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Prevalence and Correlates of Cardio-Metabolic Risk Factors Among Regular Street Food Consumers in Dar es Salaam, Tanzania

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Background: Regular street food consumers (RSFCs) in Africa are at an increased risk of unhealthy eating practices, which have been associated with intermediate risk factors of cardio-metabolic diseases. However, knowledge of the magnitude and correlates of these risk factors is limited in Tanzania. This study aimed to fill this gap using data collected from RSFCs in Dar es Salaam, the largest city in Tanzania.

Methodology: A cross-sectional study was carried out among 560 RSFCs in three districts of Dar es Salaam between July and September 2018. Information on socio-economic factors and demographics, behavioral risks, anthropometric and biochemical indicators was collected. Adjusted odds ratios (OR) and prevalence ratio (PR) with corresponding 95% confidence intervals (CI) were estimated using multivariable binary logistic and modified Poisson regression models, respectively.

Results: On average, participants consumed 11 street food meals/week. The prevalence (95% CI) of cardio-metabolic risk factors was 63.9% (60.6–69.9%) for overweight/obesity, 42.5% (38.3–46.9%) for raised blood pressure, 13.5% (10.9–16.8%) for raised triglycerides and 6.6% (4.9–9.3%) for raised glucose levels. The correlates of overweight/obesity were female vs male sex (APR=1.3; 95% CI 1.2–1.5), age of 41–64 vs 25–40 years (APR=1.4; 95% CI 1.2–1.6), high vs low income (APR=1.2; 95% CI 1.04–1.3), being married/cohabiting vs other (APR=1.2; 95% CI 1.01–1.4) and family history of diabetes vs no family history (APR=1.2; 95% CI 1.01–1.3). Age 41–64 vs 25–40 years, was the only significant factor associated with raised blood pressure APR (95% CI) 2.2 (1.7–2.9) and raised glucose AOR (95% CI) 3.9 (1.5–10.5).

Conclusion: Our study revealed that RSFCs are at risk of cardio-metabolic health problems, especially women, middle-aged people and those with higher incomes. Transdisciplinary studies to understand the drivers of street food consumption are needed in order to inform interventions to mitigate the risk of developing cardio-metabolic diseases. These interventions should target both street food vendors and their consumers.

Keywords: street food consumers, cardio-metabolic risks, cardio-metabolic correlates, Tanzania

Introduction

Cardio-metabolic diseases such as type 2 diabetes, hypertension and cardiovascular diseases are growing public health problems. They affect approximately 425 million people globally.[1] Without effective preventive interventions, the burden of type 2 diabetes is estimated to increase by 55% between 2017 and 2030.[1–3] In Tanzania, the prevalence of type 2 diabetes in the general population has increased

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from 1% in 1989 to 9.1% in 2012.[4,5] In the past two decades, type 2 diabetes was among the top 20 causes of mortality in Tanzania; but it has risen in rank to be among the top 10 in recent years.[4] Previous studies have showed that the risk factors for cardio-metabolic diseases in the general population are increasing due to unhealthy eating habits, physical inactivity, family history of related diseases, tobacco use and excessive alcohol consumption.[5–8] It has also been demonstrated that interventions targeting socio-economic, behavioral and biological risk factors may reduce cardio-metabolic risk factors.[9–11] This calls for prioritization of cardio-metabolic diseases in the Global Security Health Agenda.[12] Regular street food consumers – defined as persons who consume foods and/or beverages prepared in the street or at home, and sold in public areas[13,14] – are a high-risk population for developing cardio-metabolic diseases.

It is estimated that more than 2.5 billion urban dwellers in the world and at least 70% of low- and middle-income earners in Dar es Salaam, Tanzania consume food from street vendors daily. The street food market therefore supports livelihoods and provides employment to a significant number of people.[15,16] However, the diversity and nutritional quality of street food are often questionable, especially in low-income settings, including Tanzania.[15–17] Street food vendors, due to the business nature of their activities, may prioritize taste over nutritional value and hygiene when preparing food, which may result in consuming high carbohydrate and/or high protein dishes that contain limited – if any – fruit and vegetables.[15,16] The street food consumer, therefore, struggles to consume the minimum of 400 grams of fruits and vegetables per day, as recommended by the WHO in order to prevent non-communicable diseases.[18] Furthermore, food quality control and enforcement authorities focus more on monitoring risk factors associated with food-borne illnesses, while less attention is paid to nutritional value.[19–21] Other barriers to adhere to the WHO recommendations include limited knowledge of nutrition among both vendors and consumers and the fact that consumers have limited control over the nutritional values of the meals they purchase.[16,22] All these factors put regular street food consumers at increased risk of cardio-metabolic diseases.

There is scant data on the prevalence and correlates of cardio-metabolic risk factors among regular street food consumers in Tanzania. This study aimed to describe the prevalence and correlates of cardio-metabolic risks among regular street food consumers in three districts of Dar es Salaam, the largest city in Tanzania. These include overweight/obesity, raised blood pressure, raised blood triglycerides and raised blood glucose.[23–25] Findings will be used to co-develop comprehensive, cost-effective intervention programmes to mitigate the cardio-metabolic risks in this context.

Materials and Methods

Study Area

Dar es Salaam is the seventh-largest city by population in Africa and one of fastest growing cities in the world. The current population is about 7 million and projected to reach 13 million by 2035.[26,27] Dar es Salaam was sampled for this study since nearly 70% of its low- and middle-income population consume street food daily.[16]

Study Design, Setting and Population

A cross-sectional study was conducted between July and September 2018 in three districts of Dar es Salaam, Tanzania. These districts, which were randomly selected out of five districts in Dar es Salaam, include: Kinondoni, Ubungo and Ilala. We collected information on regular street food consumers as part of a baseline assessment for a planned nutritional intervention. In this study, regular street food consumers were defined as those who purchase and consume at least three lunch-meals per week (7 days) from street food vendors.

We mapped all markets in each district and randomly selected two markets per district for inclusion in this study. All street vendors in these six markets were screened for eligibility. Eligibility criteria for vendors were as follows: i) aged 18 or above; ii) has been vending food at the current site for at least 12 months; iii) has at least seven customers who have been consuming at least three lunch meals per week for at least 3 months; iv) is ready to implement the components required for an intervention; and v) will continue vending food at the same site for at least another 12 months. Eligible vendors were asked to provide the names and contact details of their regular clients. This was possible because regular consumers typically call vendors to bring food to their workplace. Vendors were asked to list all of their regular customers to avoid selection bias; vendors were informed in advance that only consented customers will be included in the study. With the customers' list, the principal researcher approached each of the customers and gave information about the study and sought informed consent, the good thing all participants were literate hence able to sign the consent form. Regular street food consumers were eligible for participation if they met the following criteria: i) aged 25–64 years; ii) consume at least three lunches per week at the same street food vendor; iii) have no plans to move out of the study area in the next 12 months; and iv) have been consuming street food for not less than one year; and v) are willing to participate in the study. Figure 1 summarizes sampling procedures of the study subjects and sites.

Data Collection Methods

Field data collectors were selected based on prior experience in data collection in similar topics. The team was comprised of two nurses, three laboratory technicians, two sociologist, one demographer, three medical doctors and one statistician. Before starting data collection, the team attended a 3-day training on the study protocol and ethical issues, interview procedures and physical and laboratory measurements. The survey questionnaire was adapted from previous, similar surveys including the WHO STEPwise approach to surveillance (STEPS) surveys and published articles,[5,28] and translated into the local language (Kiswahili). Before initiating field activities, the data collection team and supervisory team pilot-tested the study tools and data collection procedures at Tegeta site in Dar es Salaam.

Five days of data collection were done at each site. Together with a focal person at each sampling cluster, the principal investigator identified a suitable building close to the site, where data could be collected in privacy. Participants were informed and asked to attend interviews and complete

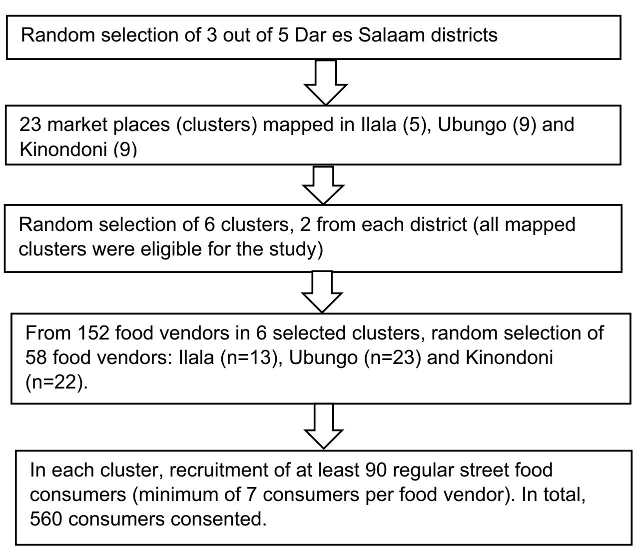

Figure 1 Flow chart of the procedures for the selection of street-food consumers in Dar es Salaam city, Tanzania.

blood tests and anthropometric measurements. A total of 0.5 microliter blood volume was taken from finger (finger pricks) for blood glucose test and for cholesterol test, the laboratory technician took 5mls from Venous vein. Blood samples for cholesterol were stored in a cool box and transported immediately after collection to the St. Laurent Diabetes Centre, Dar es Salaam, for analysis. Additionally, the team collected the following self-reported information from each participant: socio-economic and demographic characteristics; behavioral data including tobacco smoking, types of cooking oils used at home, alcohol consumption, fruit and vegetable consumption, and physical activity; personal history of diabetes and family history of diabetes.

Study Variables and Measurements

Dependent Variables

Four cardio-metabolic risk factors were the primary outcomes of interest: overweight/obesity, raised blood pressure (BP), raised blood glucose and raised triglycerides.[29] BP was measured in triplicate with three minutes between repeated measurements and with arms elevated at heart-level using an electronic sphygmomanometer (OMRON®). The average of the last two readings was used. A participant was considered having raised BP if he/she was on medication for raised BP, had a diastolic BP of ≥90 mmHg, and/or systolic BP of ≥140 mmHg.[5]

Weight (kg) and height (cm) measurements were taken using a digital scale (SECA®) and a portable stadiometer (SECA®), respectively. Before measuring weight and height, the participants were instructed to remove any heavy clothing and their shoes. The machines were calibrated on a daily basis according to the manufacturer's manual. Height measurements were taken with heels, buttocks and upper back in contact with the stadiometer. Weight (in kg) divided by height (in meters-squared) was used to calculate body mass index (BMI). A person was considered to be overweight/obese if he/she had a BMI ≥25.0 kg/m^2.[30]

Before collecting blood for blood glucose and cholesterol measurements, each participant was asked to fast for at least 8 hours. Blood glucose tests were taken using a point-of-care device (GlucoPlus).[31,32] Participants were defined as having raised blood glucose if they had a fasting blood glucose ≥7 mmol/L or were on medication for raised blood glucose.[5,33] Cholesterol reagents in liquid form were used in testing triglycerides using Elba semi-automated machine.[5,34] Participants were defined as having raised triglycerides if they had a fasting triglyceride >1.7 mmol/

L or were on medication for raised cholesterol.[5] Blood tests were taken and analyzed by trained laboratory technicians.

Independent Variables

Twelve explanatory variables categorized into three groups including socio-economic and demographic factors; family history; and behavioral risks[29,35,36] were used to predict each component of cardio-metabolic risk factors. The socio-economic and demographic factors included sex (male vs female [referent]), age (25–40 years [referent] vs 41–64 years), education (none/primary vs secondary or above [referent]), marital status (married/cohabiting vs others including single, widowed, divorced, or separated [referent]) and household monthly income (low [<median Tshs 360,000 equivalent to USD 159, referent] vs high [≥median]). We also recorded family history of diabetes (Yes/No[referent]). Behavioral risks included alcohol consumption (current/past vs never[referent])[37], smoking (current/past [referent] vs never), fruits/vegetables (<5 days/week [referent] vs ≥5 days/week),[34] cooking with oil (vegetable oil [referent] vs non-vegetable oil), physical activity (low <600 MET/week vs high [≥600 MET/week, referent])[38] and meals eaten outside the home/per week (3–7 meals/week [referent] vs 8–28 meals/week).

Sample Size Estimation

A prior sample size was estimated for cluster randomized control trial while this paper is reporting cross-sectional baseline results. For the sake of the design of the current paper, sample size was recalculated to ensure a large enough sample to estimate prevalence statistics of interest. The following parameters were used: prevalence of raised BP among adults aged 25–64 in Dar es Salaam of 27%;[39] Z=1.96; value of standard normal distribution at 95% confidence level and marginal of error "e"= 5%; design effect of 1.5; and a non-response rate of 20%. With the above statistical parameters a sample size of 570 was deemed sufficient, only slightly higher than our actual sample size of 560. The formula for sample size calculation can be accessed from.[40]

Statistical Analysis

Data were collected electronically using the open data kit (ODK) system,[41] cleaned and stored on the main server at the National Institute for Medical Research Muhimbili Centre. Univariate statistics were used to describe the sample including the prevalence of cardio-metabolic risk factors. We also assessed the magnitude of cumulative risks as per WHO standards to determine the risk dosage among the participants.[5] The prevalence of raised blood glucose was <10%, and so odds ratios (OR) with 95% confidence intervals (CI) were estimated using binary logistic regression for socio-economic, family history, and behavioral risks associated with raised blood sugar.[42–44] The prevalence of the three other dependent variables (overweight/obesity, high BP and raised triglycerides) was >10%. Logistic regression was not suitable as it overestimates ORs when the outcome of interest is >10%.[42–44] Thus, a modified Poisson regression model was used to estimate adjusted prevalence ratios with 95% CI for socio-economic, family history and behavioral risks associated with overweight/obesity, raised BP and raised triglycerides.[42,45] We first estimated bivariate (eg, unadjusted) models for each independent variable. All variables significant at $p<0.20$ in these unadjusted analyses were included in a multivariable model.[46,47] In these final adjusted (eg, multivariable) models, variables were considered statistically significant at level of $p<0.05$. In sensitivity analyses, we modelled BMI, systolic blood pressure (SBP), blood glucose and triglycerides as continuous variables using linear regression. All statistical analyses were conducted using Stata version 15 (STATA Corp Inc., TX, USA).

Ethical Clearance

This study was done following set of ethical principles in accordance to with revised 1964 Declaration of Helsinki including ethical approval and informed consent.[48] Specifically, this study was approved by the National Medical Research and Coordinating Committee and given ethical approval number NIMR/HQ/R.8a/Vol.IX/2794. This study was also reviewed and approved by the Kilimanjaro Christian Medical University College Review Board and given approval number 2291. Written informed consent was obtained from all participants. They were also assured that participation was voluntary and could be stopped at any time, and nobody would be affected negatively for not consenting to participate in the study. Study subjects found to have cardio-metabolic risks were advised according to the WHO guidelines[49] and those found with disease problems were informed and referred to a nearby health facility for further management.

Data Sharing Statement

The data used to produce this manuscript are available from the corresponding author upon reasonable request.

Results

Socio-Economic and Demographic Characteristics of Study Participants

Table 1 shows the participants' socio-economic and demographic characteristics. A total of n=560 street food consumers were enrolled in the study between July and September 2018. The response rate was 98.2% (560/570). More than half (57.5%) of participants were male and seven out of ten participants were aged between 35 and 64 years. The majority (84%) of participants had either no formal education or had primary level education. Three quarters (75%) were married and the majority (90.7%) were self-employed with small to large businesses. The median household monthly income was Tshs 360,000, equivalent to 159 USD.

Table 1 Distribution of Socio-Economic and Demographic Characteristics of Regular Street Food Consumers in Dar es Salaam, Tanzania (N=560)

Characteristics	Total
Age (years)	
Mean (SD)	42.7(11.4)
Age group (years)	
25–34	163(29.1)
35–44	151(27.0)
45–54	164(29.3)
55–64	82(14.6)
Education	
None	30(5.4)
Primary	440(78.6)
Secondary	65(11.6)
College	25(4.5)
Marital status	
Single	67(12.0)
Married	419(74.8)
Widowed	12(2.1)
Divorced	15(2.7)
Separated	40(7.1)
Cohabiting	7(1.3)
Occupation	
Employment without pay	2(0.4)
Self-employment	508(90.7)
Non-government employee	26(4.6)
Government employee	24(4.3)
Household monthly income (Tshs)	
Median (IQR)	360,000 (240,000–600,000)
Household monthly income (USD)*	
Median (IQR)	158.94 (106.0–264.9)

Notes: Values are n (percent) unless otherwise specified. *Exchange Rate= 1$: Tshs 2265.

Prevalence of Cardio-Metabolic Risk Factors, Behavioral Risks and Family History

Table 2 shows the prevalence (95% CI) of cardio-metabolic risk factors among regular street food consumers: 63.9% (60.6–69.9%) overweight/obese, 42.5% (38.3–46.9%) raised BP, 13.5% (10.9–16.8%) raised triglycerides and 6.6% (4.9–9.3%) raised blood glucose. Only one-third (35.5%) of participants reported consuming fruit/vegetables 5 days per week. About 18% (13.7–20.2%) were either past or current smokers, one-third (35.9%) reported non-vegetable oil as a common cooking oil at home. On average, regular street food consumers reported consuming 11 meals per week outside their homes. About 29.0% (25.1–32.7%) reported having a history of diabetes in their family and on average each participant had four cumulative risks. About 72% participants aged 25–40 years had at least three and above cumulative risks while those aged 40–64 years had 90.0% (86.2–92.8%).

Table 3 shows the results of models estimating the correlation of socio-demographic characteristics, behavioural risks and family history with cardio-metabolic risks among regular street food consumers. Female sex (=1.3; 95% CI 1.1–1.4), older age (41–64 years, APR=1.4; 95% CI 1.2–1.6), high income (high, APR=1.2; 95% CI 1.04–1.3), married/cohabiting marital status (APR=1.2; 95% CI 1.01–1.4), family history of diabetes (APR=1.1; 95% CI 1.01–1.3), consuming fruit/vegetables at least 5 days/week (APR=1.1; 95% CI 1.03–-1.2) and current/past smoking (never smoked, APR=1.3; 95% CI 1.04–1.6) were significantly positively associated with overweight/obesity. Older age (41–64 years vs 25–40 years) was the only significant factor associated with raised BP (APR=2.2; 95% CI 1.7–2.9) and raised blood glucose (AOR=3.9; 95% CI 1.5–10.5).

Table 4 shows the sensitivity analyses modelling dependent variables continuously. Results were largely consistent for overweight/obesity except that married/

Table 2 Prevalence of Cardio-Metabolic, Behavioural, Familial and Cumulative Risk Factors of Type 2 Diabetes Among Street Food Consumers (N=560)

Type of Risk Factors	Number	Percent (95% CI)
Cardio-metabolic risk factors		
Body mass index		
Normal/underweight (<25.0 kg/m^2)	202	36.1(31.1–39.4)
Overweight/obese(≥25.0 kg/m^2)	358	63.9(60.6–69.9)
Blood Pressure (BP)		
Normal BP (DBP<90 mmHg, SBP <140 mmHg, and not on medication for raised BP)	322	57.5(53.1–61.7)
Raised BP (DBP ≥90 mmHg, SBP ≥140 mmHg, or on medication for raised BP)	238	42.5(38.3–46.9)
Blood Glucose (BG)		
Normal BG (<7 mmol/L) and not on medication for raised BG	509	93.4(90.6–95.1)
Raised BG (≥7 mmol/L) or on medication for raised BG	36	6.6(4.9–9.3)
Missing	15	
Triglycerides (TG)		
Normal TGs (<1.7 mmol/L) and not on medication for raised triglycerides	455	86.5(83.2–89.1)
Raised triglycerides(>1.7 mmol/L) or on medication for raised triglycerides	71	13.5(10.9–16.8)
Missing	34	
Behavioural and familial risk factors		
Alcohol consumption		
Never	388	69.1(65.0–73.0)
Current/past	172	30.9(27.0–35.0)
Smoking cigarettes		
Never	462	82.5(80.0–86.0)
Current/past	98	17.5(13.7–20.2)
Vegetable/fruit consumption		
≥5 days/week	215	38.4(35.5–43.9)
<5 days/week	345	61.6(56.1–64.5)
Physical activity		
Low physical activity (<600 MET/week)	138	24.6(21.7–29.2)
Moderate/high physical activity(≥600 MET/week)	422	75.4(70.8–78.3)
Common cooking oil used at home		
Vegetable oil	355	64.1(59.4–67.7)
Non-vegetable oils	199	35.9(32.2–40.6)
Missing	6	
Meals eaten outside/week		
Mean (SD)	10.9(4.7)	10.9(10.4–11.4)
Family History of Diabetes		
Yes	161	28.8(25.1–32.7)
No	399	71.2(67.3–74.9)
Summary of combined risk factors[5]*		
Mean (SD) risks factors	3.8(1.5)	3.8(37–3.9)
Percentage with ≥3 risk factors aged 25–40 years (n=230)	165	71.7(65.5–77.2)
Percentage with ≥3 risk factors aged 40–64 years (n=330)	297	90.0(86.2–92.8)
Percentage with ≥3 risk factors aged 25–64 years (n=560)	462	82.5(79.1–85.4)

Notes: *The following 7 risk factors were included: Current/past-smokers, current/past-drinker, eat fruits and vegetables <5 days/week, low level of physical activity (<600 MET/week), overweight/obesity (BMI ≥25 kg/m^2), raised BP, and raised BG.[5]

Table 3 Factors Associated with Prevalence of Cardio-Metabolic Risk Factors Among Regular Street Food Consumers (N=560)

Factor	Overweight/Obese		Raised Blood Pressure		Fasting Blood Glucose(FBG)		Triglycerides (TG)	
	Unadjusted PR, 95% CI	**Adjusted PR, 95% CI**	**Unadjusted PR, 95% CI**	**Adjusted PR, 95% CI**	**Unadjusted OR, 95% CI**	**Adjusted OR, 95% CI**	**Unadjusted PR, 95% CI**	**Adjusted PR, 95% CI**
Sex								
Male	Ref	Ref	Ref		Ref		Ref	Ref
Female	1.3(1.1–1.4)	1.3 (1.2–1.5)	1.0(0.8–1.2)		0.8(0.4–1.6)		0.7(0.5–1.1)	0.8(0.5–1.3)
Age group (years)								
25–40	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
41–64	1.4(1.2–1.6)	1.4(1.2–1.6)	2.3(1.8–2.9)	2.2(1.7–2.9)	4.6(1.7–11.9)	3.9(1.5–10.5)	1.4(0.9–2.1)	1.2(0.7–1.9)
Education								
Non/primary	1.03(0.9–1.2)		1.2(0.9–1.6)		0.8(0.3–1.8)		1.4(0.7–2.8)	
Secondary/above	Ref		Ref		Ref		Ref	
Marital status								
Married/cohabiting	1.2(1.01–1.4)	1.2(1.01–1.4)	1.2(0.9–1.5)	1.0(0.8–1.2)	2.0(0.8–5.3)	1.4(0.5–3.9)	1.6(0.9–3.0)	1.5(0.8–2.8)
Others*	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Household monthly income								
Low	Ref	Ref	Ref		Ref		Ref	
High	1.2(1.1–1.4)	1.2(1.04–1.3)	1.0(0.8–1.2)		1.4(0.7–2.8)		0.9(0.6–1.4)	
Family history of diabetes								
Yes	1.2(1.03–1.3)	1.1(1.01–1.3)	1.0(0.8–1.3)		1.4(0.7–2.9)		1.2(0.7–1.8)	
No	Ref	Ref	Ref		Ref		Ref	
Alcohol								
Current/past-drinker	1.0(0.9–1.1)		1.1(0.9–1.3		1.7(0.8–3.3)	1.4(0.7–2.8)	1.3(0.8–2.0)	
Non-life drinker/never	Ref		Ref		Ref	Ref	Ref	
Smoking								
Current/past-smoker	Ref	Ref	Ref		Ref	Ref	Ref	Ref
Non/-life smoker/never	1.3(1.1–1.6)	1.3(1.04–1.6)	1.0(0.8–1.3)		0.5(0.2–1.1)	0.8(0.3–1.7)	0.7(0.4–1.2)	0.8(0.5–1.4)
Fruit/vegetables								
<5 days/week	Ref	Ref	Ref		Ref		Ref	
≥5 days/week	1.2(1.1–1.3)	1.1(1.03–1.2)	1.1(0.9–1.3)		1.1(0.6–2.3)		0.8(0.5–1.3)	

(*Continued*)

Table 3 (Continued).

Factor	Overweight/Obese		Raised Blood Pressure		Fasting Blood Glucose(FBG)		Triglycerides (TG)	
	Unadjusted PR, 95% CI	Adjusted PR, 95% CI	Unadjusted PR, 95% CI	Adjusted PR, 95% CI	Unadjusted OR, 95% CI	Adjusted OR, 95% CI	Unadjusted PR, 95% CI	Adjusted PR, 95% CI
Cooking oil								
Vegetable oil	Ref	Ref	Ref	Ref	Ref		Ref	Ref
Non-vegetable oil	0.9(0.8–1.03)	0.9(0.8–1.06)	0.9(0.7–1.1)	0.9(0.7–1.1)	0.7(0.3–1.4)		0.6(0.4–1.1)	0.6(0.4–1.1)
Physical activity (MET/week)								
Low <600	1.1(0.9–1.2)		1.0(0.8–1.2)		1.0(0.5–2.2)		1.2(0.8–2.0)	
High 600+	Ref		Ref		Ref		Ref	
Meals eaten outside home/per week								
3–7 meals	Ref	Ref	Ref		Ref		Ref	
8–28 meals	1.1(0.9–1.3)	1.1(1.0–1.3)	1.0(0.8–1.2)		0.7(0.3–1.4)		0.8(0.5–1.2)	

Notes: All covariates whose p-value at unadjusted analysis stage was not <0.2 were excluded in adjusted analysis models. *Single/divorced/separated/widow/widower.

cohabiting marital status and consuming fruit/vegetables at least 5 days/week were no longer statistically significant. Results for SBP were consistent with aged 41–64 years having higher SBP compared to aged 25–40 years. The positive association between older age and fasting blood glucose was no longer statistically significant.

Discussion

In the present study, we provide prevalence of cardio-metabolic risks including overweight/obesity, raised BP, raised blood glucose and raised triglycerides among regular street food consumers in Tanzania's largest city. Results indicated that more than half of the daily three standard meals were consumed outside homes, ie, on average, out of 21 standard meals per week, 11 were consumed outside the home. The prevalence of cardio-metabolic risks documented among regular street food consumers in this study is high. Being married/cohabiting, never smoker, family history of diabetes and consuming fruit/vegetables at least 5 days per week were significant factors associated with overweight/obesity. Other factors which were associated with overweight/obesity included being female, aged 41 years or older and high income. This study also revealed that participants aged 41 years and older were more likely to have raised BP and raised blood glucose. We also documented a considerable magnitude of prevalence of having three or more risks factors. These risk factors include: being a current/past-smoker or drinker, eating fruit/vegetables <5 times per week, a low level of physical activity, overweight/obesity, raised BP and raised blood glucose. More studies with robust study designs and those covering different geographic zones in the country are needed to assess the contribution of street food to non-communicable diseases in Tanzania.

As expected, this analysis indicated that the prevalence of overweight/obesity was extremely high. The easily available ready-made food and unhealthy dietary behaviours, which are common in urban settings, may explain why the majority of consumers are overweight/obese.[50,51] Unhealthy food consumption has been linked with accessibility and livelihoods.[52–54] A high prevalence (33.5%) of overweight/obesity was also documented among preadolescents in Thailand, where street food purchased and consumed at school had a significant positive effect on BMI.[52] In India, a study among adults indicated that high availability of fast food restaurants in residential areas was associated with poor diet, including reduced intake of fruit and vegetables as well as increased prevalence of

Table 4 Factors Associated with Prevalence of Cardio-Metabolic Risk Factors Among Regular Street Food Consumers (N=560)

Factors	Body Mass Index		Systolic Blood Pressure		Fasting Blood Glucose		Fasting Triglycerides	
	Unadjusted Beta Coefficient 95% CI	**Adjusted Beta Coefficient 95% CI**	**Unadjusted Beta Coefficient 95% CI**	**Adjusted Beta Coefficient 95% CI**	**Unadjusted Beta Coefficient 95% CI**	**Adjusted Beta Coefficient 95% CI**	**Unadjusted Beta Coefficient 95% CI**	**Adjusted Beta Coefficient 95% CI**
Sex								
Male	Ref	Ref	Ref		Ref		Ref	Ref
Female	1.8(0.9–2.7)	1.8(0.8–2.8)	−0.8(−4.6–3.0)		−0.03(−0.2–0.2)		0.1(−0.04–0.2)	0.1(0.01–0.3)
Age group (years)								
25–40	Ref	Ref	Ref	Ref	Ref		Ref	Ref
41–64	1.1(0.1–2.0)	1.5(0.6–2.5)	4.2(0.4–7.9)	4.9(1.1–8.8)	0.1(−0.1–0.3)		0.2(0.05–0.3)	0.2(0.1–0.3)
Education								
Non/primary	−0.5(−1.8–0.8)		1.4(−3.6–6.5)		0.1(−0.2–0.4)		0.05(−0.1–0.2)	
Secondary/above	Ref		Ref		Ref		Ref	
Marital status								
Married/cohabiting	0.5(−0.7–1.6)		0.4(−4.0–4.8)		0.1(−0.2–0.3)		0.1(0.0–0.3)	0.1(−0.01–0.3)
Others*	Ref		Ref		Ref		Ref	Ref
Household monthly income								
Low	Ref	Ref	Ref		Ref		Ref	
High	1.03(0.1–2.0)	1.04(0.12–2.0)	1.6(−2.1–5.4)		0.01(−0.2–0.2)		−0.02(−0.1–0.1)	
Family history of diabetes								
Yes	1.8(0.8–2.9)	1.7(0.7–2.7)	−0.1(−4.2–4.0)		0.1(−0.1–0.4)		0.1(−0.1–0.2)	
No	Ref	Ref	Ref		Ref		Ref	
Alcohol								
Current/past-drinker	−0.4(−1.4–0.6)		−5.8((−9.8 to −1.7)	−5.8(−9.9 to −1.6)	0.1(−0.1–0.4)		0.1(−0.1–0.2)	
Non-life drinker/never	Ref		Ref	Ref	Ref		Ref	
Smoking								
Current/past-smoker	Ref	Ref	Ref	Ref	Ref		Ref	
Non/-life smoker/never	1.3(0.01–2.5)	0.7(−0.6–2.0)	4.1(−0.8–9.0)	3.2(−1.9–8.3)	−0.04(−0.3–0.2)		−0.01(−0.2–0.2)	
Fruit/vegetables								
<5 days/week	Ref		Ref	Ref	Ref		Ref	
≥5 days/week	−0.4(−1.4–0.5)		2.7(−1.1–6.5)	1.9(−2.0–5.7)	−0.1(−0.3–0.1)		−0.002(−0.1–0.12)	

(*Continued*)

Table 4 (Continued).

Factors	Body Mass Index Unadjusted Beta Coefficient 95% CI	Body Mass Index Adjusted Beta Coefficient 95% CI	Systolic Blood Pressure Unadjusted Beta Coefficient 95% CI	Systolic Blood Pressure Adjusted Beta Coefficient 95% CI	Fasting Blood Glucose Unadjusted Beta Coefficient 95% CI	Fasting Blood Glucose Adjusted Beta Coefficient 95% CI	Fasting Triglycerides Unadjusted Beta Coefficient 95% CI	Fasting Triglycerides Adjusted Beta Coefficient 95% CI
Cooking oil								
Vegetable oil	Ref		Ref	Ref	Ref		Ref	Ref
Non-vegetable oil	−0.4(−1.4–0.6)		−3.4(−7.3–0.5)	−3.2(−7.0–0.7)	−0.2(−0.4–0.1)	−0.2(−0.4–0.05)	−0.1(−0.2–0.01)	−0.1(−0.2–0.01)
Physical activity(MET/week)								
Low <600	−0.5(−1.6–0.6)		−2.0(−6.4–2.3)		−0.1(−0.3–0.2)		−0.01(−0.1–0.1)	
High 600+	Ref		Ref		Ref		Ref	
Meals eaten outside home/per week								
3–7 meals	Ref		Ref		Ref	Ref	Ref	Ref
8–28 meals	−0.6(−1.7–0.4)		0.7(−3.3–4.8)		−0.2(−0.4–0.04)	−0.2(−0.4–0.04)	−0.1(−0.2–0.2)	−0.1(−0.2–0.03)

Notes: All covariates whose p-value at unadjusted analysis stage was not <0.2 were excluded in adjusted analysis models. *Single/divorced/separated/widow/widower.

overweight/obesity.[53] A study conducted in Brazil among school children also reported a positive relationship between overweight/obesity and living closer to restaurants.[54] From the current findings and evidence from the above literature, it can be postulated that, the spread of food selling points, including street food vendors and the quality of food sold in terms of nutritional values, may act as an enabling or impeding environment for body weight gain or control, respectively.

Surprisingly, in this study, we found that high intakes of fruits and vegetables was associated with higher likelihood of overweight/obesity, which is likely the result of reverse causality – e.g., those with overweight/obesity who are trying to lose weight may increase their intake of fruits and vegetables. It could also be the case that vegetables are consumed in an unhealthy way – e.g., fried in large amounts of unhealthy oils – in this context. Similar mixed results have been found for another healthy food group – fish – because in some cultural contexts fish is typically consumed deep-fried, negating its health benefits. Research is mixed regarding the association between fruits and vegetables and adiposity, but rarely has a study found that fruits and vegetables cause obesity in free-living individuals.[55,56] Future, case–control or longitudinal research studies will shed more light on this association in the context of Tanzania.

The current study also documented a high prevalence of raised BP among participants. The prevalence documented in this study (42.5%) was higher than that observed in other populations in Tanzania including people living with HIV (26.2%) and regular red meat consumers (9.8%).[34,57] The magnitude of raised BP observed in this study may be explained by the alarming prevalence of overweight/obesity also observed in this sample given that excess adiposity is a leading risk factor for high BP.[58–61]

Hypertriglyceridemia is among the highest risk factors for cardiovascular diseases and increases the risk for insulin resistance.[62,63] Proper intervention measures including a balanced diet, weight reduction and physical exercise are recommended if one aims to reverse the problem.[64,65] In this study, the prevalence of raised triglycerides was higher compared to what was observed (10.2%) in South Africa among the general population and lower compared to the level observed among people living with HIV (16.6%) in Tanzania and in Tanzanian general population (33.8%).[5,34,66] However, it was not equivalent to the magnitude of overweight/obesity observed. This might be due to the lipid paradox observed in different studies among black Africans; for example, a study conducted among overweight/obese African-American and white American women with pre-diabetes found that the mean serum triglycerides were lower among black than white women.[67] It has been also discussed that there is a need for conducting ancestral studies to investigate racial difference in triglyceride levels and other lipid profile parameters between black and white people.[68]

Generally, in this study, we found that socio-economic and demographic, familial and behavioral risk factors were significant correlates of cardio-metabolic risks among regular street food consumers. This study found age to be a cross-cutting factor which was associated with all cardio-metabolic components including overweight/obesity, raised BP and raised blood glucose. Thus, geriatric interventions are recommended in order to prevent or delay manifestations of cardio-metabolic diseases among older people. For a long time, the national available food regulatory bodies in Tanzania were investing in interventions and monitoring of foodborne related risks and prioritized nutritional values less.[19–21] It is high time now for these bodies to establish new and strengthen existing interventions for effective prevention of food-related cardio-metabolic diseases risks, including overweight and obesity, raised BP, raised blood glucose and cholesterol levels among street food consumers.

Transdisciplinary studies are needed to understand and explain the root behaviours that promote nutrition-related chronic diseases in order to inform prospective interventions that can mitigate risk. These interventions should target both street food vendors and their consumers and should involve different stakeholders including food regulatory authorities, decision-makers and policymakers. Intervention measures such as awareness creation on the importance of buying and consuming healthy food among consumers, and street food vendors, who are charged with prioritising taste over nutrition,[15,16] should be concentrated. Vendors are unlikely to serve less fruit and vegetables hence keeping clients from consuming their 400 g/day, the amount of fruit and vegetables recommended by the WHO for non-communicable disease prevention, including type 2 diabetes.[18] This practice is mainly influenced by food preference among consumers, cultural issues, low purchasing power among consumer and limited capital among vendors to afford costs for fruits and vegetables, limited knowledge of consumers on food nutritional values as well as high costs of fruits and vegetables.[16,69–71] For non-communicable disease prevention, awareness creation of food consumers and vendors is essential, since available evidence indicates that these people have limited knowledge on the nutritional value of the food they consume or sell, respectively.[16,22]

Study Limitations

This study relied on self-reported lifestyle behaviors including physical activity, consumption of fruit/vegetables, commonly used cooking oils, etc., and hence is vulnerable to reporting bias. To minimize the above risks we adopted the WHO STEPs survey questionnaire which has been validated in collecting self-reported data.[5] We also kept questions short and explained the benefits of answering truthfully. The study had no sensitive questions which could lead the respondents to hide information. Another limitation is that our study design was cross-sectional, which is not a strong design for elucidating causal relationships and is subject to reverse causality. The study focused on cardio-metabolic risks from the International Diabetes Federation guidelines,[23] and did not evaluate other emerging cardio-metabolic risk factors such as uric acid.[72] We also did not measure HDL due to the high cost of analyzing this biomarker. Despite these limitations, the extremely high prevalence of risks observed among consumers warrants an immediate, urgent response.

Conclusion

This is the first study conducted in Tanzania among street food consumers to assess risk factors for cardio-metabolic diseases. Findings revealed that cardio-metabolic risk factors were prevalent among regular street food consumers, a situation which implies that regular street food consumption is among the drivers of cardio-metabolic diseases including type 2 diabetes in the general population. Socio-economic and demographic characteristics and behavioural risks were significant correlates of cardio-metabolic risk factors. This implies that interventions aiming to reduce cardio-metabolic risks among regular street food consumers should consider factors like socio-economic and demographic, familial and behavioural risk factors. For effective prevention and reduction of cardio-metabolic diseases risks; transdisciplinary studies to understand and explain the root behaviours are needed in order to inform prospective interventions that can mitigate the risk of developing cardio-metabolic diseases. These interventions should target both street food vendors and their consumers.

Abbreviations

AOR, adjusted odds ratio; APR, adjusted prevalence ratio; BG, blood glucose; BP, blood pressure; CI, confidence interval; MET, metabolic equivalent task; NCDs, non-communicable diseases; NIMR, National Institute for Medical Research; SD, standard deviation; TG, triglycerides; Tshs, Tanzanian shillings; USA, United State of America; WHO, World Health Organization.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing conflicts of interests.

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