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Investigating dietary quality among South Africans aged 15 years and over by diabetes status using demographic and health survey data

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The 2016 South African Demographic and Health Survey (SADHS) estimated that 11.7% of individuals aged 15 years and older had poor glycaemic control, despite only 4.7% reporting a previous diabetes diagnosis. Entrenched socioeconomic inequalities may present barriers to maintaining a healthy diet, a key factor in diabetes management. Using 2016 SADHS data, this study investigated whether dietary choices differ by diabetes status, defined by previous diagnosis and HbA1c levels, and whether the diet of people living with diabetes (PLWD) varies according to key sociodemographic factors. Reporting of fruit, vegetables, sugar-sweetened beverages, fruit juice, and fast-food consumption was used to construct a dietary quality index. Ordered logistic regression models were employed to examine the effects of diabetes status and sociodemographic variables on diet. Concurrent low fruit and vegetable consumption was common among both the general population and PLWD. In the general population, previous diabetes diagnosis, age ≥55 years, non-Black African population group, and high wealth quintile were significantly associated with higher odds of a healthier diet. Among PLWD, high wealth remained significantly associated with a healthier diet, while female gender and having health insurance also became significant predictors of healthier dietary patterns. Future dietary-related public health interventions should focus on improving access to fruits and vegetables for younger, Black, and socioeconomically disadvantaged populations, regardless of diabetes status.

Key words: Type 2 diabetes, diet, fruit and vegetables, sub-Saharan Africa.

INTRODUCTION

An epidemiological transition has been occurring in many low- and middle-income countries (LMICs), with infectious diseases such as malaria, tuberculosis, and diarrhoeal diseases declining as leading causes of mortality and

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being replaced by non-communicable diseases (NCDs), such as type 2 diabetes mellitus (T2DM) (Global Burden of Disease [GBD], 2015). T2DM prevalence in South Africa has increased over the past decade, from 7.1% in 2011 to 10.8% in 2021 (International Diabetes Federation [IDF], 2021), with as many as 60% of cases remaining undiagnosed (Stokes et al., 2017). This undiagnosed population is particularly vulnerable to the micro- and macrovascular complications of T2DM, including heart attack, stroke, renal failure, and retinopathy. Individuals diagnosed with T2DM but untreated, or those whose diabetes remains uncontrolled despite treatment, are also at risk, although these groups are smaller compared to the undiagnosed population (Stokes et al., 2017).

T2DM incidence and progression are strongly associated with obesity (Kahn et al., 2006). Interventions in high-income countries, such as individualized dietary advice (Guess, 2018) and diets low in refined carbohydrates (Copell et al., 2010), have been shown to improve glycaemic control and prevent T2DM complications. However, these approaches are resource-intensive and do not account for cultural dietary differences, limiting their generalizability to LMICs. Evidence on the effectiveness of both individual- and population-level dietary interventions to reduce T2DM incidence and progression in South African adults remains limited.

The prevalence of overweight and obesity in sub-Saharan Africa has risen over the past three decades, with South Africa having the highest rates in the region (Gona et al., 2021). These trends, combined with poor diabetes screening and surveillance, leave many South Africans vulnerable to T2DM and its numerous complications.

Despite its classification as an upper-middle-income country (World Bank, 2022), South Africa's legacy of colonialism and apartheid has resulted in some of the highest rates of socioeconomic and racial inequality globally (World Inequality Lab, 2022), which are reflected in healthcare access and outcomes (Stokes et al., 2017). Black South Africans have been shown to have poorer dietary diversity than white South Africans and are more likely to consume energy-dense foods from informal vendors (Steyn et al., 2011). These patterns occur within a broader context of poor dietary diversity and food insecurity, which has been exacerbated by the COVID-19 pandemic (De Wet-Billings, 2023).

Internal migration may also affect diet. South Africa is the most urbanized country in sub-Saharan Africa, with 62% of the population living in cities due to rural-urban migration (Oni et al., 2015). Globally, urban residence and lifetime exposure to urban environments have been associated with a higher incidence of T2DM and overweight (Eckert and Kohler, 2014). Studies in urban and peri-urban South Africa have documented shifts in dietary composition toward a "Western diet," characterized by high intake of energy-dense, nutrient-poor foods and low intake of nutrient-dense fresh fruits, vegetables, lean meats, and fish (Oni et al., 2015). The obesogenic environment in many urban areas may therefore predispose individuals to the dual risks of obesity and food insecurity, with energy-dense diets and manifestations of food insecurity, such as childhood stunting, occurring concurrently within households and neighborhoods (Misselhorn and Hendriks, 2017), and presenting additional challenges for healthcare providers and policymakers.

The 2016 South African Demographic and Health Survey (SADHS) (Demographic and Health Surveys Program, 2019) is a large, nationally representative survey that collected both biomarker samples and survey data on a range of health and social variables. The survey estimated that 13% of women and 8% of men aged over 15 years had poor glycaemic control (HbA1c $\geq$ 6.5%), despite only 5% of women and 4% of men reporting a previous diabetes diagnosis. Biomarker sampling also indicated that 64% of women and 66% of men aged over 15 years had prediabetes ($5.7 \leq$ HbA1c $\leq$ 6.4), suggesting that a large proportion of the population is at risk of developing T2DM (Demographic and Health Surveys Program, 2019).

Despite this, few analyses have examined the associations between diabetes status and diet in South Africa, and most existing studies are highly localized or population-specific. More extensive, biomarker-focused analyses of population surveys such as the SADHS may provide greater insight into dietary differences between sociodemographic groups in relation to T2DM and inform the design of future public health interventions. This study aims to investigate whether the odds of good dietary quality differ by diabetes status when controlling for key sociodemographic variables (research question one) and to examine the associations between sociodemographic factors and dietary quality among people living with diabetes (PLWD) (research question two).

METHODLOGY

Data collection

Cross-sectional survey and biomarker data from the 2016 SADHS were used, with data collection occurring between 27 June and 4 November 2016. The survey was administered by Statistics South Africa in collaboration with the South African Medical Research Council. The sampling frame was based on 2011 census enumeration areas (EAs), which were divided into Primary Sampling Units (PSUs). The frame included information on geographic type and the estimated number of residential dwelling units (DUs) in each PSU. The SADHS 2016 employed a stratified two-stage sample design, using probability-proportional-to-size sampling of PSUs at the first stage, followed by systematic sampling of DUs at the second stage (Demographic and Health Surveys Program, 2019). Women aged over 15 years in odd-numbered DUs were eligible for the individual questionnaire, while

Table 1. Coding of variables comprising the healthy diet group variable and their corresponding SADHS survey question.

Variable	Survey question	Answer options	Considered in analysis as
Fast food consumption	How often do you eat fast-foods or take-away foods from places like Chicken Licken, KFC, Captain DoRego's, Steers, Nando's, McDonalds, pizza delivery, etc?	'Every day', 'at least once a week', 'occasionally', 'never'.	Binary (high if every day or at least once a week, low if occasionally or never)
Fruit consumption	Yesterday, how many types of fruit did you eat?	Continuous variable	Binary (high if ≥2, low if <2)
Vegetable consumption	Yesterday, how many types of vegetables, excluding potatoes, did you eat?	Continuous variable	Binary (high if ≥2, low if <2)
Sugar-sweetened beverage consumption	Yesterday, did you drink any sugar-sweetened drinks? Sugar-sweetened drinks include fizzy drinks like Coke or drinks like Squash where water is added, but not diet or unsweetened cold drinks.	Yes/No	Binary
Unsweetened fruit juice consumption	Yesterday, did you drink any fruit juice?	Yes/No	Binary

both men and women aged over 15 years in even-numbered DUs were eligible. Participants provided informed verbal consent for interviews, which was witnessed and documented by the interviewer. Biomarker measurements, including HbA1c, were collected from participants aged over 15 years in even-numbered DUs with written consent. For participants aged 15 to 17 years, consent was obtained from both the participant and their legal parent or guardian.

HbA1c was measured using dried blood spot sampling, with thresholds defined as follows: HbA1c ≥ 6.5% indicated diabetes, 5.7 ≤ HbA1c ≤ 6.4% indicated prediabetes, and HbA1c ≤ 5.6% indicated no diabetes. These thresholds are consistent with World Health Organization (WHO) guidelines (WHO, 2019) and DHS classifications (Demographic and Health Surveys Program, 2019). These HbA1c-based classifications were used to define diabetes status in all analyses and are referred to as 'HbA1c' for the remainder of this paper. The term 'T2DM' is preferred when referring to diabetes, although 'diabetes' is used when referring to cases where the type is unspecified, and 'glycaemic control' is used when discussing blood sugar management among participants with known T2DM. Data were accessed by the authors between 20 December 2021 and 30 June 2022, and no information that could identify individual participants was accessed at any stage.

The participant-reported dietary quality index was the categorical outcome measure, calculated from reports of five dietary components: consumption of fast food, fruit, vegetables, sugar-sweetened beverages (SSBs), and unsweetened fruit juice. The relevant 2016 SADHS survey questions, response options, and recoding for analysis is presented in Table 1. Coding fruit and vegetable consumption as high (>2 types/day) does not meet the national recommendation of five daily portions of fruits and vegetables (Food and Agriculture Organization of the United Nations, 2021).

Healthy dietary choices were defined as high fruit, high vegetable, high unsweetened fruit juice, low fast-food, and low SSB consumption. Although the effect of unsweetened fruit juice on T2DM is debated, current evidence does not link it to major T2DM-related cardiovascular outcomes (Bhandari et al., 2024), and it may serve as a more nutritious alternative to SSBs in middle-income countries with low fruit and vegetable intake (Cabrera et al., 2013). Unhealthy dietary choices were defined as low fruit, low vegetable, low unsweetened fruit juice, high fast-food, and high SSB consumption. SSB intake has a dose-dependent association with obesity and T2DM (Qin et al., 2020), while fast-food consumption is positively associated with weight gain and obesity (Nago et al., 2014). Ultra-processed foods (UPFs), including SSBs and industrially prepared meals, are associated with increased T2DM incidence and obesity prevalence (Levy et al., 2021). Although the SADHS collected additional dietary variables, salt intake was excluded due to it not being a direct measure of consumption, fried food consumption was excluded due to overlap with fast food, and salty snacks and processed meats were excluded due to limited direct relevance to T2DM risk.

Individuals were initially categorized into six groups based on the number of healthy dietary choices, ranging from five healthy and zero unhealthy choices to zero healthy and five unhealthy choices. Due to the small number of individuals with zero or five healthy choices, the zero and one healthy choice groups were combined to form a single 'unhealthy' diet group, and the four and five healthy choice groups were combined to form a single 'healthy' diet group.

The groups with two and three healthy choices were retained independently as 'somewhat healthy' and 'moderately healthy,' respectively, creating a four-category dietary quality index. Further details on the formation of the dietary quality index are provided in Appendix 1. Body mass index (BMI), doctor-diagnosed heart attack, doctor-diagnosed stroke, and doctor-diagnosed diabetes were selected as potential individual-level confounding variables, based on the rationale that recognition of high BMI or non-communicable disease (NCD) diagnoses provides opportunities to initiate lifestyle changes (Sebire et al., 2018). Additionally, as a diabetes diagnosis itself provides an opportunity for dietary modification and improved glycaemic control, a joint variable combining diabetes status by HbA1c and previous diagnosis was created. This variable differentiated individuals with 'controlled diabetes' (diagnosed diabetes with HbA1c < 6.5% at the time of the survey). Participants who reported being unsure of a previous diabetes diagnosis (N=31) were excluded from analyses.

Demographic variables included age group (Mutyambizi et al., 2017), gender (Mutyambizi et al., 2017), self-reported population group (Shisana et al., 2013), and type of residence (urban/rural) (Chersich et al., 2017; Okop et al., 2019), as these are known risk factors for dietary quality and T2DM status. Socioeconomic variables included highest level of education completed (Mutyambizi et al., 2019), wealth quintile (Mutyambizi et al., 2019), employment in the past 12 months (Mutyambizi et al., 2019), and health insurance coverage (Grundlingh et al., 2022). Demographic and socioeconomic variables were selected based on documented associations with dietary quality or diabetes status in the literature. Due to the limited number of participants reporting a doctor-diagnosed heart attack or stroke, these were combined into a single variable indicating doctor-diagnosed heart attack and/or stroke. Age was recoded into three categories: younger adults (15 to 34 years), middle-aged adults (35 to 54 years), and older adults (55 years and above).

Statistical analysis

All analyses were conducted in Stata Standard Edition 17.0 for Windows (StataCorp, 2022). Descriptive analyses applied two-stage sampling weights to account for the complex survey design. Clustering of dietary choices within healthy diet groups was visualized using the UpSetR package (v1.4.0) in R (Conway et al., 2017), with patterns explored both overall and by gender. Two-way tables with Chi-squared tests were used to examine initial associations between potential confounding variables and dietary quality index groups. As the dietary quality index had four ordered categories, ordered logistic regression models were initially applied for the first research question to examine the association between diabetes status, defined by the joint diabetes variable, and dietary quality. Bivariate analysis explored the unadjusted association of each variable with dietary quality. However, Brant tests indicated that several variables violated the proportional odds assumption (Appendix 2). Accordingly, generalized ordered logistic regression models were fitted using the user-written gologit2 command with the "autofit" option, allowing the proportional odds assumption to be relaxed for some explanatory variables while maintained for others (Williams, 2005). Reducing parallelism for individual levels of a variable is consistent with previous approaches (Vilar-Compte et al., 2015; Ziraba et al., 2009). Although the interaction between self-reported population group and wealth is relevant in the South African socio-historical context, sample size limitations prevented construction of a joint variable, as more than half of the categories had insufficient observations. A multivariable generalized ordered logistic regression model was built using a backward stepwise approach, including variables significant at the bivariate stage (Williams, 2005). For the second research question, all individuals with HbA1c indicating diabetes (≥6.5%) were included, as this group is at increased risk of T2DM complications and is a key population for public health interventions. Univariable associations between demographic and socioeconomic factors and healthy diet groups were explored before applying the same steps used for research question one (Appendix 3).

RESULTS

Participant characteristics

The overall 2016 SADHS sample included 10,336 participants (response rate 81.6%). For the first research question, 3,596 participants were excluded due to not being selected for biomarker sampling (3,565) or having an unknown previous diabetes diagnosis (31), leaving a final sample of 6,709 participants, representing 66% of female participants (4,159) and 59% of male participants (2,581) (Demographic and Health Surveys Program, 2019). Table 2 presents the distribution of participants by the number of healthy choices and their classification into healthy diet groups. Most participants demonstrated a mix of healthy and unhealthy dietary choices, with unhealthy choices predominating. Nearly half of participants had two healthy and three unhealthy choices, followed by those with one healthy and four unhealthy choices (22.0%). Less than 1% of participants had five healthy choices, and 3.6% had five unhealthy choices.

Figures 1 to 3 show that across all dietary quality groups in both men and women, low fast-food consumption was the most common healthy choice (82.1%). Low fruit juice consumption was the most frequent unhealthy choice in both men and women across all dietary quality groups (87.2%). Among participants in the somewhat healthy group (two healthy choices), the most commonly reported combination was low fast-food and low SSB consumption, accounting for 54% of all two-healthy-choice combinations, with a similar pattern observed in men and women. The least commonly reported combination in this group was high fruit juice and high fruit consumption (4%). For participants in the moderately healthy group (three healthy choices), the most frequently reported combination was low fast-food, low SSB, and high vegetable consumption in both men and women (7.5%), whereas the least commonly reported combination was high unsweetened fruit juice, high fruit, and high vegetable consumption in both men and women (0.3%).

Table 3 summarizes weighted participant characteristics by dietary quality group, showing that the majority of participants had not previously received a diagnosis of diabetes and that most had an HbA1c indicating prediabetes. Among those with a previous diabetes diagnosis, 71.9% had poorly controlled diabetes (HbA1c ≥ 6.5%), and a further 25.3% had somewhat controlled diabetes (5.7% ≤ HbA1c ≤ 6.4%). Of those without a previous diabetes diagnosis, 8.7% had diabetes (HbA1c ≥ 6.5%) and 66.3% had prediabetes. The distribution of each dietary quality index category by diabetes status and sociodemographic characteristics is presented in Appendix 4.

On bivariate analysis, education showed no consistent association with diabetes status or dietary quality and was therefore excluded. Diagnosis of heart attack or stroke was also excluded due to the low number of reported cases, making it unsuitable for inclusion in multivariable models. As expected, a previous diagnosis of diabetes was associated with higher odds of being in a healthier dietary quality group compared to individuals without a diabetes diagnosis (OR 1.83, 95% CI 1.42 to

Table 2. Distribution of participants by number of healthy dietary choices and organisation into healthy diet groups.

No. of healthy choices	Frequency	%	Dietary quality index group
0	243	3.6	Unhealthy
1	1474	22.0	Unhealthy
2	3193	47.6	Somewhat Healthy
3	1320	19.7	Moderately Healthy
4	415	6.2	Healthy
5	64	0.9	Healthy
Total	6709	100.00	-

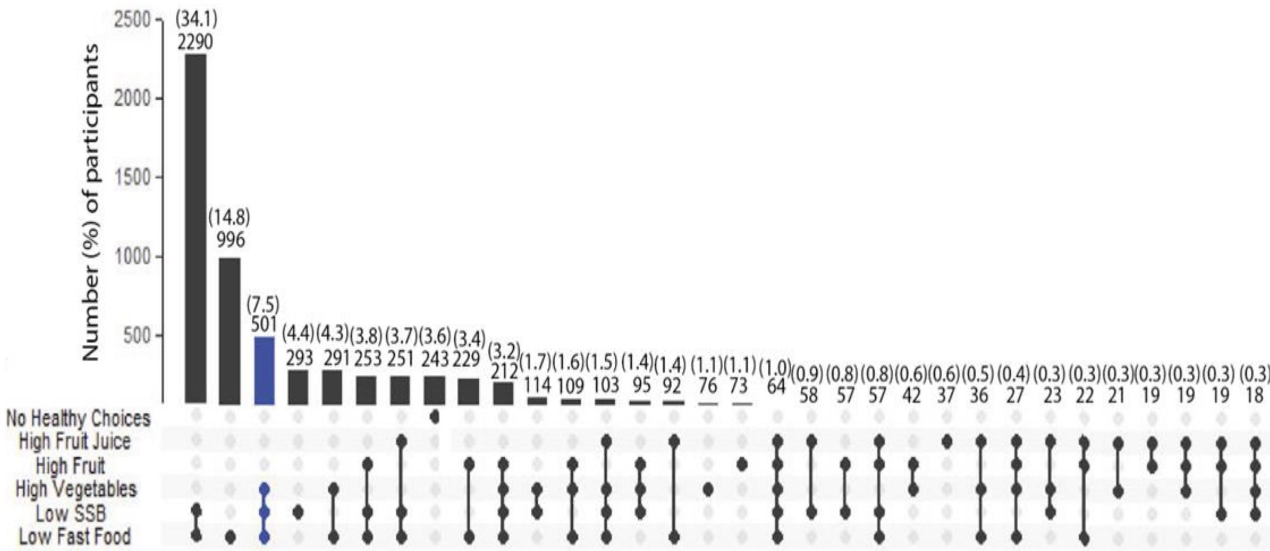

Figure 1. UpSet plots showing patterns of dietary choices among adults aged 15 years and over (All adults aged 15 years and over in South Africa (N = 6709)[1,2]. ● – For example, a participant with only high vegetable, low SSB and low fast food consumption would be in the moderately healthy diet group, [2]SSB – Sugar-sweetened beverages.

2.35 for those with uncontrolled diabetes; OR 1.66, 95% CI 1.11 to 2.51 for those with somewhat controlled diabetes). Among other significant associations, individuals of black African population group had substantially lower odds of being in a healthier dietary quality group relative to other population groups (OR 4.43, 95% CI 2.64–7.45 for white individuals; OR 1.31, 95% CI 1.01 to 1.69 for coloured individuals; OR 2.53, 95% CI 1.22 to 5.22 for Indian/Asian individuals). Individuals covered by health insurance had higher odds of being in a healthier dietary quality group compared to those without health insurance (OR 1.48, 95% CI 1.05 to 1.09).

Likelihood ratio testing at the bivariate stage indicated that all variables except type of place of residence and BMI had p-values < 0.10 and were therefore considered for inclusion in the multivariable model. Brant testing of the remaining variables at the bivariate stage revealed that age, wealth index, employment status in the last 12 months, and health insurance coverage violated the parallel odds assumption.

Table 4 presents the results of the final multivariable generalized ordered logistic regression model. Variables meeting the proportional odds assumption—joint diabetes status, gender, self-reported population group, and employment in the last 12 months—are represented by a single set of estimates. Individuals with a previous diagnosis of diabetes and uncontrolled diabetes (HbA1c ≥ 6.5%) remained significantly more likely to be in a healthier dietary quality group compared to individuals without diabetes (OR 2.14, 95% CI 1.10 to 4.18). No other category of the joint diabetes status variable was statistically significant relative to the reference group (no diabetes: no previous diagnosis and HbA1c <5.7%), although the estimate for somewhat controlled diabetes was in the same direction, while the controlled diabetes group had a very small sample (N = 18).

Middle-aged and older adults had significantly higher odds of being in the somewhat healthy, moderately

Table 3. Distribution of Dietary Quality Index categories by diabetes status and sociodemographic characteristics of survey participants[1,2].

Variable	Unhealthy	Somewhat healthy	Moderately healthy	Healthy	Total N (%)	P-value[3]
	N (%)	N (%)	N (%)	N (%)		
Joint diabetes status variable						
No diabetes (No previous diabetes diagnosis and HbA1c < 5.7%)	447 (28.1[4])	741 (46.6)	294 (18.5)	109 (6.8)	1591 (23.7[5])	
Prediabetes (No previous diabetes diagnosis and 5.7% ≤HbA1c ≤ 6.4%)	1105 (26.1)	1999 (47.1)	847 (20.0)	290 (6.8)	4241 (63.2)	
Undiagnosed diabetes (No previous diabetes diagnosis and HbA1c ≥ 6.5)	119 (21.3)	288 (51.4)	110 (19.6)	43 (7.7)	560 (8.4)	<0.01
Controlled diabetes (Previous diabetes diagnosis and HbA1c <5.7%)	2 (22.2)	5 (55.6)	1 (11.1)	1 (11.1)	9 (0.1)	
Somewhat-controlled diabetes (Previous diabetes diagnosis and 5.7% ≤HbA1c ≤ 6.4%)	11 (13.8)	45 (56.2)	14 (17.5)	10 (12.5)	80 (1.2)	
Uncontrolled diabetes (Previous diabetes diagnosis and HbA1c ≥ 6.5)	33 (14.5)	115 (50.4)	54 (23.7)	26 (11.4)	228 (3.4)	
Body mass index						
Underweight or normal weight	820 (26.0)	1.575 (50.0)	587 (18.6)	169 (5.4)		
Overweight	430 (26.9)	717 (44.9)	322 (20.2)	128 (8.0)		<0.01
Obese	444 (23.6)	863 (45.8)	397 (21.1)	180 (9.6)		
Not Recorded[6]	23 (29.9)	38 (49.4)	14 (18.2)	2 (2.6)		
Diagnosis of heart attack and/or stroke						
No	1.662 (25.9)	3.044 (47.4)	1.264 (19.7)	450 (7.0)		0.02
Yes	55 (19.0)	149 (51.6)	56 (19.4)	29 (10.0)		
Gender						
Male	744 (29.1)	1.179 (46.1)	477 (18.6)	160 (6.3)		<0.01
Female	974 (23.5)	2.014 (48.5)	843 (20.3)	319 (7.7)		
Age group						
Young adults (15-34 years)	1.030 (31.9)	1.423 (44.1)	581 (18.0)	195 (6.0)		
Middle-aged adults (35-54 years)	446 (23.5)	919 (48.5)	382 (20.2)	148 (7.8)		<0.01
Older adults (55+ years)	241 (15.2)	851 (53.7)	357 (22.5)	136 (8.6)		
Type of place of residence						
Urban	882 (26.2)	1.481 (44.1)	703 (20.9)	296 (8.8)		<0.01
Rural	835 (24.9)	1.712 (51.2)	617 (18.4)	183 (5.5)		
Self-reported population group						<0.01
Black African	1.575 (26.5)	2.884 (48.6)	1.106 (18.6)	374 (6.3)		

Table 3. Cont'd

White	21 (8.8)	72 (30.3)	83 (34.9)	62 (26.1)	
Coloured	116 (24.2)	214 (44.6)	115 (24.0)	35 (7.3)	
Indian/Asian/Other	5 (9.6)	23 (44.2)	16 (30.8)	8 (15.4)	
Highest level of education completed					
No education	104 (17.3)	363 (60.3)	103 (17.1)	32 (5.3)	
Primary	297 (22.2)	738 (55.3)	237 (17.8)	63 (4.7)	<0.01
Secondary	1,174 (27.6)	1,933 (45.5)	845 (19.9)	296 (7.0)	
Higher	142 (27.1)	159 (30.3)	135 (25.8)	88 (16.8)	
Wealth quintile					
Poorest	341 (22.4)	863 (56.7)	264 (17.3)	54 (3.5)	
Poorer	398 (27.0)	733 (49.8)	255 (17.3)	87 (5.9)	
Middle	458 (28.8)	745 (46.8)	299 (18.8)	90 (5.7)	<0.01
Richer	329 (25.2)	566 (43.3)	286 (21.9)	125 (9.6)	
Richest	191 (23.4)	286 (35.0)	216 (26.5)	123 (15.1)	
Employment in last 12 months					
Unemployed Last 12 Months	982 (22.9)	2,192 (51.1)	829 (19.3)	289 (6.7)	
Employed in Last 12 Months, but not currently employed	113 (34.7)	138 (42.3)	62 (19.0)	13 (4.0)	<0.01
Currently employed[7]	622 (29.7)	863 (41.3)	429 (20.5)	177 (8.5)	
Covered by health insurance					
No	1.516 (25.6)	2.937 (49.7)	1.116 (18.9)	340 (5.8)	<0.01
Yes	201 (25.1)	256 (32.0)	204 (25.5)	139 (7.4)	

[1]Survey weighting is applied, [2]N=6709, [3]Chi-square p-values, [4]As exemplar to aid interpretation, 28.1% of those with no diabetes were in the unhealthy dietary quality index group, [5]As exemplar to aid interpretation, 28.7% of all participants had no diabetes, [6]Participants who did not have height and weight measured for BMI to be recorded were retained in analysis providing they had a valid HbA1c, with these individuals recorded in analyses as a separate 'not recorded' category, [7]Currently employed' includes participants who did not work in the past 7 days, but who are regularly employed and absent from work due to leave, illness, vacation or any other such reason[15].

healthy, or healthy diet groups relative to the unhealthy diet group, compared to younger adults (OR 1.54, 95% CI 1.28 to 1.86 for middle-aged adults; OR 2.06, 95% CI 1.23 to 3.43 for older adults). This association was attenuated and became statistically insignificant when comparing the unhealthy and somewhat healthy diet groups to the moderately healthy and healthy groups by age (OR 1.04, 95% CI 0.86 to 1.27 for middle-aged adults; OR 1.22, 95% CI 0.77 to 1.95 for older adults).

Individuals of the black African population group remained significantly less likely to have a healthy diet compared to all other population groups. A U-shaped relationship was observed between wealth

Table 4. Final multivariable generalised ordered logistic regression model for the odds of a healthy diet.

Variable	Dietary quality group[1]		
	Unhealthy	Somewhat healthy	Moderately healthy
	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Joint diabetes status variable			
(Base: No diabetes (no previous diagnosis of diabetes and HbA1c< 5.7%))			
Prediabetes (No previous diabetes diagnosis and 5.7% ≤HbA1c ≤ 6.4%)		1.05 (0.91-1.21)[2]	
Undiagnosed diabetes (No previous diabetes diagnosis and HbA1c ≥ 6.5)		0.92 (0.68-1.23)	
Controlled diabetes (Previous diabetes diagnosis and HbA1c<5.7)		0.78 (0.14-4.25)	
Somewhat-controlled diabetes (Previous diabetes diagnosis and 5.7% ≤HbA1c ≤ 6.4%)		1.35 (0.70-2.61)	
Uncontrolled diabetes (Previous diabetes diagnosis and HbA1c ≥ 6.5)		2.14[3] (1.10-4.18)	
Gender			
(Base male)			
Female		1.03 (0.88-1.20)[2]	
Age group			
(Base young adults)			
Middle-aged adults	1.54[4] (1.28-1.86)	1.04 (0.86-1.27)	0.90 (0.66-1.22)
Older adults	2.07 (1.24-3.44)	1.22 (0.77-1.95)	0.58 (0.25-1.38)
Self-reported population group			
(Base black African)			
White		3.29 (2.01-5.40)[2]	
Coloured		1.23 (0.96-1.59)	
Indian/Asian/Other		2.36 (1.06-5.25)	
Wealth quintile			
(Base poorest)			
Poorer	0.64 (0.51-0.82)	0.99 (0.76-1.29)	1.23 (0.77-1.95)
Middle	0.64 (0.50-0.81)	1.07 (0.80-1.43)	1.58 (0.92-2.72)
Richer	0.68 (0.52-0.90)	1.32 (0.94-1.85)	1.70 (0.99-2.93)
Richest	0.67 (0.47-0.96)	1.17 (0.78-1.73)	1.93 (1.09-3.43)
Employment in last 12 months			
(Base unemployed during last 12 months)			
Worked in last 12 months, but not currently working		0.67 (0.50-0.88)[2]	

Table 4. Cont'd

Currently working	0.76 (0.64-0.90)	1.00 (0.81-1.22)	1.17 (0.82-1.67)
Health insurance coverage			
(Base no)			
Yes	0.83 (0.63-1.08)	1.36 (0.96-1.93)	1.46 (0.93-2.31)

[1]Uses most healthy dietary quality group as referent, [2]Variable reduced to parallel, therefore one adjusted OR and CI used across all levels, [3]As exemplar of interpretation when parallel odds is assumed, when controlling for all other variables, individuals with a previous diagnosis of diabetes and uncontrolled diabetes by HbA1c were on average 2.14 times more likely to be in a healthier diet group, compared to individuals with no previous diagnosis of diabetes and an HbA1c <5.7%, [4]As exemplar of interpretation when parallel odds is not assumed, middle-aged adults were 1.54 times more likely to be in the somewhat healthy, moderately healthy or healthy diet group than the unhealthy diet group compared to young adults, when controlling for all other variables, but were 1.04 times more likely to be in the healthy or moderately healthy diet groups than the somewhat healthy or unhealthy diet group compared to young adults.

wealth quintile and diet: all wealth quintiles were more likely to be in the unhealthy diet group than the healthy, moderately healthy, or somewhat healthy groups relative to the poorest quintile. However, higher wealth quintiles had an increasingly higher likelihood of being in the healthy diet group compared to the moderately healthy, somewhat healthy, or unhealthy groups, reaching statistical significance for the richest quintile (OR 1.95, 95% CI 1.10 to 3.46). Individuals who had been employed in the last 12 months but were currently unemployed were significantly less likely to have a healthy diet compared to those unemployed throughout the last 12 months (OR 0.66, 95% CI 0.50 to 0.88), while those currently employed were significantly less likely to be in the unhealthy diet group (OR 0.76, 95% CI 0.64 to 0.90). Table 4 shows the final multivariable generalised ordered logistic regression model for the odds of a healthy diet.

People living with diabetes

The distribution of individuals with uncontrolled diabetes, defined by HbA1c regardless of previous diagnosis, was broadly similar to that in the general population, with the exception that individuals with three healthy and two unhealthy choices formed the second largest group rather than the third largest among PLWD. Overall, the distribution of PLWD by sociodemographic characteristics was similar to that of the general population, as shown in Appendix 5. Likelihood ratio testing indicated that employment status, education level, self-reported population group, and type of place of residence had p-values > 0.10 and were therefore excluded from further analyses. Additional likelyhood ratio testing was conducted on smaller models in a backward stepwise manner, as done for research question one. Age, gender, wealth quintile, and health insurance coverage were retained for further analyses.

Brant testing of the final ordered logistic regression model showed that none of the included variables violated the parallel odds assumption, confirming that the ordered logistic regression model was appropriate. Table 5 presents the results of the final ordered logistic regression model for a healthy diet among PLWD. After controlling for other variables, females with diabetes were significantly more likely than males to be in a healthier dietary quality group (OR 1.40, 95% CI 1.03 to 1.90). Middle-aged adults were no more likely than younger adults to be in a healthier dietary quality group, while older adults were borderline significantly more likely to have a healthier diet compared to younger adults (OR 1.55, 95% CI 0.99 to 2.43). Participants in the richer (OR 1.63, 95% CI 1.06 to 2.51) and richest (OR 1.85, 95% CI 1.14 to 3.02) wealth quintiles were significantly more likely to be in a healthier dietary quality group relative to the poorest quintile. Health insurance coverage showed an independent, statistically significant association with dietary quality: individuals with coverage were almost twice as likely as those without coverage to have a healthier diet (OR 1.96, 95% CI 1.27 to 3.01), holding wealth quintile and all other factors constant.

DISCUSSION

Having both a previous diagnosis of diabetes and an HbA1c indicating uncontrolled diabetes was associated with a healthier diet, whereas having an HbA1c indicating diabetes but no previous diagnosis was not associated with a healthier diet

Table 5. Final Multivariable ordered logistic regression model of dietary quality among people living with diabetes[1,2].

Variable	Likelihood ratio test p-value	Odds Ratio	95% confidence interval
Previous diagnosis of diabetes		(Variable of interest)	
No			(Base)
Yes		1.14	0.83 – 1.55
Gender			
Male	0.04		(Base)
Female		1.40[1]	1.03 – 1.90
Age group			
Young adults	<0.01		(Base)
Middle-aged adults (34-54 years)		1.03	0.64 – 1.65
Older adults (55+)		1.55	0.99 – 2.43
Wealth quintile			
Poorest			(Base)
Poorer	0.04	1.12	0.73 – 1.70
Middle		1.21	0.79 – 1.83
Richer		1.63	1.06 – 2.51
Richest		1.85	1.14 – 3.02
Covered by health insurance			
No	<0.01		(Base)
Yes		1.96	1.27 – 3.01

[1]Females were 1.37 times more likely to be in a healthier diet group than males, when controlling for all other variables, [2]N=788.

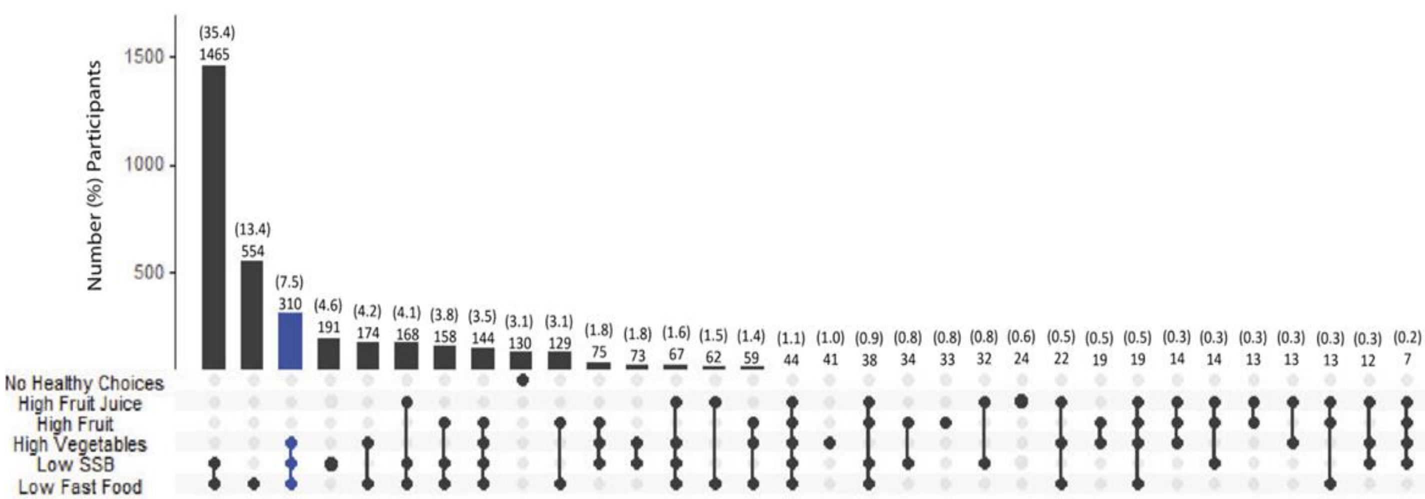

Figure 2. Women aged 15 years and over in South Africa (N = 4148).

after controlling for other variables. Given that a diagnosis presents an opportunity to discuss, facilitate, and motivate lifestyle change (Sebire et al., 2018), this difference highlights that the large number of individuals with undiagnosed diabetes are at increased risk of continuing to make unhealthy dietary choices. It is noteworthy that

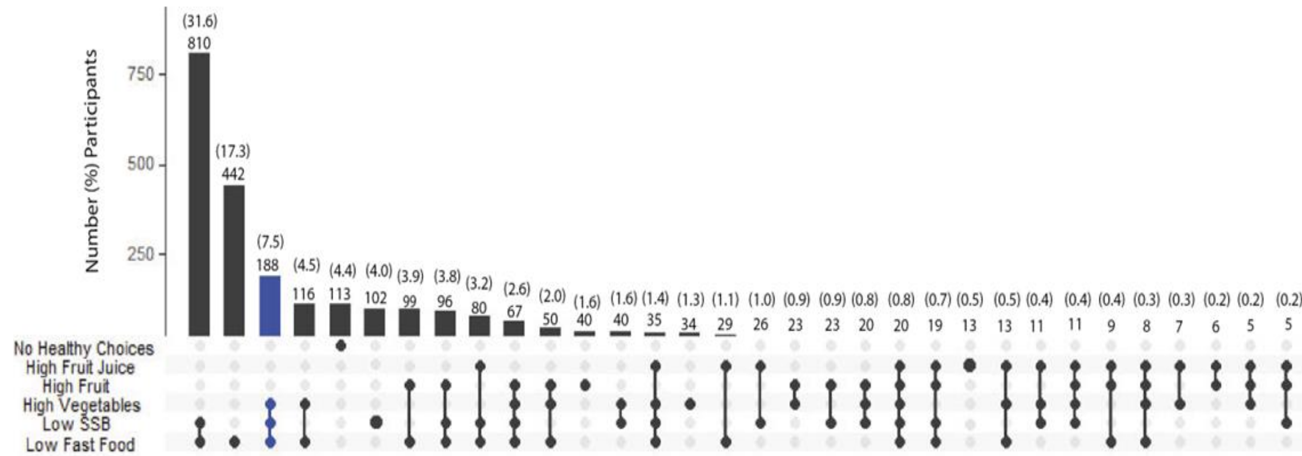

Figure 3. Men aged 15 years and over in South Africa (N = 2560).

most individuals with a diagnosis of diabetes still had poor glycaemic control, and care cascade data indicate that almost half of individuals receiving treatment still have uncontrolled diabetes (HbA1c ≥ 6.5%) (Stokes et al., 2017). This suggests that dietary change alone may be insufficient to achieve glycaemic control, potentially due to poor access to T2DM follow-up care or medication. Existing literature shows that black African population groups and individuals of low socioeconomic status (SES) are more likely to have undiagnosed diabetes (Mutyambizi et al., 2019) and poorer access to healthcare (Harris et al., 2011) compared to non-black African and higher-SES groups, consistent with our findings. Qualitative and quantitative studies suggest that the high cost of fresh fruit and vegetables is a major barrier, with affordability being the most important factor influencing dietary choices among South Africans (Hunter-Adams et al., 2019; South African Non-Communicable Diseases Alliance, 2020). Encouragingly, early NCD detection in primary care is included as a strategic action area in South Africa’s 2020–2025 NCD plan (South African Non-Communicable Diseases Alliance, 2020), which includes implementing a care cascade system similar to HIV management. Integrating T2DM screening with enhanced lifestyle counselling and education in primary care could improve access to appropriate diabetes management and promote healthier dietary choices among PLWD.

The pattern of concurrent low fruit, fruit juice, and vegetable consumption observed in both the general population and PLWD is consistent with previous South African studies (Shisana et al., 2013; Okop et al., 2019; Miller et al., 2017). Longitudinal data from a repeat panel study (Ronquest-Ross et al., 2015) indicated low baseline fruit and vegetable consumption, with a 7.9% reduction in vegetable intake (from 42.0 to 38.7 kg/capita/year) but a 6.4% increase in fruit consumption (from 28.1 to 29.9 kg/capita/year) between 1999 and 2012. Although low fruit and vegetable intake is a global issue (Ronquest-Ross et al., 2015), it is particularly concerning in South Africa and other LMICs due to rapid and unplanned urbanization (Oni et al., 2015), rising cost of living (Statistics South Africa 2022), and increasing unemployment contributing to food insecurity (De Wet-Billings, 2023). These systemic drivers of health inequality disproportionately affect black African populations.

While this study observed low SSB consumption overall, national data indicate that SSB intake in South Africa increased by 68.9% between 1994 and 2012 (from 55 L/capita/year to 92.9 L/capita/year) (Ronquest-Ross et al., 2015). Analysis of both the general population and PLWD found that older age was associated with healthier dietary quality. This aligns with previous research showing higher fruit and vegetable consumption among older adults (Okop et al., 2019) and qualitative findings suggesting older adults may have a greater preference for vegetables compared to younger individuals (Hunter-Adams et al., 2019). In contrast, research involving PLWD recruited at hospital clinics found no association between age and diet quality (Mutyambizi et al., 2020). Given the rising prevalence of NCDs primarily among older adults, the finding of poorer dietary quality in younger populations, combined with the high rate of prediabetes observed in this study, is concerning. It supports predictions that the T2DM burden will continue to grow without urgent intervention (GBD, 2015; IDF, 2021).

This study and localized research (Mutyambizi et al., 2020) found that women with T2DM had healthier diets than men. These findings are consistent with broader demographic patterns in South Africa, where men have an increasing risk of obesity (Jaacks et al., 2019) and a greater likelihood of physical inactivity compared to women (Tomaz et al., 2020), suggesting that future NCD burdens may be higher among men, as seen in high-income countries (IDF, 2021), while women may have lower but still substantial rates of complications.

Overall, these findings and the existing evidence suggest that future public health interventions should prioritize making fruits and vegetables more accessible, particularly for younger, predominantly black, low-SES populations. Although the South African Department of Health's NCD plan includes objectives to improve the availability and affordability of healthy foods, it identifies few specific target populations or interventions. Previous initiatives, such as a 25% cashback program for healthy dietary purchases, increased fruit and vegetable intake by 0.64 servings on average and reduced sugary and fast-food consumption (Janssen et al., 2018). However, it did not impact BMI and was only available to private health insurance members, who are already more likely to afford healthier foods (An et al., 2013).

Qualitative evidence indicates that individuals in low-income areas are often aware of the consequences of an unhealthy diet (Hunter-Adams et al., 2019; Booyson and Sclemmer, 2015), highlighting the need for policies to create more enabling food environments. Overly simplistic dietary advice from healthcare professionals, perceived as harsh or judgmental by patients, further underscores the importance of recognizing environmental barriers when motivating lifestyle change (Booyson and Sclemmer, 2015). The 2018 'Health Promotion Levy' on SSBs in South Africa successfully reduced sugar density in SSBs and decreased intake among high-consumption groups (Wrottesley et al., 2021). While this could inform similar policies for foods, no relative price decrease was observed for healthier beverages one year post-implementation (Wrottesley et al., 2021), indicating that broader policies may be needed to reduce the cost and increase the availability of healthy foods without worsening food insecurity in low-SES households.

Although South Africa's racial and socioeconomic inequalities are particularly entrenched, these findings are generalizable to other LMICs experiencing global epidemiological and nutritional transitions. Obesity rates across Southern Africa Development Community countries increased between 1990 and 2019 (Gona et al., 2021), as have T2DM-related morbidity and mortality (GBD, 2015). Proactive strategies to prevent and treat T2DM, including policies targeting dietary risk factors, will therefore be needed in many LMICs to address the growing burden of disease.

Strengths and limitations

The large, nationally representative sample of the SADHS is a key strength of this study, as is the breadth of available variables, which allowed for consideration of multiple dietary groups and potential confounding factors. Using HbA1c as the primary measure of diabetes status, rather than relying on self-reported diagnosis, provides a biologically objective indicator and enables inclusion of individuals with undiagnosed diabetes. However, HbA1c is an indirect measure of blood glucose and relies on a single measurement, making it less precise than a fasting glucose test (WHO, 2020). The use of generalised ordered and ordered logistic regression appropriately models the hierarchical nature of dietary quality groups. To the authors' knowledge, this is the first study to use such modelling to examine the association between diabetes status and diet. Limitations include the cross-sectional design of the SADHS, which prevents assessment of temporal changes. Dietary data collected via 24-h or 7-day recall are vulnerable to recall bias, though such methods have been shown to provide results comparable to more detailed dietary surveys for cross-sectional analysis in large samples (Lee et al., 2014) and are suitable for populations with lower literacy rates, reducing response errors and missing data (Bailey, 2021). Future diet quality surveys with enhanced cross-cultural validity may yield more detailed dietary data (Herforth et al., 2024).

The low number of participants in the healthy diet group limited statistical power for comparisons with this group. Similarly, the use of a nationally representative sample resulted in small sample sizes for minority groups, such as Indian/Asian and elderly populations. Given the low reported fruit juice consumption, combining fruit juice with fruit and vegetable intake to create a binary variable reflecting national recommendations (≥5 vs <5 portions/day) may have increased statistical power; however, its inclusion in our dietary quality index likely had minimal impact on overall outcomes. The dataset did not support the creation of a joint variable combining wealth quintile and self-reported population group, preventing assessment of their interaction, which would have been informative in South Africa's sociohistorical context. Other potentially important dietary variables, such as whole grain, legume, and meat intake, and factors associated with healthier diets in the literature, such as increased grocery expenditure (Okop et al., 2019) and time spent cooking (Janssen et al., 2018), were not collected in the 2016 SADHS and could not be considered. Food preparation methods were also not included. While other types of diabetes are rare in South Africa relative to T2DM (GBD, 2015; Macaulay et al., 2014), the SADHS does not differentiate between diabetes types.

Conclusions

This study's findings, together with existing evidence, should inform actionable public health policies in South Africa, with a particular focus on improving fruit and vegetable consumption among younger, black, and low-

SES populations, particularly those without health insurance. Key healthcare stakeholders—including the South African government, non-governmental organisations, and health insurance providers—should integrate T2DM screening with both individualised lifestyle management and population-level interventions to address the growing burden of the disease.

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CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Appendix 1. Survey participants aged 15 years and over (n=6709).

Variable	OR	95% CI	Brant p-value
Joint diabetes status variable			0.31
No diabetes (No previous diagnosis diabetes and HbA1c <5.7)		Referent	
Prediabetes (No previous diabetes diagnosis and 5.7% ≤HbA1c ≤ 6.4%)	1.09	0.98 – 1.22	
Diabetes (No previous diabetes diagnosis and HbA1c ≥ 6.5)	1.25	1.05 – 1.50	
Controlled diabetes (previous diabetes diagnosis and HbA1c <5.7)	1.12	0.34 – 3.77	
Somewhat-controlled diabetes (Previous diabetes diagnosis and 5.7% ≤HbA1c ≤ 6.4%)	1.66	1.11 – 2.51	
Uncontrolled diabetes (previous diabetes diagnosis and HbA1c ≥ 6.5)	1.83	1.42 – 2.35	
Body mass index			0.18
Normal weight		Referent	
Overweight	1.02	0.86 – 1.22	
Obese	1.09	0.93 – 1.29	
Diagnosis of heart attack/stroke			
No		Referent	
Yes	2.29	1.38 – 3.80	
Gender			0.54
Male		Referent	
Female	1.00	0.86 – 1.16	
Age group			<0.01
Younger adults		Referent	
Middle-aged adults	1.30	1.12 – 1.51	
Older adults	1.70	1.20 – 2.41	
Type of place of residence			
Urban		Referent	
Rural	0.93	0.78 – 1.10	
Ethnicity			0.19
Black African		Referent	
White	4.43	2.64 – 7.45	
Coloured	1.31	1.01 – 1.69	
Indian/Asian/Other	2.53	1.22 – 5.22	
Highest level of education			
No formal education		Referent	
Primary	0.87	0.61 – 1.25	
Secondary	0.93	0.67 – 1.28	
Higher	1.17	0.77 – 1.80	
Wealth quintile			<0.01
Poorest		Referent	
Poorer	0.79	0.65 – 0.95	
Middle	0.83	0.68 – 1.03	

Appendix 1. Cont'd

Richer	1.03	0.81 – 1.32	
Richest	1.32	0.95 - 1.82	
Employment in last 12 months			<0.01
No work in past 12 months		Referent	
Employed in past 12 months, but not currently employed	0.68	0.52 – 0.88	
Currently employed	0.98	0.83 – 1.15	
Covered by Health Insurance (base no)			<0.01
No		Referent	
Yes	1.48	1.05 – 2.09	

[1]Estimates from an ordered logistic regression model that included diabetes status represented by our joint diabetes status variable.

Appendix 2. Distribution of Healthy Diet categories by characteristics of survey participants living with diabetes (Hba1c ≥ 6.5%, N=788[1]).

Variable	Unhealthy	Somewhat Healthy	Moderately Healthy	Healthy	P-value
	N (%)	N(%)	N(%)	N(%)	
Gender					0.08[2]
Male	54 (24.4)	102 (46.2)	42 (19.0)	23 (10.4)	
Female	98 (17.3)	301 (53.1)	122 (21.5)	46 (8.1)	
Age group					0.02
Young adults (15-34)	25 (27.5)	44 (48.4)	17 (18.7)	5 (5.5)	
Middle-aged adults (34-54)	61 (24.4)	121 (48.4)	48 (19.2)	20 (8.0)	
Older adults (55+)	66 (14.8)	238 (53.2)	99 (22.2)	44 (9.8)	
Type of place of residence					0.03
Urban	64 (17.3)	182 (49.2)	93 (25.1)	31 (8.4)	
Rural	88 (21.1)	221 (52.9)	71 (16.9)	38 (9.1)	
Ethnicity					0.03
Black African	134 (19.8)	352 (52.1)	132 (19.5)	58 (8.6)	
White	3 (10.7)	10 (35.7)	13 (46.4)	2 (7.1)	
Coloured	13 (18.8)	36 (52.2)	15 (21.7)	5 (7.2)	
Indian/Asian/Other	2 (13.3)	5 (33.3)	4 (26.7)	4 (26.7)	
Highest level of education					<0.01
No education	23 (16.9)	84 (61.8)	21 (15.4)	8 (5.9)	
Primary	37 (16.5)	125 (55.8)	47 (21.0)	15 (6.7)	
Secondary	76 (21.3)	170 (47.6)	83 (23.2)	28 (7.9)	
Higher	16 (22.5)	24 (33.8)	13 (18.3)	18 (25.4)	
Wealth quintile					<0.01
Poorest	30 (21.0)	84 (58.7)	24 (16.8)	5 (3.5)	
Poorer	37 (22.1)	91 (54.5)	25 (15.0)	14 (8.4)	
Middle	38 (21.6)	90 (51.1)	37 (21.0)	11 (6.3)	
Richer	28 (17.2)	76 (46.6)	41 (25.2)	18 (11.0)	
Richest	19 (13.7)	62 (44.6)	37 (26.6%)	21 (15.1)	

Appendix 2. Cont'd

Employment in last 12 months					0.03
Unemployed last 12 months	89 (16.9)	288 (54.8)	104 (19.8)	45 (8.5)	
Employed in last 12 months, but not currently employed	4 (25.0)	8 (50.0)	1 (6.3)	3 (18.8)	
Currently employed[3]	59 (24.0)	107 (43.5)	59 (24.0)	21 (8.5)	
Covered by health insurance					<0.01
No	135 (20.2)	357 (53.3)	133 (19.9)	44 (6.6)	
Yes	17 (14.3)	46 (38.7)	31 (26.1)	25 (21.0)	

[1]Survey weighting is applied, [2]Chi-square p-values,[3]'Currently employed' includes participants who did not work in the past 7 days, but who are regularly employed and absent from work due to leave, illness, vacation or any other such reason[15].

Appendix 3. Results of univariate ordered logistic regression analysis investigating associations between sociodemographic variables and healthy diet group among survey participants living with diabetes (HbA1c≥ 6.5%, n=788).

Variable	Adjusted odds ratio	95% CI	Brant P-value
Gender			
Male	Referent		
Female	1.18	0.88 – 1.59	0.21
Age group			
Young adults	Referent		
Middle-aged adults	1.20	0.76 – 1.90	0.92
Older adults	1.77[1, 2]	1.15 – 2.72	0.40
Type of place of residence			
Urban	Referent		
Rural	0.76	0.58 – 0.99	
Ethnicity			
Black African	Referent		
White	2.24	1.14 – 4.39	
Coloured	1.03	0.65 – 1.64	
Indian/Asian/Other	2.97	1.11 – 7.97	
Highest level of education			
No formal level of education	Referent		
Primary	1.19	0.80 – 1.75	
Secondary	1.16	0.81 – 1.68	
Higher	2.04	1.16 – 3.61	
Wealth quintile			
Poorest	Referent		
Poorer	1.09	0.72 – 1.65	0.24
Middle	1.20	0.79 – 1.81	0.38
Richer	1.78	1.67 – 2.71	0.28
Richest	2.35	1.52 – 3.65	0.69

Appendix 3. Contd

Employment status			
Currently unemployed	Referent		
Employed in past 12 months, but not currently employed	0.82	0.31 – 2.20	
Currently employed	0.93	0.70 – 1.25	
Covered by health insurance			
No	Referent		
Yes	2.41	1.65 – 3.51	0.12

[1]Statistically significant results are shown in bold, [2]Older adults were 1.77 times more likely to be in a healthier diet group, compared to younger adults.

Appendix 4. Distribution of Dietary Quality Index categories by Diabetes Status and Sociodemographic status[1,2].

Variable	Unhealthy (N=1717)	Somewhat healthy (N=3193)	Moderately healthy (N=1320)	Healthy (N=479)	Total (N=6709)
	N (%)	N (%)	N (%)	N (%)	N (%)
Joint diabetes status variable					
No diabetes (No previous diabetes diagnosis and HbA1c < 5.7%)	447 (26.0[3])	741 (23.2)	294 (22.3)	109 (22.8)	1591 (23.7[4])
Prediabetes (No previous diabetes diagnosis and 5.7% ≤HbA1c ≤ 6.4%)	1105 (64.4)	1999 (62.6)	847 (64.2)	290 (60.5)	4241 (63.2)
Undiagnosed diabetes (No previous diabetes diagnosis and HbA1c ≥ 6.5)	119 (6.9)	288 (9.0)	110 (8.3)	43 (9.0)	560 (8.4)
Controlled diabetes (Previous diabetes diagnosis and HbA1c <5.7%)	2 (0.2)	5 (0.2)	1 (0.1)	1 (0.2)	9 (0.1)
Somewhat-controlled diabetes (Previous diabetes diagnosis and 5.7% ≤HbA1c ≤ 6.4%)	11 (0.6)	45 (1.4)	14 (1.1)	10 (2.1)	80 (1.2)
Uncontrolled diabetes (Previous diabetes diagnosis and HbA1c ≥ 6.5)	33 (1.9)	115 (3.6)	54 (4.1)	26 (5.4)	228 (3.4)
Body mass index					
Underweight or normal weight	820 (47.8)	1.575 (49.3)	587 (44.5)	169 (35.3)	3148 (46.9)
Overweight	430 (25.0)	717 (22.5)	322 (24.4)	128 (26.7)	1597 (23.8)
Obese	444 (25.9)	863 (27.0)	397 (30.1)	180 (37.6)	1884 (28.1)
Not Recorded[5]	23 (1.3)	38 (1.2)	14 (1.1)	2 (0.4)	77 (1.1)
Diagnosis of heart attack and/or stroke					
No	1,662 (96.8)	3.044 (95.3)	1.264 (95.8)	450 (93.9)	6420 (95.7)
Yes	55 (3.2)	149 (4.7)	56 (4.2)	29 (6.1)	289 (4.3)
Gender					
Male	744 (43.3)	1.179 (36.9)	477 (36.1)	160 (6.3%)	2560 (38.2)
Female	974 (56.7)	2.014 (63.1)	843 (63.9)	319 (7.7%)	4149 (61.8)
Age group					
Young Adults (15-34 years)	1,030 (60.0)	1.423 (44.6)	581 (44.0)	195 (40.7)	3229 48.2
Middle-Aged Adults (35-54 years)	446 (26.0)	919 (28.8)	382 (28.9)	148 (30.9)	1895 (28.2)

Appendix 4. Cont'd

Older Adults (55+ years)	241 (14.0)	851 (26.7)	357 (27.0)	136 (28.4)	1585 (23.6)
Type of place of residence					
Urban	882 (51.4)	1.481 (46.4)	703 (53.3)	296 (61.8)	3362 (51.1)
Rural	835 (48.6)	1.712 (53.6)	617 (46.7)	183 (38.2)	3347 (49.9)
Self-reported population group					
Black African	1,575 (91.7)	2.884 (90.3)	1.106 (83.8)	374 (78.1)	5939 (88.5)
White	21 (1.2)	72 (2.3)	83 (6.3)	62 (12.9)	238 (3.5
Coloured	116 (6.8)	214 (6.7)	115 (8.7)	35 (7.3)	480 (7.2)
Indian/Asian/other	5 (0.3)	23 (0.7)	16 (1.2)	8 (1.7)	52 (0.8)
Highest level of education completed					
No Education	104 (6.1)	363 (11.4)	103 (7.8)	32 (6.7)	602 (9.0)
Primary	297 (17.3)	738 (23.1)	237 (18.0)	63 (13.2)	1335 (19.9)
Secondary	1,174 (68.4)	1.933 (60.5)	845 (64.0)	296 (61.8)	4248 (63.3)
Higher	142 (8.3)	159 (5.0)	135 (10.2)	88 (18.4)	524 (7.8)
Wealth quintile					
Poorest	341 (19.8)	863 (27.0)	264 (20.0)	54 (11.3)	1522 (22.7)
Poorer	398 (23.2)	733 (23.0)	255 (19.3)	87 (18.2)	1473 (22.0)
Middle	458 (26.7)	745 (23.3)	299 (22.7)	90 (18.8)	1592 (23.7)
Richer	329 (19.2)	566 (17.7)	286 (21.7)	125 (26.0)	1306 (19.5)
Richest	191 (11.1)	286 (9.0)	216 (16.3)	123 (25.7)	816 (12.2)
Employment in last 12 months					
Unemployed Last 12 Months	982 (57.2)	2.192 (68.7)	829 (62.8)	289 (60.3)	4292 (64.0)
Employed in last 12 months, but not currently employed	113 (6.6)	138 (4.3)	62 (4.7)	13 (2.7)	326 (4.9)
Currently employed[6]	622 (36.2)	863 (27.0)	429 (32.5)	177 (37.0)	2091 (31.1)
Covered by health insurance					
No	1,516 (88.3)	2.937 (92.0)	1.116 (84.5)	340 (71.0)	5909 (88.1)
Yes	201 (11.7)	256 (8.0)	204 (15.5)	139 (29.0)	800 (1.9)

[1]Survey weighting is applied, [2]N=6709, [3]As exemplar to aid interpretation, 26.0% of participants in the unhealthy group had no evidence of diabetes, [4]As exemplar to aid interpretation, 23.7% of all participants had no evidence of diabetes, [5]Participants who did not have height and weight measured for BMI to be recorded were retained in analysis providing they had a valid HbA1c, with these individuals recorded in analyses as a separate 'not recorded' category, [6]Currently employed' includes participants who did not work in the past 7 days, but who are regularly employed and absent from work due to leave, illness, vacation or any other such reason[15].

Appendix 5. Distribution of dietary quality index categories by characteristics of survey participants living with diabetes (Hba1c ≥ 6.5%, N=788[1]).

Variable	Unhealthy	Somewhat healthy	Moderately healthy	Healthy	P-value
	N (%)	N (%)	N (%)	N (%)	
Gender					
Male	54 (24.4)	102 (46.2)	42 (19.0)	23 (10.4)	0.08[2]
Female	98 (17.3)	301 (53.1)	122 (21.5)	46 (8.1)	
Age group					
Young Adults (15-34)	25 (27.5)	44 (48.4)	17 (18.7)	5 (5.5)	
Middle-Aged Adults (34-54)	61 (24.4)	121 (48.4)	48 (19.2)	20 (8.0)	0.02
Older Adults (55+)	66 (14.8)	238 (53.2)	99 (22.2)	44 (9.8)	
Type of place of residence					
Urban	64 (17.3)	182 (49.2)	93 (25.1)	31 (8.4)	0.03
Rural	88 (21.1)	221 (52.9)	71 (16.9)	38 (9.1)	
Self-reported population group					
Black African	134 (19.8)	352 (52.1)	132 (19.5)	58 (8.6)	
White	3 (10.7)	10 (35.7)	13 (46.4)	2 (7.1)	0.03
Coloured	13 (18.8)	36 (52.2)	15 (21.7)	5 (7.2)	
Indian/Asian/Other	2 (13.3)	5 (33.3)	4 (26.7)	4 (26.7)	
Highest level of education					
No Education	23 (16.9)	84 (61.8)	21 (15.4)	8 (5.9)	
Primary	37 (16.5)	125 (55.8)	47 (21.0)	15 (6.7)	<0.01
Secondary	76 (21.3)	170 (47.6)	83 (23.2)	28 (7.9)	
Higher	16 (22.5)	24 (33.8)	13 (18.3)	18 (25.4)	
Wealth quintile					
Poorest	30 (21.0)	84 (58.7)	24 (16.8)	5 (3.5)	
Poorer	37 (22.1)	91 (54.5)	25 (15.0)	14 (8.4)	
Middle	38 (21.6)	90 (51.1)	37 (21.0)	11 (6.3)	<0.01
Richer	28 (17.2)	76 (46.6)	41 (25.2)	18 (11.0)	
Richest	19 (13.7)	62 (44.6)	37 (26.6)	21 (15.1)	
Employment in last 12 months					
Unemployed Last 12 Months	89 (16.9)	288 (54.8)	104 (19.8)	45 (8.5)	0.03

Appendix 5. Cont'd

Employed in Last 12 Months, but not currently employed	4 (25.0)	8 (50.0)	1 (6.3)	3 (18.8)	
Currently employed[3]	59 (24.0)	107 (43.5)	59 (24.0)	21 (8.5)	
Covered by health insurance					
No	135 (20.2)	357 (53.3)	133 (19.9)	44 (6.6)	<0.01
Yes	17 (14.3)	46 (38.7)	31 (26.1)	25 (21.0)	

[1]Survey weighting is applied, [2]Chi-square p-values, [3]'Currently employed' includes participants who did not work in the past 7 days, but who are regularly employed and absent from work due to leave, illness, vacation or any other such reason[15].