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PROJECT: Delineating the role of social vulnerability in the pathophysiology of non-communicable diseases (NCDs) and their prominent risk factors in middle-aged Black South African women.

Background and Rationale

Although everyone is inherently at risk of suffering in a natural disaster, or developing infectious and chronic diseases, some people are at greater risk than others due to having unfavourable social, economic, and environmental exposures.

This phenomenon is known as social vulnerability and it is defined as the attributes of society that make people and places susceptible to natural disasters, adverse health outcomes, and social inequalities (1,2).

Social vulnerability is assessed using several tools including the social vulnerability index (SVI) (1,2), which was developed to identify individuals and communities' susceptibility to environmental disasters. Since its development, SVI has been adopted to describe social vulnerability to other external stressors on human health, including COVID pandemic (3), food insecurity (4), obesity (5), and physical fitness (6).

Notably, the majority of these studies have been conducted in high-income countries and are lacking in countries with high social vulnerabilities such as South Africa (SA). In terms of income distribution, SA is the most unequal country in the world, with a Gini coefficient of 0.63 (7). Unfortunately, South African women, especially Black women, are the most vulnerable group in SA (Mtintsilana et al., unpublished work) (4). They are vulnerable to poverty and food insecurity, which in turn predisposes them to other social inequalities such as increased risk for infectious diseases (i.e. HIV) and gender-based violence.

This may partly explain why SA has one of the highest rates of HIV and gender-based violence against women (8,9). Furthermore, poverty and food insecurity are inherently associated with malnutrition and obesity in children and adults (10). Early undernutrition, followed by excessive weight gain is associated with increased risk for non-communicable

diseases (NCDs) (e.g., diabetes mellitus and cardiovascular diseases) across the life course (11).

Accordingly, SA has one of the highest levels of obesity- and related NCDs in the Sub-Saharan African region, with women disproportionately more affected than men (12–14). The World Health Organisation (WHO) has identified NCDs as one of the ten leading threats to health (15). Regrettably, 77.0% of all NCD-related deaths occur in low- and middle-income countries such as SA (15). In SA, diabetes mellitus was the second leading cause of mortality, after tuberculosis, accounting for 5.5% of all deaths in 2016 (16). When stratified by sex, diabetes-attributable mortality was greater in South African women than men (7.2% vs. 4.0%) and ranked first and fifth as the cause of death in women and men, respectively (16). Behavioural (e.g., harmful use of alcohol and tobacco, and physical inactivity) and metabolic risk factors (e.g., high obesity and blood glucose levels) are the major drivers of NCDs (15), and have also been implicated in the development of NCDs in Black South African women (17,18). The role of social vulnerability in the pathophysiology of NCDs and their prominent risk factors in Black South African women are lacking, thus requiring exploration.

Objectives and methodology

This study aims to explore the use of SVI in understanding the risk of developing NCDs and the prevalence of associated risk factors in middle-aged Black South African women. This aim will be addressed in four parts (Table 1):

Table 1: Anticipated study findings

Study design (Manuscript)	Objectives	Hypotheses
Cross-sectional (Manuscript 1)	To examine the association between social vulnerability and NCD risk factors including tobacco use and alcohol intake, and objective measures of lifestyle factors such as physical activity and sedentary behaviours, and dietary inflammatory index, and food insecurity scale.	Middle-aged black South African women high SVI score and/or socially vulnerable groups will have a higher prevalence of smoking and alcohol intake, physical inactivity, and sedentary behaviours than those with low SVI score. Furthermore, SVI will be associated with a pro-inflammatory diet and a higher food insecurity scale score.
Cross-sectional (Manuscript 2)	To determine whether social vulnerability measured by SVI is associated with hypertension risk, and if this association is mediated by food insecurity scale.	A high SVI will be associated hypertension risk, and this association will be mediated by food insecurity scale.
Longitudinal study (Manuscript 3)	To use a longitudinal study design to explore the association between SVI and body composition, using basic anthropometric measures (weight, BMI, and waist	At baseline and follow-up (1.5 years later), socially vulnerable groups (groups with high SVI score) will have higher levels of obesity, especially central obesity, and lower peripheral adiposity compared to their counterparts.

	circumference), and dual-energy x-ray absorptiometry (DXA)-derived measures of body fat and fat distribution.	
Longitudinal study **(Manuscript 4)**	To investigate if baseline and/or change in SVI was associated with measures of glycaemia and the risk of developing T2D 1.5 years later.	At baseline, Black South African women with a high SVI score will have higher glucose and insulin levels, low insulin sensitivity, and higher risk of developing T2D at follow-up compared to women with low SVI score

Study design

A sample of 221 Black South African women were recruited between 2015-2016 and tested again 1.5 years later (2017-2018) as they fulfilled the criteria of being a caregiver (e.g., mother or grandmother) from the Birth-to-Twenty plus cohort (BT20+). These criteria included being younger than 65 years of age, HIV negative and willing to be tested for HIV. At both time points, a demographic questionnaire was administered and included housing density, household structure (e.g., tap water in the house), household asset index score (based on 12 household items measuring household wealth), household food insecurity, marital status, educational assessment, and employment. Moreover, questions on medication use and lifestyle factors, including smoking and alcohol intake were recorded. Physical activity and sedentary behaviour were measured using ActiGraph GT3X-Plus triaxial accelerometers (ActiGraph TX3+, ActiGraph LLC, Pensacola, Florida) and activPAL devices (activPAL3c, PAL Technologies Ltd., Glasgow, UK). Habitual dietary food intake was measured using a seven-day food frequency questionnaire and was used to calculate the energy-adjusted-DII scores (19).

Body composition and biochemical analysis

At baseline and follow-up, basic anthropometric measurements (e.g., height, weight, and waist and hip circumferences) and DXA-derived body whole composition including estimates of abdominal visceral adipose tissue (VAT) and abdominal subcutaneous adipose tissue (SAT) (S/N 71201), Bedford, MA, USA; software version 13.4.2:7) were measured on all participants. Body mass index (BMI) was calculated as weight(kg)/height $(m)^2$. After an overnight fast, a blood sample was drawn from all participants for the determination of HbA1c, plasma glucose, serum insulin and C-peptide levels, adipokines, and liver enzymes from which FLI was estimated. Thereafter, all non-T2D participants (based on self-reported status and/or use of T2D medication) completed a standard oral glucose tolerance test (OGTT) and blood samples were taken at 10, 20 30, 60, 90, and 120 min. Both fasting and OGTT-derived samples were used for the analysis of insulin sensitivity (Matsuda Index) and calculation of insulin secretion and clearance using the Mari mathematical model of beta-cell function (20).

Timeline

This project is feasible as the dataset is already in place for me to successfully complete this project within the proposed time frame (September 2022-September 2023).

Results or preliminary data

Not applicable. However, I hope the results generated from this project will assist in formulating policies and intervention programmes to curb the rapid increase in the prevalence of NCDs and associated risk factors in this socially vulnerable group. Also, to attract investors to support and strengthen programmes such as the gender-based socio-economic initiatives (i.e. “The women empowerment and gender quality Bill” (2013)), which aim to address social challenges faced by South African women

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