropometric measurements) between males (mean 2.5 ±SD = 0.8) and females (mean = 2.7, ±SD = 0.8); t (405) = -1.99, p = 0.047, non-smokers (mean = 2.7, ±SD = 0.8) and smokers (mean = 2.4, ±SD = 0.7); t (405) = 3.35, p = 0.001, women who have had cancer screening in the previous year (mean = 2.8, ±SD = 0.7) and women who have not (mean = 2.5, ±SD = 0.8); t (245) = -2.40, p = 0.017, and between participants who believe that drinking alcohol increases risk of cancer (mean = 2.7, ±SD = 0.7) and those who do not (mean = 2.5, ±SD = 0.8); t (404) = -2.24, p = 0.026. Significant differences in mean overall adherence scores were seen between men who have been screened (mean = 3.5, ±SD = 0.8) and men who have not (mean = 3.0, ±SD = 0.9); t (104) = -2.39, p = 0.018, and between participants who believe bowel cancer is controllable if detected early (mean = 3.1, ±SD = 0.8) and those who do not (mean = 2.8, ±SD = 0.9); t (298) = -2.41, p = 0.017.

One-way ANOVA analysis revealed a significant difference in mean overall score according to age category (F(3, 296) = 3.83, p = 0.010). Bonferroni's post-hoc test found that the mean adherence score was significantly lower in the 20-29 age-group, compared to the 30-39 (p = 0.041) and 50-55 (p = 0.010) age-groups. Likewise, a difference in mean score (excluding anthropometric component) was found (F(3, 403) = 7.50, p = 0.000), with a significantly lower adherence score in the 20-29 age-group, compared to the 30-39 (p = 0.038), 40-49 (p = 0.030), and 50-55 (p = 0.000) age-groups . A significant difference was also seen in mean overall score according to level of education (F(2, 297) = 4.07, p = 0.018), with Bonferroni's test showing a significantly higher adherence score in participants who have no schooling or have completed primary level, compared to those who have completed secondary level (p = 0.014). This difference was also detected for mean score (excluding anthropometric component) (F(2, 404) = 6.68, p = 0.001), with adherence scores following a similar pattern between the same two categories (p = 0.001). Furthermore, mean overall score differed significantly according to household hunger (F(2, 297) = 3.16, p = 0.044). However, according to Bonferroni's test, no differences between individual categories reached significance. When comparing mean score (excluding anthropometric component), a significant difference was also found (F(2, 404) = 4.76, p = 0.009), with lower adherence occurring

Table 3: Differences in mean World Cancer Research Fund and American Institute for Cancer Research (WCRF/AICR) adherence scores (overall and excluding anthropometric components) according to socio-demographic/SES, psychosocial, and cancer-related health factors (n=407).

	n	Mean score* (range 0-7)	(±SD)	P	n	Mean score – excluding AM (range 0-6)	(±SD)	P
Sex[1]								
Male	107	3.1	(0.9)	0.184	160	2.5	(0.8)	0.047
Female	194	3.0	(0.8)		249	2.7	(0.8)	
Age category[2]								
20-29	60	2.7[a,c]	(0.9)	0.010	78	2.3[d]	(0.8)	0.000
30-39	105	3.1	(0.9)		138	2.6	(0.8)	
40-49	75	3.0	(0.9)		102	2.6	(0.8)	
50-55	60	3.2	(0.8)		89	2.9	(0.7)	
Education level[2]								
No schooling, or primary complete	89	3.2[a]	(0.8)	0.018	123	2.8[a]	(0.7)	0.001
Secondary complete	149	2.9	(0.8)		204	2.5	(0.8)	
Tertiary complete	63	3.0	(1.0)		82	2.7	(0.8)	
Residential location (affluence level)								
Moderate	248	3.0	(0.9)	0.104	332	2.6	(0.8)	0.220
High	21	2.9	(0.7)		29	2.7	(0.8)	
Low	31	3.3	(0.6)		46	2.8	(0.5)	
Currently employed[1]								
Yes	93	3.0	(0.9)	0.471	125	2.5	(0.8)	0.074
No	207	3.0	(0.8)		282	2.7	(0.8)	
Employed in last 12 months[1]								
Yes	147	3.0	(0.9)	0.553	198	2.5	(0.8)	0.069
No	153	3.0	(0.8)		209	2.7	(0.7)	
Household income[2]								
R1000	142	3.0	(0.8)	0.473	197	2.7	(0.7)	0.105
R5000	71	3.1	(0.8)		102	2.6	(0.8)	
R5001-10000	38	2.8	(1.0)		49	2.4	(0.8)	
R10000+	41	3.0	(0.9)		50	2.5	(0.9)	
HHS category[2]								
Little to no household hunger	184	2.9	(0.9)	0.044	258	2.5[a]	(0.8)	0.009
Moderate household hunger	90	3.2	(0.8)		119	2.7	(0.7)	
Severe household hunger	27	3.2	(0.9)		32	2.8	(0.8)	
MVPA[2] (min/week) **								
30	42	2.4	(0.7)	0.029	57	2.2	(0.7)	0.436
>30-60	58	2.8	(0.9)		92	2.3	(0.7)	
90-120	201	2.7	(0.8)		260	2.3	(0.7)	
Currently smoking[1]†								
Yes	109	3.0	(0.8)	0.381	145	2.4	(0.7)	0.001
No	192	3.0	(0.9)		264	2.7	(0.8)	
Family history of cancer[2]								
None	215	3.0	(0.9)	0.337	299	2.6[b]	(0.8)	0.044
One family member	58	3.1	(0.8)		73	2.7	(0.7)	
Two or more family members	27	3.2	(0.7)		35	2.9	(0.7)	
Bowel cancer is controllable if detected early[1]								
Yes	237	3.1	(0.8)	0.017	325	2.6 2.5	(0.8)	0.101
No	63	2.8	(0.9)		82		(0.9)	
Drinking alcohol, even in moderation, increases the risk of cancer[1]						2.7 2.5		
Yes	125	3.1	(0.8)	0.207	171		(0.7)	0.026
No	175	3.0	(0.9)		235		(0.8)	
Being overweight can help protect against cancer[1]						2.6 2.8		
Yes	282	3.0	(0.9)	0.110	380		(0.8)	0.154
No	17	3.3	(0.8)		25		(0.6)	
Risk perception score tertiles[2] ‡						2.5		
1	110	2.9	(0.8)	0.130	146	2.6	(0.8)	0.007
2	105	3.1	(0.9)		142	2.8	(0.7)	
3	85	3.1	(0.8)		119		(0.8)	
Cancer screening in last 12 months[1] (CBE/BSE))						2.8 2.5		
Yes	119	3.0	(0.8)	0.304	155		(0.7)	0.017
No	74	2.9	(0.9)		92		(0.8)	
Cancer screening in last 12 months[1] (PSA/DRE)					25 134	2.7 2.5		
Yes	19	3.5	(0.8)	0.018			(0.8)	0.279
No	87	3.0	(0.9)				(0.8)	

Abbreviations: AM, anthropometric measurements; MVPA, moderate-to-vigorous physical activity; HHS, household hunger scale; BMI, body mass index; CBE, clinical breast examination; BSE, breast self-examination; PSA, prostate-specific antigen test; DRE, digital rectal exam; SD, standard deviation; P, p-value.

[1]Differences in WCRF/AICR scores for categorical variables with two categories are estimated using the independent sample T-test.

[2]Differences in WCRF/AICR scores for categorical variables with three or more categories are estimated using one-way analysis of variance (ANOVA).

Post hoc Bonferroni test: [a]between first and second; [b]between first and third; [c]between first and fourth; [d]between all groups ($p<0.05$)

*This score includes anthropometric components and was calculated with n=301

**MVPA component was excluded from both scores to calculate these differences

†Includes respondents who smoke non-tobacco products

‡Risk perception score was categorised into three data-driven tertiles, ranging from low (1) to moderate (2) to high (3) risk perception

in those experiencing little to no household hunger (p = 0.030) compared to those experiencing moderate household hunger. Regarding family history of cancer, a significant difference in mean score (excluding anthropometric component) was detected (F(2, 404) = 3.15, p = 0.044), with lower adherence occurring in participants without family history of cancer (p = 0.045), compared to those with two or more direct family members who were previously or currently diagnosed with cancer. Finally, mean score (excluding anthropometric component) differed by risk perception score (F(2, 404) = 5.10, p = 0.007), with higher adherence occurring in participants with high risk perception compared to those with low risk perception (p = 0.005).

Results for multivariable regression analysis are shown for both overall adherence score and adherence score (excluding anthropometric component) in Tables 4a and 4b respectively. Model results are for overall sample and according to sex. The regression model for the whole sample was significant for both the overall score (R^2 = 0.16, F(23, 271) = 2.27, p = 0.001) and the score (excluding anthropometric component) (R^2 = 0.16, F(23, 375) = 3.10, p = 0.000). Sex-specific models for both scores were also significant: overall score for males (R^2 = 0.39, F(23, 82) = 2.24, p = 0.004) and females (R^2 = 0.24, F(23, 164) = 2.25, p = 0.002); score (without anthropometric component) for males (R^2 = 0.22, F(23, 133) = 1.67, p = 0.039) and females (R^2 = 0.20, F(23, 217) = 2.32, p = 0.001).

A higher overall adherence score was significantly associated with the 30-39 (β = 0.27, 95% CI = [0.00, 0.54]) and 50-55 (β = 0.44, 95% CI = [0.13, 0.76]) age groups, compared to the 20-29 age-group; living in low-SES area (β = 0.42, 95% CI = [0.08, 0.76]), compared to moderate-SES area; being employed in the last 12 months (β = 0.29, 95% CI = [0.03, 0.55]); earning R5000 (β = 0.39, 95% CI = [0.14, 0.65]), compared to earning R1000; and believing that bowel cancer is controllable if detected early (β = 0.27, 95% CI = [0.04, 0.51]). A lower overall adherence score was significantly associated with having completed secondary level education (β = -0.29, 95% CI = [-0.53, -0.05]), compared to having no schooling or completed primary level; and being currently employed (β = -0.36, 95% CI = [-0.66, -0.06]). Some notable differences were observed between males and females according to the sex-specific models. A lower adherence score was significantly associated with the 40-49 age-group for males (β = -0.70, 95% CI = [-1.31, -0.09]), compared to 20-29 age-group. In contrast, a higher score was associated with all older age-groups for females, compared to 20-29 age-group. A lower score was associated with having completed secondary level education for females only, whereas a higher score was associated with living in the low-SES area for males only. The associations observed for employment status and household income were only detected for females. Likewise, the association with adherence score and believing bowel cancer is controllable if detected early was found for males only. A higher score was significantly

associated with having been screened for cancer in the last 12 months for both males (β = 0.56, 95% CI = [0.08, 1.04]) and females (β = 0.24, 95% CI = [0.00, 0.48]). Several significant associations not observed in the overall sample model but in the sex-specific models include a higher score being associated with experiencing moderate hunger (β = 0.52, 95% CI = [0.08, 0.95]) for males only, compared to experiencing little to no hunger; and a higher score being associated with believing that drinking alcohol increases risk of cancer (β = 0.33, 95% CI = [0.08, 0.58]) for females only.

A higher adherence score (excluding anthropometric component) was significantly associated with the 50-55 year age-group (β = 0.39, 95% CI = [0.15, 0.63]; believing that bowel cancer is controllable if detected early (β = 0.19, 95% CI = [0.01, 0.37]); and having high risk perception (β = 0.21, 95% CI = [0.01, 0.40]), compared to having low risk perception. A lower score was significantly associated with having completed secondary level education (β = -0.20, 95% CI = [-0.38, -0.02]); and currently smoking (β = -0.22, 95% CI = [-0.39, -0.06]). According to sex-specific models, a higher score was significantly associated with the 30-39, 40-49, and 50-55 year age-groups, believing that bowel cancer is controllable if detected early, believing that drinking alcohol increases risk of cancer, and having been screened for cancer in the last 12 months, for females only. A lower score was significantly associated with currently smoking (β = -0.43, 95% CI = [-0.70, -0.16]), and a higher score was significantly associated with having high risk perception, for males only.

Sensitivity analyses

No significant difference in score (excluding anthropometric component) was found between participants with and without body weight measurements, thus indicating overall comparability regarding the remaining adherence score components. Also, no difference was found in the proportion of males and females.

Table 4a. Results of multivariable linear regression models investigating associations of the World Cancer Research Fund/American Institute of Cancer Research (WCRF/AICR) continuous adherence score with socio-demographic/SES, psychosocial, and other cancer-related health factors for the overall sample and according to sex.

WCRF/AICR adherence score (continuous)	Overall[1] (n=294)			Male[1] (n=105)			Female[1] (n=188)		
	β	P	(95% CI)	β	P	(95% CI)	β	P	(95% CI)
Sex									
Female	-0.16	0.167	(-0.40, 0.07)	n/a	n/a	n/a	n/a	n/a	n/a
Age category									
20-29	Ref.			Ref.			Ref.		
30-39	0.27	0.046	(0.00, 0.54)	0.05	0.871	(-0.51, 0.60)	0.36	0.024	(0.05, 0.68)
40-49	0.15	0.320	(-0.15, 0.46)	-0.70	0.025	(-1.31,-0.09)	0.51	0.007	(0.14, 0.88)
50-55	0.44	0.006	(0.13, 0.76)	-0.06	0.851	(-0.40, 0.61)	0.49	0.011	(0.11, 0.86)
Education level									
No schooling or primary complete	Ref.			Ref.			Ref.		
Secondary complete	-0.29	0.017	(-0.53, -0.05)	-0.09	0.694	(-0.54, 0.36)	-0.40	0.006	(-0.68,-0.12)
Tertiary complete	-0.14	0.371	(-0.46, 0.17)	-0.14	0.588	(-0.64, 0.36)	-0.10	0.655	(-0.52, 0.33)
Residential location (SES level)									
Moderate	Ref.			Ref.			Ref.		
High	-0.12	0.624	(-0.52, 0.27)	-0.45	0.188	(-1.13, 0.23)	0.12	0.646	(-0.36, 0.58)
Low	0.42	0.027	(0.08, 0.76)	0.92	0.011	(0.22, 1.62)	0.30	0.138	(-0.10, 0.69)
Currently employed									
Yes	-0.36	0.018	(-0.66, -0.06)	-0.16	0.499	(-0.64, 0.32)	-0.55	0.006	(-0.94,-0.16)
Employed in last 12 months									
Yes	0.29	0.029	(0.03, 0.55)	0.30	0.226	(-0.19, 0.78)	0.41	0.008	(0.11, 0.71)
Household income[2]									
R1000	Ref.			Ref.			Ref.		
R5000	0.39	0.003	(0.14, 0.65)	0.10	0.668	(-0.38, 0.59)	0.35	0.028	(0.04, 0.66)
R5001-10000	0.15	0.394	(-0.19, 0.49)	-0.11	0.708	(-0.67, 0.46)	0.20	0.356	(-0.23, 0.64)
R10000+	0.29	0.115	(-0.07, 0.66)	0.17	0.540	(-0.39, 0.74)	0.02	0.944	(-0.49, 0.52)
HHS category									
Little to no household hunger	Ref.			Ref.			Ref.		
Moderate household hunger	0.17	0.127	(-0.05, 0.40)	0.52	0.021	(0.08, 0.95)	0.14	0.294	(-0.12, 0.40)
Severe household hunger	0.19	0.290	(-0.16, 0.55)	-0.02	0.958	(-0.75, 0.71)	0.24	0.242	(-0.16, 0.64)
Currently smoking									
Yes	-0.09	0.402	(-0.30, 0.12)	-0.35	0.072	(-0.73, 0.03)	-0.01	0.923	(-0.29, 0.27)
Family history of cancer									
None	Ref.			Ref.			Ref.		
One family member	0.13	0.283	(-0.11, 0.38)	0.11	0.603	(-0.30, 0.52)	0.26	0.082	(-0.03, 0.56)
Two or more family members	0.22	0.243	(-0.15, 0.58)	0.64	0.242	(-0.44, 1.71)	0.06	0.746	(-0.32, 0.44)
Bowel cancer is controllable if detected early									
Yes	0.27	0.022	(0.04, 0.51)	0.65	0.006	(0.19, 1.11)	0.23	0.094	(-0.04, 0.51)

Drinking alcohol, even in moderation, increases the risk of cancer									
Yes	0.11	0.281	(-0.09, 0.32)	-0.20	0.269	(-0.57, 0.16)	0.33	0.009	(0.08, 0.58)
Being overweight can help protect against cancer									
No	-0.31	0.153	(-0.73, 0.12)	-0.57	0.074	(-1.20, 0.06)	0.03	0.926	(-0.56, 0.61)
Risk perception score tertiles									
1	Ref.			Ref.			Ref.		
2	0.19	0.111	(-0.04, 0.42)	0.30	0.174	(-0.13, 0.73)	0.10	0.462	(-0.17, 0.37)
3	0.09	0.477	(-0.16, 0.35)	0.33	0.151	(-0.12, 0.77)	-0.14	0.371	(-0.46, 0.17)
Cancer screening in last 12 months									
Yes	n/a	n/a	n/a	0.56	0.023	(0.08, 1.04)	0.24	0.051	(0.00, 0.48)

Abbreviations: SES, socioeconomic status; HHS, household hunger scale; β, unstandardized regression coefficient; P, p-value; CI, confidence interval; Ref., reference.

[1]Regression coefficients indicate the difference in mean WRCF/AICR adherence score between groups when compared to reference group for each explanatory variable while controlling for all other variables in the model. Models were run separately for overall sample and according to sex.

Table 4b. Results of multivariable linear regression models investigating associations of the World Cancer Research Fund/American Institute of Cancer Research (WCRF/AICR) continuous adherence score, when anthropometric (AM) components are excluded from the score, with socio-demographic/SES, psychosocial, and other cancer-related health factors for the overall sample and according to sex.

WCRF/AICR adherence score -excluding AM (continuous)	Overall[1] (n=398)			Male[1] (n=156)			Female[1] (n=241)		
	β	P	(95% CI)	β	P	(95% CI)	β	P	(95% CI)
Sex									
Female	0.10	0.255	(-0.07, 0.27)	n/a	n/a	n/a	n/a	n/a	n/a
Age category									
20-29	Ref.			Ref.			Ref.		
30-39	0.20	0.059	(-0.01, 0.41)	0.11	0.583	(-0.28, 0.49)	0.27	0.044	(0.01, 0.53)
40-49	0.19	0.108	(-0.04, 0.42)	-0.14	0.495	(-0.55, 0.27)	0.42	0.007	(0.12, 0.73)
50-55	0.39	0.001	(0.15, 0.63)	0.21	0.350	(-0.24, 0.67)	0.42	0.007	(0.12, 0.72)
Education level									
No schooling or primary complete	Ref.			Ref.			Ref.		
Secondary complete	-0.20	0.031	(-0.38, -0.02)	-0.15	0.351	(-0.47, 0.17)	-0.24	0.041	(-0.47, -0.01)
Tertiary complete	-0.05	0.547	(-0.19, 0.30)	0.07	0.694	(-0.30, 0.45)	0.04	0.824	(-0.32, 0.40)
Residential location (SES level)									
Moderate	Ref.			Ref.			Ref.		
High	0.02	0.869	(-0.27, 0.32)	0.06	0.808	(-0.43, 0.55)	0.08	0.673	(-0.30, 0.46)
Low	0.12	0.342	(-0.13, 0.37)	0.46	0.080	(-0.06, 0.97)	0.04	0.807	(-0.27, 0.34)
Currently employed									
Yes	-0.11	0.333	(-0.34, 0.11)	-0.04	0.816	(-0.40, 0.31)	-0.17	0.278	(-0.48, 0.14)
Employed in last 12 months									
Yes	-0.01	0.894	(-0.19, 0.22)	0.05	0.777	(-0.30, 0.40)	0.05	0.687	(-0.20, 0.31)
Household income									
R1000	Ref.			Ref.			Ref.		
R5000	0.14	0.162	(-0.05, 0.33)	0.13	0.414	(-0.19, 0.46)	0.07	0.593	(-0.18, 0.32)
R5001-10000	-0.09	0.513	(-0.34, 0.17)	-0.20	0.332	(-0.62, 0.21)	-0.03	0.876	(-0.37, 0.31)
R10000+	0.02	0.893	(-0.26, 0.30)	0.04	0.841	(-0.37, 0.45)	-0.14	0.527	(-0.57, 0.29)
HHS category									
Little to no household hunger	Ref.			Ref.			Ref.		
Moderate household hunger	0.07	0.438	(-0.11, 0.24)	0.23	0.179	(-0.12, 0.56)	0.06	0.557	(-0.15, 0.28)
Severe household hunger	0.19	0.198	(-0.10, 0.47)	-0.14	0.626	(-0.70, 0.42)	0.26	0.138	(-0.09, 0.61)
Currently smoking									
Yes	-0.22	0.007	(-0.39,-0.06)	-0.43	0.002	(-0.70, -0.16)	-0.13	0.267	(-0.36, 0.10)
Family history of cancer									
None	Ref.			Ref.			Ref.		
One family member	0.01	0.910	(-0.18, 0.21)	-0.07	0.663	(-0.41, 0.26)	0.10	0.413	(-0.14, 0.35)
Two or more family members	0.16	0.254	(-0.12, 0.44)	0.16	0.607	(-0.44, 0.75)	0.07	0.682	(-0.26, 0.40)
Bowel cancer is controllable if detected early									
Yes	0.19	0.040	(0.01, 0.37)	0.14	0.383	(-0.17, 0.45)	0.26	0.031	(0.02, 0.49)

Drinking alcohol, even in moderation, increases the risk of cancer									
Yes	0.12	0.143	(-0.04, 0.27)	-0.08	0.571	(-0.34, 0.19)	0.23	0.028	(0.02, 0.43)
Being overweight can help protect against cancer									
No	-0.20	0.199	(-0.51, 0.10)	-0.35	0.135	(-0.81, 0.11)	-0.01	0.954	(-0.43, 0.41)
Risk perception score tertiles									
1	Ref.			Ref.			Ref.		
2	0.10	0.288	(-0.08, 0.27)	0.21	0.193	(-0.12, 0.53)	0.00	0.997	(-0.22, 0.22)
3	0.21	0.039	(0.01, 0.40)	0.46	0.005	(0.14, 0.78)	0.03	0.842	(-0.24, 0.29)
Cancer screening in last 12 months									
Yes	n/a	n/a	n/a	0.16	0.392	(-0.20, 0.51)	0.27	0,009	(0.07, 0.47)

Abbreviations: SES, socioeconomic status; HHS, household hunger scale; β, unstandardized regression coefficient; P, p-value; CI, confidence interval; Ref., reference.
[1]Regression coefficients indicate the difference in mean WRCF/AICR adherence score between groups when compared to reference group for each explanatory variable while controlling for all other variables in the model. Models were run separately for overall sample and according to sex.

Discussion

This study adds to the limited knowledge base in South Africa of levels of adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations and associated factors. It involves both men and women, using the newly updated recommendations and standardised scoring algorithm, thus allowing comparison with present and future studies that use the same system.

In this population, a low adherence to the WCRF/AICR Cancer Prevention Recommendations was observed for both the overall score and score excluding the anthropometric measurements (BMI and waist circumference). When investigating adherence to individual recommendations, high levels of non-adherence were seen for overweight and obesity (especially among women), and several nutrition-related behaviours, including low consumption of fruit and vegetables and dietary fibre and high consumption of SSBs. More than a third of participants did not meet the minimum MVPA guideline (less than 75 min/week) and nearly a quarter did not meet the alcohol consumption guideline (higher among men). Surprisingly, most participants practiced moderate to high adherence for red and processed meat and UPF recommendations. There were some notable differences in adherence between men and women.

There is a limited body of evidence investigating adherence to the WCRF/AICR Recommendations in South Africa and for Black African populations in general. The two previous studies also reported low adherence to WCRF/AICR cancer guidelines in South Africa (26,27). Jacobs et al. observed very low levels of adherence to the recommendation for healthy weight (over 80% of women had a BMI of >25 kg/m^2), in addition to the physical activity, fruit and vegetable, dietary fibre, and ultra-processed food recommendations among Black African, urban women living in Soweto, although relatively low levels of alcohol consumption were seen. As expected, adherence to the alcohol guidelines was significantly higher in women compared to men. Levels of alcohol consumption was comparable to other South African studies (17), with almost half of participants reporting drinking alcohol, although higher than national estimates for women in South Africa (17).

In the current study there was a surprisingly low intake of ultra-processed foods. In the FFQ, a wide range of foods were included in a single item for the UPFs category, including sweet and savoury high-fat snack food categories. Participant responses may have reflected low levels of sweets consumption, while masking higher intakes of other processed foods. Given that a third of our sample reported food insecurity, it is also possible that limited household income was spent on staples which are energy dense but do not include sweets and cakes.

In addition, it could be that participants under-reported for this item. However, while research has shown that single summary questions tend to underestimate absolute intake levels compared to estimates from summed individual food items, relative ranking of individuals within a population is less affected and both methods have proven to be suitable under certain conditions (88,89). Given that high rates of intake of other energy dense processed foods like fast foods, and comparatively lower intake of sweet and salty snacks, have been reported in South African township communities (4–8), our finding needs to be interpreted with caution as a comprehensive measure of adherence to ultra-processed food guidelines. Levels of SSB intake were comparable to those found in other studies (10,11).

Several demographic and SES factors were associated with lower adherence to the overall WCRF/AICR score in this study, including younger age, secondary level education , high food security , and living in moderate-SES area . Upon adjusting for other demographic, SES, cancer-related beliefs and risk perception, and other cancer-related health factors, including family history of cancer and smoking status, younger age, secondary level education, high food security (for men only), current employment, and residing in moderate-SES area were associated with lower adherence. Earning R5000(US$341) (vs R1000(US$69)) and past employment were associated with higher adherence to the overall score. Males differed to females in that the 40-49 year age-group (vs 20-29 year age-group) was associated with lower adherence. Of these, only secondary level education and younger age remained significant in relation to the score excluding the anthropometric component. The differences between the two scores may partly be explained by body weight driving the additional associations observed in relation to the overall score. Our sensitivity analyses suggest that participants with and without anthropometric measurements are comparable with respect to the remaining adherence score components and sex. However, the possibility of other sub-group differences was not accounted for.

There is a scarcity of studies investigating adherence to cancer prevention guidelines across different SES strata in LMICs. A study involving 18 African countries observed wide variation in adherence to WCRF/AICR prevention guidelines across socio-demographic/SES population sub-groups (26). While this study reported an overall connection between residing in lower SES households and reduced adherence, important regional differences were observed. For instance, in urban settings, this relationship was not statistically significant for men and the reverse pattern was observed for women, possibly due to greater exposure to advertisements of high-fat foods, cigarettes, and alcohol in higher SES households, and easier access to these products, in urban areas, compared to rural areas.

Additional explanations could also account for the association between lower adherence and several indicators of higher SES observed in our study. Due to rapid urbanisation and nutritional transition occurring in developing countries, lower SES populations are experiencing higher burdens of unhealthy lifestyles (35,36). However, important SES gradients in lifestyle trends persist within these countries. For instance, according to McLaran (90), prevalence in overweight and obesity typically begins to shift to lower SES groups as countries develop economically, with shifts often occurring earlier for women compared to men (34). In South Africa, overweight and obesity are still largely associated with higher SES, although this relationship is attenuated in women (91,92). This has been largely attributed to more affluent populations consuming a surplus of energy-dense foods, combined with higher rates of sedentary behaviour. The finding by Goetjes et al. (92) that tertiary education had a decreasing effect on obesity, particularly for women, may partly explain the lack of significant association observed for tertiary education in our study. As these authors highlight, this could be due to more highly educated individuals having the advanced skills to interpret health-related information and overall decision-making ability with respect to health and nutrition. Notable variations in dietary lifestyle have also been shown to occur within disadvantaged communities in South Africa. One study investigating obesogenic environments in a large township community, found high levels of ultra-processed food consumption, although households experiencing income deprivation within the community consumed far less (40).

It is unclear why no clear patterns were observed for higher income levels in our study. This could be due to how participants answered this question, or to the overall low levels of household income in our sample. Higher fast food and SSB intake among higher SES groups in South Africa has been reported elsewhere (93). It is important to note however, that local fast food variants are increasingly becoming affordable to poorer individuals and the young, especially in 'township' communities, where there is a large number of informal food vendors (94). Alarmingly, as Feeley et al. demonstrate, fast food intake is already higher among South African adolescents living in poorer urban environments compared to their American counterparts, likely due to them spending their disposable income differently (94). Making healthier dietary options such as fruits and vegetables more affordable and accessible in these communities will be important to combat the rising NCD burden. Additional bivariate analyses of our data to determine relationships between SES indicators and individual WCRF/AICR recommendations have shown some of the patterns discussed here.

Important cancer-related health behaviours were found to be associated with adherence in both our unadjusted and adjusted analyses. Being a current smoker was associated with lower

adherence to the score without the anthropometric component, for men only, and being recently screened for cancer was associated with higher adherence to both scores. Furthermore, holding certain cancer-related beliefs and having higher risk perception was associated with higher adherence depending on sex and the score. The relationship between smoking status and lower adherence score (excluding anthropometric component) could partly be explained by the fact that smoking substantially increases the odds of drinking alcohol at any amount and of binge drinking for both genders (17). The absence of an association between smoking and adherence for the overall score could reflect the complex relationship that exists between smoking behaviour and body weight (12). It is promising that cancer screening behaviour seems to be associated with higher adherence to the WCRF/AICR recommendations, although additional work is needed to verify the predictive potential of adherence regarding screening behaviour. Higher risk perceptions have been shown to drive various cancer-related health behaviours (43,72,95). Further research in these communities is needed to understand why high risk perception was associated with higher adherence for men only in our study. Longitudinal studies investigating the mechanisms underlying the interplay between cancer-related lifestyle risk, risk perception and beliefs, and screening behaviour could be especially informative.

This study has several important limitations. Due to the cross-sectional study design, no conclusions can be drawn regarding causality between adherence to WCRF/AICR recommendations and associated factors. While objective measures were used to assess body weight, self-report measurements were used to assess dietary intake and other health behaviours, and hence the possibility of recall and social desirability bias cannot be altogether excluded. Although risk perception and cancer-related beliefs were measured, other important theoretical constructs that may help explain behavioural phenomena were not accounted for in this study.

The use of the evidence-based CANSA Lifestyle Risk Assessment Tool shows promise as a means to collect comprehensive data on cancer-related lifestyle behaviour. However, the tool has not been formally tested for reliability and validity in this population. Due to a programming error, we were not able to detect MVPA levels of >150min/week. However, only 5-6% of women reported these levels of MVPA in a study conducted recently in a similar population with a similar age range (27), a pattern also observed elsewhere (96). It is therefore plausible that the degree of underestimation in our study is not high. Whether this holds for men is less certain. However, while often higher compared to women, low levels of MVPA have also been reported for males, with almost 50% of males classified as not physically active in one South

African study (97). Furthermore, as highlighted earlier regarding our measurement of ultra-processed food intake, measuring individual food and beverage items within different categories was not always possible. Additionally, due to frequency category configuration, this study may have underestimated alcohol consumption, while overestimating fruit and vegetable, dietary fibre, red and processed meat, and SSB consumption. To illustrate, high-adherence to the WCRF/AICR red and processed meat recommendation (red meat <500 and processed meat <21 g/week) could not be assessed due to the measurement of processed meat intake of <21g/week, which practically accounts for trace amounts of processed meat (25), not being possible. This is due to the lowest consumption category being 'three or less' portions per week. The mid-point for this range was taken (1.5) and multiplied by the estimated standard portion sizes of 100g and 30g for red and processed meat, respectively, to obtain g/week equivalents. Hence 45g/week was the lowest amount measurable for processed meat in this study. However, due to the national average of processed meat intake being 12g per capita daily (98), which translates to 84g/week, in addition to relatively high consumption in townships (94), the degree of overestimation was likely not high. Despite these factors, our study generally shows comparable levels of consumption with other studies.

It has been reported that the use of asset-based measures are a more effective way of measuring SES in LMICs, compared to individual income and education (99). Moreover, differing patterns between males and females in how SES relates to different NCD lifestyle risk factors have been observed depending on the SES indicator in question (90). Therefore, it is possible that additional insights into this relationship might have been observed had we used additional SES measures. Due to time and resource constraints, we were not able to achieve the target sample size of 500. There was also a high non-response rate for anthropometric measurements and among those living in the high-SES residential area. This is partly due to data collection taking place during the COVID-19 pandemic as this was often cited as a reason for non-response. This, in addition to the lower response rate among men, resulted in small sample sizes in high-income and high-SES residential sub-categories, probably lacking sufficient statistical power to detect any potential associations. Notwithstanding this, our sample size was generally appropriate for the analyses conducted. Finally, interviews were conducted during the week and a limited number on weekends, due to fieldworker constraints. Hence, while current employment rates were comparable to another recent township-based study (16), the number of employed persons may have been under-represented in our sample.

In conclusion, low adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations was observed in this black urban population, with younger age, higher SES, and smoking associated with lower adherence. Low to moderate levels of adherence to the individual WCRF/AICR recommendations on being at a healthy weight, being physically active, consuming more fruits and vegetables and dietary fibre, and limiting consumption of sweet and sugar beverages and alcohol was observed, with differing patterns for men and women. Overall adherence to recommendations was associated with high risk perception and several cancer-related beliefs, as well as cancer screening behaviour. Future programmes should encourage adherence to both the overall 2018 WCRF/AICR Recommendations and key individual recommendations to promote long-term health, targeting individuals who are younger, have higher SES, have low risk perception, who have not screened for cancer, and who smoke, while accounting for differences between men and women.

Chapter 4 – Additional analyses

To assess potential relationships between SES indicators and individual WCRF/AICR recommendations, additional bivariate analyses of our data were performed. Chi-squared analyses found that lower adherence to the waist circumference guideline was associated with higher education level for males (p=0.005), while current employment was associated with lower adherence to the SSB guideline (p=0.013) for females. Previous employment (while not currently employed) was associated with higher adherence to the fruit and vegetable (p=0.040), and waist circumference (p=0.002) guidelines, which may partly explain the discrepancy between current and past employment in our models. Lower adherence to the alcohol guideline was strongly associated with higher household income category (p=0.000), education level (p=0.001), and living in a higher affluence residential area (p=0.006).

Although testing these associations while controlling for other variables was not carried out, it would be possible to do with our data and could yield some additional insights into the patterns observed in our current models, potentially starting to disentangle the individual recommendation effects. Nevertheless, these additional results do appear to resonate with some of our overall study findings. Further research is required to improve understanding of how adherence to both overall WCRF/AICR recommendations and individual recommendations is influenced by different factors. Longitudinal studies could strengthen evidence for key predictors of adherence at different levels, among different groups, thus enabling future interventions to target important lifestyle elements more effectively and efficiently.

Chapter 5 – Conclusions and recommendations

In conclusion, low adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations was observed in this urban population, with younger age, higher SES, and smoking associated with lower adherence. Low to moderate levels of adherence to the individual WCRF/AICR recommendations on being at a healthy weight, being physically active, consuming more fruits and vegetables and dietary fibre, and limiting consumption of sweet and sugar beverages and alcohol was observed, with differing patterns for men and women. Although findings were mixed, overall adherence to recommendations was associated with high risk perception and several cancer-related beliefs, as well as cancer screening behaviour.

The 2018 WCRF/AICR Recommendations provide a valuable framework to measure the healthiness of an individual's lifestyle and future programmes should aim to promote adherence to these guidelines to improve long-term health and to help prevent both cancer and other NCDs. According to our findings, programmes should be tailored to those at higher risk in low-income urban settings, including individuals who are younger, have higher SES, have low risk perception, who have not screened for cancer, and who smoke, while accounting for differences between men and women. However, it is essential that interventions go beyond individual behaviour-change to address the broader living environments in which people make lifestyle choices, thus making healthy choices more accessible. This includes the urgent need to target the food environment, which is becoming increasingly obesogenic in many urban contexts in South Africa (100). Fast-food outlets and informal street vendors that sell highly processed and energy-dense foods and beverages, which are often cheaper than healthier items (101), play a major role in daily provisioning within lower-income communities in the more urbanised parts of South Africa, such as Gauteng province (100). Policy interventions that limit the number of fast-food outlets, lower the price of healthy foods, and increase the cost of unhealthy items, while limiting their advertising, could help address some of these environmental factors, and have already shown positive results in regards to SSB consumption (102). Beyond the food environment, urban designing and social mobilisation at the municipal level that promotes physical activity, especially among women, are needed. In addition, multi-faceted interventions to reduce alcohol abuse continue to be essential, including pricing and marketing policies, drink-driving countermeasures, and community awareness campaigns. While it is beyond the scope of this study to delve further into the complex structural factors that inhibit healthy living, and the strategies to address them, multi-

sectoral collaboration and multi-level interventions will undoubtedly prove key to ensure a healthier population in the future.

Regarding the CANSA Life Risk Assessment Tool, re-configuring frequency categories for certain dietary intake items could assist with obtaining higher-resolution low-end and high-end estimates of intake depending on item. In addition, measuring intake of common food-types within food categories separately might assist with identifying varying intake patterns within overall food groups. For example, measuring common ultra-processed food items separately and including a measure of intake amount, as opposed to just frequency, could yield more reliable results. Likewise for meat intake, measuring red and processed meat consumption separately could help differentiate intake patterns. Finally, framing questions in terms of level of adherence, rather than level of risk, could help minimise potential risk denial while increasing self-efficacy, as explained in the Extended Parallel Processing Model (103,104).

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Appendix 1: *International Journal of Cancer (IJC)* author guidelines

1. MANUSCRIPT PREPARATION

IJC asks authors to ensure that their manuscript meets the journal's formal requirements as concerns presentation, formatting, and other accompanying documentation upon submission. In the event that papers do not fulfill these formal requirements, the editorial staff will "unsubmit" the manuscript. Authors will be asked to either upload files as needed or correct/revise the paper accordingly. Peer review will not commence until all requirements have been met.

1.1 Manuscript text

All manuscripts should be written in good English and clear phrasing (either British or American spelling). English language editing might be required before the paper is taken into consideration. We strongly suggest that authors who are not native speakers of English have their papers edited before submission. The text file should be in .doc, .docx or .rtf format and start with a title page including short title, full list of authors and affiliations, corresponding author name, affiliation, valid institutional e-mail, and Twitter handles if available, three to five key words, a list of abbreviations used (in alphabetical order), and the appropriate article category. The abbreviations should also be defined the first time they are mentioned in the abstract and text. Research Articles, Special Reports and Short Reports should also include a brief description (max. 75 words) of the "Novelty and Impact" of the work on the title page of the paper. Upon acceptance, this will be edited and presented within the article as "What's New". All manuscripts except Letters should also contain an unstructured abstract (no sub-headings/sections, maximum 250 words).

1.1.1 Research Articles and Short Reports

Research Articles and Short Reports should follow the IMRAD format (Introduction, Materials and Methods, Results, and Discussion). If appropriate, the results and discussion may be written as one section. Acknowledgments and further disclosures (i.e. conflict of interest, data availability statement and, if applicable ethics statement, disclaimer, funding, etc), References, Figure Legends, and Tables follow the body of the text.

Research Articles should not exceed 5,000 words in length (body of the text from Introduction to Discussion/Conclusions) and may contain a maximum of 50 references and 6 tables/figures in total. For Short Reports, these limitations are 2,500 words, 25 references, and 3 tables/figures in total. Please note that page charges are applied to articles which exceed 8 typeset pages (see 8.1).

1.1.2 Reviews

Reviews should not exceed 4,000 words in length (from Introduction to Discussion/Conclusions) and should be limited to a maximum of 6 tables/figures in total. There is no limit on the number of references.

1.1.3 Letters to the Editor

Letters should report the title of the Letter and begin with “Dear editor”. In case it refers to a published paper, the title should be “Comments on <title of the original paper>” and Replies to Letters should be entitled “Reply to: Comments on <title of the original paper>. A list of abbreviations, statements, the full list of authors and affiliations, and corresponding author contact information should appear at the end of the text. Length should not exceed 1,000 words plus 1 figure or table and 10 references. An abstract is not required.

1.1.4 Special Reports

These papers are generally commissioned by the Editors. The main text should not exceed 2500 words in length and the paper should be limited to 25 references and 3 tables/figures in total. Acknowledgments and further disclosures (i.e. conflict of interest, disclaimer, funding, etc), References, Figure Legends, and Tables follow the body of the text. Additional individual guidance in preparing the reports will be given.

1.2 References

References are listed in a separate reference section immediately following the text. Follow Index Medicus[2] for standard journal abbreviations (please see examples below). Number references sequentially in the order cited in the text; do not alphabetize. A reference cited only in a table or figure is numbered in the sequence established by the first mention in the text of the table or figure containing the reference. The corresponding author is responsible for verifying the references that are cited.

Reference to a personal communication or to work in preparation or submitted for publication, is discouraged. However, if such a reference is essential and refers to a written communication, the source is cited parenthetically in the text (not in the reference section) with the comment "unpublished data" or "personal communication”. Written permission from the source that is cited must be sent to the Editorial Office. Reference to a paper accepted but not yet published is listed in the reference section as “in press”. “In press” references must be updated by the authors as soon as publication data are available. Preprints, including the DOI, should be cited in a separate reference list named “Posted on preprint servers”.

For review, please provide names of ALL authors in the reference list. At proof stage, however, this will be reduced to 3 names to accommodate our print publication layout. Upon request, the Editorial Office can provide authors with an Endnote style sheet or it can be downloaded via the quick link above.

References to journal articles shall include: ALL authors, article title and subtitle, journal abbreviation, year, volume number in Arabic numerals, and inclusive pages and appear in that order:

1. Ferlay J, Soerjomataram I, Dikshit R, Eser S, Mathers C, Rebelo M, Parkin DM, Forman D, Bray F. Cancer incidence and mortality worldwide: Sources, methods and major patterns in GLOBOCAN 2012. Int J Cancer 2015; 136: E359–E386

Book references are listed as follows: authors, title, edition (if other than the first), volume (if more than one), city, publisher, year, pages:

2. Sobin LH, Gospodarowicz MK, Wittekind C, eds. TNM classification of malignant tumors, 7th ed. Chichester: Wiley, 2010. 310p

When referencing a book chapter, the order changes as follows: authors of the chapter, title of the chapter, "In:" editors/authors of the book, title of the book, edition (if there are more than one), volume (if there are more than one), city, publisher, year, and inclusive pages of the chapter:

3. Stilgenbauer S,Lichter P,Döhner H.Genetics of B-Cell Chronic Lymphocytic Leukemia. In: Faguet GB. Chronic Lymphocytic Leukemia: Molecular Genetics, Biology, Diagnosis, and Management. Heidelberg: Springer 2004:57–75

1.3 Tables

Tables can be included at the end of the “main document” or submitted as separate files. They are numbered using Arabic numerals. Submit tables in .doc, .docx or .rtf format, exceptionally as .xls or .xlsx for Supplementary Material. All tables should be cited in the text. Each table requires a separate legend.

1.4 Figures

Authors should upload high-quality figures. It is recommended to create the figures in the preferred format required when the paper is accepted:

Line art (graphs, flowcharts, diagrams, scatter plots, and other text-based figures that are not tables) in PDF and 600 – 1000 dpi.

Images (photographs, drawings, imaging system outputs (such as MRIs or ultrasound), and other graphical representations) in TIFF or EPS and 300 dpi.

If a figure includes both, line art and images, the line art requirements apply.

For exceptions during peer review and further details please see: https://authorservices.wiley.com/asset/photos/electronic_artwork_guidelines.pdf).

Figures should be numbered using Arabic numerals. Helvetica or Arial font should be used for any text in the figures, and different panels should be labeled with capital letters in parentheses (i.e., (A), (B), etc.). All figures, including supplementary figures, should be cited in the text and require a separate legend.

All color figures will be reproduced in full color in the online edition of the journal at no cost to authors. Authors are requested to pay the cost of reproducing color figures in print (see 8.2).

Electrophoretic gel/blots, Photomicrographs and Flow cytometry plots

Any processing and modifications should be disclosed to the editors, who could require the original source data or images at submission or any time during or after the review process. Information present in the original images, however, should not be eliminated, and adjustments of brightness, contrast, or color can be accepted only if applied to the whole

image. Grouping of images from different gels or different parts of a gel should be made explicit (e.g. by drawing a line) and stated in the legend. Loading controls must be run on the same gel/blot as the experimental samples. Repeated presentation of data in the manuscript must be clearly declared.

IJC has introduced a procedure of checking manuscripts to ensure the integrity of the data presented in the figures. Authors should be prepared to upload original source data as "Supplementary Material not for review" upon request:

• For all immunoblot images: clearly labeled uncropped, unprocessed original blots including molecular weight markers in one pdf-file. Please make sure that original data of proper loading controls originating from the same gel/blot like the experimental samples are provided as well, even when in the manuscript figure only one representative loading control is shown.

• For photomicrographs: uncropped, unprocessed images including scale bars.

• For flow cytometry plots: raw data underlying flow cytometry plots, as well as a brief description on how data from the raw files were analyzed (e.g. gating strategy) and further processed for creation of the final figure (usage of image editing software for final layout).

1.5 Graphical Abstract

Authors are encouraged to submit a Graphical Abstract as part of their submission to help communicate the findings in the paper. If they are unable to provide one, they can also submit an exisiting figure from their manuscript or a study flowchart. Please upload the image under the file designation 'Graphical Abstract'.

The Graphical Abstract should be designed to read online in conjunction with the "What's New" section. It should be approximately square, ideally in color and contain a high impact Figure, Graph, or Photograph that summarizes the key findings of the research. Keep it simple. Avoid tables, raw primary data or distracting cluttering components. The resolution requirement is minimum 300 dpi. The Graphical Abstract should include text in the form of labels and short phrases. Images of patients' faces should not be included. The Graphical Abstract will be placed in the online article format and not in print. It might also be used in our social media platforms.

Authors are responsible for obtaining permission to use any images that they include from outside sources, inlcuding articles, web pages, stock photo sites or Google image searches. Any needed permissions must be submitted along with your graphical abstract or identified in the Acknowledgements section of your manuscript.

1.6 Supplementary Material

Material that is not suitable for print publication such as very long tables, extensive descriptions of already published methods, database information, movies, etc., can be published online as additional supporting information. The final decision to do so, however, lies with the editors. Please submit PDF files for this material; excel tables and movies are also acceptable.

Appendix 2: Questionnaire

CANCER KNOWLEDGE, PERCEPTION, INTENTION TO SCREEN, AND LIFESTYLE RISK HOUSEHOLD SURVEY - GAUTENG

(ENGLISH)

QUESTIONNAIRE

Study identification number	***[ ] [ ] [ ] [ ]***
Visit Number	***[ ]***
Interviewer name	
Date of interview	***__ __ / __ __ / 200 __*** ***D D M M Y***
Interview Site	Specify:
Start Time of Interview	***_____h_____***
Is this questionnaire, or parts of it, self-administered?	***Yes/No***

Data Entry:

First Entry: ***__ __ / __ __ / _____***
200 __ Initials
D D M M Y

Notes and Queries:

Thank you very much for agreeing to participate in this survey. The interviewer is available to help you if you have any difficulties completing the questionnaire or if there is anything you do not understand.

Every answer you give will be strictly **confidential and anonymous**.

Please take your time and relax. All the questions are about your life and your ideas. There are no right or wrong answers. **If there is a question you do not want to answer, please skip to the next question.**

SECTION 1: BACKGROUND

Let us begin. Please remember that everything you tell me will be kept secret.

NO.	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
01	How old are you?	[ ][ ]	
02	What is the highest standard or grade you have completed at school?	No schooling……..1 Primary school incomplete ……2 Primary school complete (Grade 7) ……3 High school incomplete……4 High school complete……5 Further degree/Qualification incomplete…6 Further degree/Qualification complete…..7 DON'T KNOW……..8	
03	Are you currently studying?	YES..... 1 NO..... 0	
04	With which race group do you identify?	Black/ African ……. 1 Coloured …… 2 Indian …… 3 White …… 4 Other: …… 5	

05	What is your religion, if you have one?	Christian ..... 1 Islam ..... 2 Hindu ..... 3 Judaism ..... 4 Buddhist ..... 5 None ..... 6 Other.....7 Specify:	
05**b**	What nationality are you?	South African.....1 Southern Africa.....2 African country outside Southern region..3 Other.....4 Specify:	
06	Have you worked to earn money in the last 12 months?	YES .....1 NO.....0	→09

07	How much do you earn per month, before tax, and including benefits?	R1 – R500.....1 R501 – R1000.....2 R1 001 – R2000.....3 R2001 – R5000.....4 R5001 – R10 000.....5 R10 001 – R20 000.....6 R20 000 or more.....7	
08	What kind of work do you mainly do?	Police, security or armed forces.....1 Professional.....2 Construction work.....3 Domestic worker/cleaner.....4 Driver/transportation industry ..... 5 Mining.....6 Other .....7 Specify:	
09	Do you usually work …	Throughout the year.....1 Seasonally.....2 Once in a while.....3 Never worked.....4	
10	What type of household do you live in?	RDP.....1 Shack.....2 Renting.....3 Room on someone else's property.....4 Other.....5 Specify:	
10	If you have an emergency and R300 was needed immediately, would you say it would be very easy, easy, quite difficult or very difficult to find the money?	VERY DIFFICULT.....1 QUITE DIFFICULT.....2 EASY.....3 VERY EASY.....4	

11	How many people, including all the children, live in your home?	[ ][ ]	
12	What level of schooling did your mother complete?	No schooling……..1 Primary school incomplete ……..2 Primary school complete (Grade7) ……...3 High school incomplete……4 High school complete……5 Further degree/Qualification incomplete…6 Further degree/Qualification complete…..7 DON'T KNOW……..8	
13	What level of schooling did your father complete?	No schooling……..1 Primary school incomplete ……..2 Primary school complete (Grade7) …….3 High school incomplete……4 High school complete……5 Further degree/Qualification incomplete…6 Further degree/Qualification complete…..7 DON'T KNOW……..8	
14	In the past [4 weeks], did it happen that there was no food to eat of any kind to eat in your house, because lack of resources to get food?	Never……..1 Rarely……2 Sometimes……..3 Often……..4	
15	In the past [4 weeks], did it happen that you or any household member went to sleep hungry because there was not enough food?	Never……..1 Rarely……2 Sometimes……..3 Often……..4	
16	In the past [4 weeks], did it happen that you or any household member went a whole day and night without eating anything at all because there was not enough food?	Never……..1 Rarely……2 Sometimes……..3 Often……..4	
17	How often in the past 4 weeks have you had to borrow food or money because you did not have enough?	Never……1 Once or twice……..2 Every week……..3 Everyday……..4	
18	I am frequently stressed or depressed because of not having enough work.	Strongly disagree……..1 Disagree……..2 Agree……3 Strongly agree……4	
19	I am frequently stressed or depressed because of not having enough income.	Strongly disagree……..1 Disagree……..2 Agree……3 Strongly agree……4	
SECTION 2: LIFESTYLE PRACTICES			
DIET			

20	How many portions* of vegetables (spinach, morogo, imifino, kale, cabbage, cauliflower, broccoli, brussel sprouts, carrots, butternut, sweet potatoes) do you eat daily? *One portion is 1 cup of raw vegetables like salad and ½ cup of cooked vegetables	2 or less……1 3 to 4……2 5 or more……3	
21	How many portions* of fruits do you eat daily? *One portion of fruit is 1 medium sized fruit (medium banana or tennis ball size) or 2 small fruit (like plums or apricots) or ½ cup of chopped fruit or ½ cup non-sweetened or freshly squeezed fruit juice	2 or less……1 3 to 4……2 5 or more……3	
22	How many portions* of wholegrains do you eat daily? *One portion is ½ cup of oats/ brown rice/sorghum/millet/barley/unprocessed maize meal or 1 slice of wholegrain bread (whole wheat/ rye)	2 or less……1 3 to 4……2 5 to 8……3	
23	How many times a week do you eat dry beans, lentils, splitpeas and soya?	1 or less……1 2……2 3 or more……3	
24	How many palm sized portions of red meat (beef, lamb, mutton, pork, veal, venison, goat and braai meat,) or processed meat (polony, sausages, viennas, bacon, ham, canned meat such as corned beef, deli meats such as salami, sliced cold meats, including those made from chicken and turkey) do you eat per week?	3 or less……1 4 to 5……2 6 or more……3	
25	How often do you eat sweets, chocolates, cakes, biscuits, pastries, desserts (like puddings, custard, jelly), crisps in a week?	3 or less……1 4 to 5……2 6 or more……3	
26	How many glasses of sugar sweetened cold drink, soda, fruit juice, squash, yoghurt or cereal drink daily?	1 or less……1 2……2 3 or more……3	
PHYSICAL ACTIVITY			

27	How many minutes of, at least, moderate physical activity (e.g. brisk walking, cycling, dancing, jogging slowly, gardening, physical household work, and manual work involving carrying of moderate loads, building, painting or roofing) do you do per week?	50 or less.....1 51 to 100.....2 150 or more.....3	
TOBACCO AND ALCOHOL USE			
28	Do you smoke cigarettes, cigars, pipes, e-cigarettes, hookah or hubbly bubbly or use snuff or chewable tobacco?	Yes.....1 No.....2	→30
29	If you smoke cigarettes, how many do you smoke daily or weekly?	[ ][ ]	
30	Are you directly exposed to second hand smoke (the smoke from someone who smokes very near to you) at home or at work or during travel to or from work?	Yes.....1 No.....2	
31	Do you drink alcohol (e.g. alcopops, beer, ciders, spirits (like whiskey, vodka, gin, brandy), Umqombothi, wine, etc)?	Yes.....1 No.....2	→34
WOMEN			
32	How many times a week would you have more than one standard drink of alcohol	Never.....1 2 or less.....2 3 or more.....3	
MEN			
33	How many times a week would you have more than two standard drinks of alcohol	Never.....1 2 or less.....2 3 or more.....3	
SECTION 3: CANCER KNOWLEDGE			
41	A sore that does not heal could be a sign of cancer	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
45	Being overweight can help protect against cancer	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
46	Bewitchment/witchcraft/evil spirits can make someone get cancer	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	

38	Exercise makes cancer spread faster	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
39	Drinking alcohol, even in moderation, increases the risk of cancer	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
40	Bowel cancer is controllable if detected early	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
41	A sore that does not heal could be a sign of cancer	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
34	Breast cancer is controllable if detected early	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
43	Having multiple sex partners can increase my chance of getting cervical cancer	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
44	Breast cancer tends to run in families	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
36	In South Africa lung cancer is more common among men than among women	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
37	Being exposed to dirty air or water increases the chances of getting breast cancer	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	

SECTION 4: CANCER RISK PERCEPTION

The following questions involve the facts about your chances of getting cancer during your lifetime. These questions do not involve your feelings or intuition but require a logical and rational response. Try to be as accurate and objective as possible when estimating your risk for cancer (in the same way that a doctor or researcher would look at the situation).

47	If I keep smoking, my chances of getting lung cancer at some point in my life are	Very small.....1 Small.....2 Big.....3 Very big.....4	
48	If I keep eating red or processed meat once a day or more, my chances of getting cancer at some point in my life are	Very small.....1 Small.....2 Big.....3 Very big.....4	
49	If I do not get enough exercise, my chances of getting cancer at some point in my life are	Very small.....1 Small.....2 Big.....3 Very big.....4	
50	If I do not eat enough fruit or vegetables, my chances of getting cancer at some point in my life are	Very small.....1 Small.....2 Big.....3 Very big.....4	
51	If I keep drinking alcohol, my chances of getting cancer at some point in my life are	Very small.....1 Small.....2 Big.....3 Very big.....4	
52	If I keep smoking, my chances of getting lung cancer at some point in my life are big	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
53	If I keep eating red or processed meat once a day or more, my chances of getting cancer at some point in my life are big	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
54	If I do not get enough exercise, my chances of getting cancer at some point in my life are big	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
55	If I keep drinking alcohol, my chances of getting lung cancer at some point in my life are big	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
56	If I do not eat enough fruit or vegetables, my chances of getting cancer at some point in my life are big	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
The following questions involve your feelings about getting cancer during your lifetime. These questions do not involve logic or rationality but require an intuitive and emotional response. When answering these questions try to follow your intuition or gut feeling as much as possible.			
57	If I keep drinking alcohol, I feel vulnerable to getting cancer at some point in my life	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	

58	If I keep eating red or processed meat once a day or more, I feel vulnerable to getting cancer at some point in my life	Strongly disagree……..1 Disagree……..2 Agree……3 Strongly agree……4	
59	If I don't get enough exercise, I feel vulnerable to getting cancer at some point in my life	Strongly disagree……..1 Disagree……..2 Agree……3 Strongly agree……4	
61	If I keep eating less than five portions of fruit and vegetables a day, I feel vulnerable to getting cancer at some point in my life	Strongly disagree……..1 Disagree……..2 Agree……3 Strongly agree……4	
62	If I keep smoking, I feel vulnerable to getting lung cancer at some point in my life	Strongly disagree……..1 Disagree……..2 Agree……3 Strongly agree……4	
63	If I keep drinking alcohol, I feel:	*Very vulnerable* to getting cancer at some point in my life……1 *Vulnerable* to getting cancer at some point in my life……2 *Not vulnerable* to getting cancer at some point in my life……..3 *Definitely not vulnerable* to getting cancer at some point in my life……..4	
64	If I keep eating red or processed meat once a day or more, I feel	*Very vulnerable* to getting cancer at some point in my life……1 *Vulnerable* to getting cancer at some point in my life……2 *Not vulnerable* to getting cancer at some point in my life……..3 *Definitely not vulnerable* to getting cancer at some point in my life……..4	
65	If I keep smoking, I feel:	*Very vulnerable* to getting cancer at some point in my life……1 *Vulnerable* to getting cancer at some point in my life……2 *Not vulnerable* to getting cancer at some point in my life……..3 *Definitely not vulnerable* to getting cancer at some point in my life……..4	
66	If I don't get enough exercise, I feel:	*Very vulnerable* to getting cancer at some point in my life……1 *Vulnerable* to getting cancer at some point in my life……2 *Not vulnerable* to getting cancer at some point in my life……..3 *Definitely not vulnerable* to getting cancer at some point in my life……..4	

67	If I keep eating less than five portions of fruit and vegetables a day, I feel	*Very vulnerable* to getting cancer at some point in my life……1 *Vulnerable* to getting cancer at some point in my life……2 *Not vulnerable* to getting cancer at some point in my life……3 *Definitely not vulnerable* to getting cancer at some point in my life……4	
SECTION 5: CANCER WORRY			
WOMEN			
68	How often do you worry about developing breast cancer?	Never……1 Not often……2 Often……3 Very often……4	
69	How often does worrying about developing breast cancer interfere with your everyday life?	Never……1 Not often……2 Often……3 Very often……4	
70	How often do you worry about developing cancer of the cervix?	Never……1 Not often……2 Often……3 Very often……4	
71	How often does worrying about developing cancer of the cervix interfere with your everyday life?	Never……1 Not often……2 Often……3 Very often……4	
MEN			
72	How often do you worry about developing prostate cancer?	Never……1 Not often……2 Often……3 Very often……4	
73	How often does worrying about developing prostate cancer interfere with your everyday life?	Never……1 Not often……2 Often……3 Very often……4	
SECTION 6: INTENTION TO SCREEN **The following questions involve medical check-ups you have had for cancer and how you feel about going for these check-ups. Please free to ask the interviewer if you have any questions.**			
WOMEN			
A Pap smear is a medical test that women undergo at the clinic/hospital to check for signs of cervical cancer			

74	Have you had a Pap smear check-up in the last 12 months?	Yes.....1 No.....2	
75	I intend to go for a Pap smear check-up in the next 12 months	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
76	I would go for a Pap smear check-up if a doctor recommended it	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
77	If you do not intend to screen, please specify reason	[ ]	
A clinical breast examination (CBE) or breast self-examination (BSE) are ways that women can check for signs of breast cancer			
78	Have you had a CBE or BSE in the past 12 months?	Yes.....1 No.....2	
79	I intend to go for a CBE or do a BSE in the next 12 months	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
80	I would go for a CBE or do a BSE if a doctor recommended it	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
81	If you do not intend to screen, please specify reason	[ ]	
MEN			
Prostate specific antigen (PSA) blood test and digital rectal exam (DRE) are medical tests that men undergo at the clinic/hospital to check for signs of prostate cancer			
82	Have you had a PSA blood test or DRE in the last 12 months?	Yes.....1 No.....2	
83	I intend to go for a PSA blood test or DRE in the next 12 months	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
84	I would go for a PSA blood test or DRE if a doctor recommended it	Strongly disagree.....1 Disagree.....2 Agree.....3 Strongly agree.....4	
85	If you do not intend to screen, please specify reason	[ ]	
SECTION 7: OTHER LIFESTYLE PRACTICES			

SEXUAL PRACTICES **The following might involve some sensitive questions about sexual behaviour. Please try to be as honest as possible. Your answers will be kept secret.**			
86	How often do you use barrier protection (condom or dental dams or the female condom) when you have sex?	Never……1 Not often……2 Often……3 Very often……4	
We would like to ask you about the number of sexual partners you have had in your WHOLE LIFE including this year. We want to know about the number of different partners.			
87	How many sexual partners have you had sex with in your whole life?	None……0 1 …… 1 2-4 …… 2 5-9 …… 3 10-14 …… 4 15-19 …… 5 20-29 …… 6 30-49 …… 7 50 to 99 …… 8 100 or more …… 9	
SKIN PROTECTION			
88	Do you use sunbeds?	Yes……1 No……2	
89	When you are out in the sun, especially at midday and for long periods, do you:		
90	Use an umbrella or a shade to keep out of the sun?	Yes……1 No……2	
91	Cover your skin with clothing (long sleeves shirt or pants)?	Yes……1 No……2	
92	Wear a wide brimmed hat?	Yes……1 No……2	
93	Wear sunglasses?	Yes……1 No……2	
94	Use sunscreen with SPF of at least 20?	Yes……1 No……2	
FAMILY HISTORY			
96	Do you have a family history of cancer? (Must be direct family members – father, mother, brother, sister, grandparents)	None……1 Two or more close family members……2	
BODY WEIGHT **The following questions involve measuring your body weight. Please feel free to ask the interviewer if anything is unclear**			
97	Height (cm)		

98	Weight (kg)		
99	Current body mass index (BMI)		
Waist circumference can be measured by finding the point halfway between your lower rib and the top of your hip bone and using a tape measure, measuring level with your belly button around the body. Take a breath in and then out and measure on your out breath. Try to measure this without your clothes on or if not possible then over light clothing			
100	Waist circumference (cm)		

Appendix 3 – Consent form

Consent Form

Study ID: [ ][ ][ ][ ][ ]

Name of participant_____

Do you have any questions about the information given? Please tick

Yes_____ No_____

If yes, have these questions been resolved?

Yes_____No_____

Do you understand that you are free to choose to participate in this study, and can withdraw at any time?

Yes_____ No_____

Permission provided by participant to be interviewed with questionnaire

Signature of Participant:

Signature		Date signed			
			dd	mm	yyyy
Print name					

Permission provided by participant to undergo anthropometric measurements (BMI, waist and hip circumference)

Signature of Participant:

Signature		Date signed			
			dd	mm	yyyy

Print name	

To be completed by researcher:

I confirm that the participant has freely provided his/her consent in taking part in the interview. The participant was given the opportunity to ask any questions about anything that was unclear and was not coerced in any way into giving consent.

Signature of Study Staff taking consent:

Signature		Date signed			
			dd	mm	yyyy
Print name					

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

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

TO: Mr DM Floor
School of Public Health
Division of Social & Behaviour Change Communication
Medical School
University

E-mail: dean.floor@gmail.com

CC: Supervisor: Ms P Mistri and Professor N Christofides
<Nicola.Christofides@wits.ac.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: 2020/03/20

REF: *R14/49*

PROTOCOL NO: **M191024** *(*This is your ethics application study reference number. Please quote this reference number in all correspondence relating to this study*)*

PROJECT TITLE: *Cancer-related lifestyle risk, knowledge, risk perception and intention to screen in a socio-economically diverse urban population in South Africa*

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

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

R14/49 Mr DM Floor

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M191024

NAME: (Principal Investigator)	Mr DM Floor
DEPARTMENT:	School of Public Health Division of Social & Behaviour Change Communication Medical School University
PROJECT TITLE:	Cancer-related lifestyle risk, knowledge, risk perception and intention to screen in a socio-economically diverse urban population in South Africa
DATE CONSIDERED:	2019/10/25
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Ms P Mistri and Professor N Christofides
APPROVED BY:	CB Penny Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2020/03/20

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 3rd Floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

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 submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **October** and will therefore reports and re-certification will be due early in the month of **October** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature _____ Date _____

PLEASE QUOTE THE CLEARANCE CERTIFICATE NUMBER IN ALL ENQUIRIES