Out of the

Division of Infectious Disease & Tropical Medicine

Klinikum of the University of Munich (KUM)

Social Determinants and Exposure to Risk Factors for Chronic Non-Communicable Diseases in a Peri-urban Setting of Maputo City, Mozambique

Doctoral Thesis

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Key Words

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Abstract

Background: Chronic non-communicable diseases (NCDs) are responsible for almost three quarters of all deaths globally. The prevalence of NCDs and its behavioral and metabolic risk factors are increasing rapidly in African urban areas. Identifying the behavioral and metabolic risk factors for NCDs present in the Mozambican capital and its associated social determinants may guide health policies for the prevention and control of NCDs.

Methods: A cross-sectional study where quantitative data regarding socioeconomic status and risk factors for NCDs was collected in individuals aged 15-64 years was conducted in the Health and Demographic Surveillance System (HDSS) in Maputo city. STEPwise Approach-based procedures were used to collect physical measures (weight, height, abdominal circumference and blood pressure). Capillary blood samples were collected to measure glucose and lipid profile. Physical activity was measured using pedometers.

Results: Overall, 963 individuals from 367 households consented to participate in the study. The percentage of sedentary subjects was 20.8% while the percentage who were physically inactive was 64.8%. The prevalence of overweight (BMI ≥25 kg/m²) and obesity (BMI≥30 kg/m²) was 30.9% (95% CI: 28.0, 33.9) and 12.6% (95% CI: 10.4, 14.7), respectively. The overall prevalence of metabolic syndrome (MS) was 5.6% (95% CI: 4.1, 7.1). In general, women were more sendetary and inactive and showed a significantly higher prevalence of overweight, obesity and MS compared to men. Social determinants such as wealth, education and occupation were not associated with measured behavioral and metabolic risk factors for NCDs.

Conclusion: Both behavioral and metabolic risk factors for NCDs are highly prevalent in this peri-urban part of the Mozambican capital where underweight and infectious diseases are also present, which confirms that the country is facing a double burden of disease. The fact that behavioral and metabolic risk factors for NCDs are not associated with specific socioeconomic and environmental factors may relate to the homogenicity of the evaluated cohort. However, this finding also indicates that prevention programs should not be restricted to certain population subgroups but should target the general population.

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Abbreviations

AIC	Akaike Information Criterion
AIDS	Acquired Immunodeficiency Syndrome
AOR	Adjusted Odds Ratio
BMI	Body Mass Index
CI	Confidence Interval
CISPOC	*Centro de Investigação e Treino em Saúde da Polana Caniço* (Polana Caniço Health Research and Training Center)
CRD	Chronic Respiratory Disease
CVD	Cardiovascular Disease
DBP	Diastolic Blood Pressure
DM	Diabetes Mellitus
DSA	Demographic Surveillance Area
HBP	High Blood Pressure
HDL	High-Density Lipoprotein
HDSS	Health and Demographic Surveillance System
HIV	Human Immunodeficiency Virus
ICF	Informed Consent Form
IDF	International Diabetes Federation
INE	*Instituto Nacional de Estatística* (National Institute of Statistics)
INS	*Instituto Nacional de Saúde* (National Institute of Health)
IQR	Interquartile Range
MS	Metabolic Syndrome
MVPA	Moderate-Vigorous Physical Activity
NIAFS	*Núcleo de Investigação de Actividade Física e Saúde* (Research Center for Physical Activity and Health)
NCDs	Chronic Non-Communicable Diseases

NCDI	Non-Communicable Diseases and Injuries
ODK	Open Data Kit
PA	Physical Activity
RBP	Raised Blood Pressure
SBP	Sistolic Blood Pressure
SD	Standard Deviation
SOP	Standard Operation Procedure
SSA	Sub-Saharian Africa
STEPS	Stepwise Approach to Chronic Disease Risk Factor Surveillance
WHO	World Health Organization

1. Introduction

Chronic non-communicable diseases (NCDs) are responsible for 71% of all deaths globally (1,2). In 2016 NCDs were already responsible for more deaths than all other causes combined (total of 41 million deaths) - nearly 78% of these NCD deaths occurred in low- and middle-income countries (3), and it is projected that by 2030 NCDs will be responsible for 52 million of 57 million deaths worldwide. (4).

The prevalence of NCDs is rising rapidly and is projected to cause more deaths than communicable, maternal, perinatal, and nutritional diseases combined by 2030 in Africa (5), which might be a major barrier to attaining World Health Organization (WHO) Sustainable Development Goals (SDGs) 1, 2 and 3 in Africa (2).

NCDs are mainly related to four main behavioural risk factors (tobacco consumption, physical inactivity/sedentarism, harmful use of alcohol, and unhealthy diet) and four metabolic risk factors (high blood pressure (HBP), hyperglycemia, hypercholesterolemia and overweight/obesity) (6). The main chronic diseases attributable to common risk factors are cardiovascular diseases (CVDs) such as heart disease and stroke, chronic respiratory diseases (CRDs) and diabetes (DM) (7).

Ageing of the global population, including in African countries, is likely to be the most significant factor influencing health-care-needs, which includes the increase in the prevalence of age-related NCDs such as cancer, DM and CVDs (8). The increasing prevalence of NCDs in Africa is also related to the modern sedentary urban lifestyle in environments with no improvement in hygiene and sanitation conditions (9), leading African countries such as Mozambique to an epidemiological context described as a double burden of diasese (10).

Having a population with a high burden of infectious diseases, whose changes in daily habits lead to the increase of risk factors for NCDs, may turn disease prevention strategies more complex and challenging. Having a more robust knowledge regarding social determinants that lead to a higher burden of NCDs in urban setting of a developing country may guide health policies to the development and implementation of well-defined intervention strategies to control NCDs in such environments. The aim of this study is to identify and characterize, through a community based survey, behavioural and metabolic risk factors for NCDs and its association with social determinants of health in a peri-urban area of Maputo, Mozambique.

2. Literature review

2.1. Burden of NCDs worldwide and in developing countries

From 2005 to 2015 the total deaths due to NCDs increased by 14.1%, with NCDs being accountable for almost 40 million deaths in 2015 worldwide (11). It is estimated that almost 80% of those NCD-related deaths are due to CVD, cancer, DM and CRD (11,12).

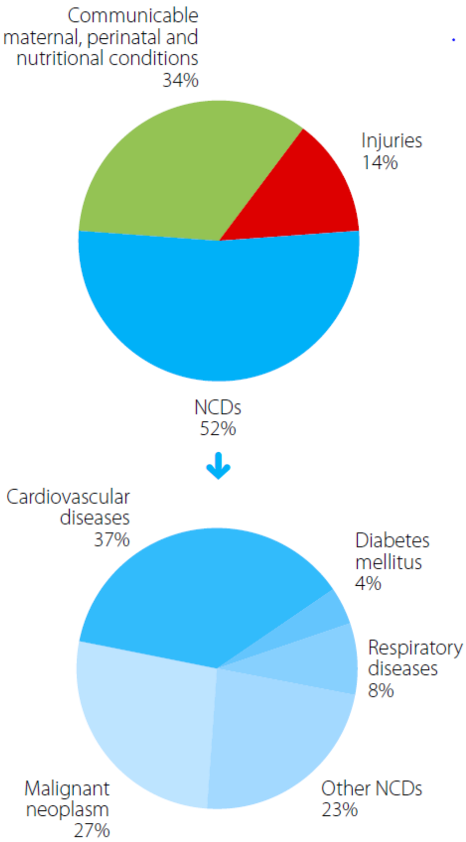

Figure 2.1. Proportion of global deaths under the age of 70 years, by cause of death, comparable estimates, 2012; reproduced from (4)

The burden of NCDs affects countries all over the world, with significant social, economical and health consequences in developing countries (7,13), with the poorest billion suffering high morbility and mortality from non-communicable diseases and injuries (NCDIs) at every age (14), including during their prime working years (15).

It was estimated that, by 2020, NCDs would cause seven out of every ten deaths in developing countries (3). Preventive strategies must consider the increasing prevalence of risk factors associated with NCDs. Meanwhile, many regions worldwide still face challenges related to high burden of infectious diseases such as malaria, tuberculosis AIDS and dengue (13).

The burden on NCDs in Africa is higher than the global average and it is mainly caused by five groups of diseases which include CVDs, cancers and DM (16).
It is estimated that by 2030, NCD-related deaths will exceed communicable, maternal, perinatal and nutritional disease-related deaths combined in Africa (5).

2004

Rank	Disease or injury	As % of total DALYs
1	Lower respiratory infections	6.2
2	Diarrhoeal diseases	4.8
3	Unipolar depressive disorders	4.3
4	Ischaemic heart disease	4.1
5	HIV/AIDS	3.8
6	Cerebrovascular disease	3.1
7	Prematurity and low birth weight	2.9
8	Birth asphyxia and birth trauma	2.7
9	Road traffic accidents	2.7
10	Neonatal infections and other[a]	2.7
13	COPD	2.0
14	Refractive errors	1.8
15	Hearing loss, adult onset	1.8
19	Diabetes mellitus	1.3

2030

Rank	Disease or injury	As % of total DALYs
1	Unipolar depressive disorders	6.2
2	Ischaemic heart disease	5.5
3	Road traffic accidents	4.9
4	Cerebrovascular disease	4.3
5	COPD	3.8
6	Lower respiratory infections	3.2
7	Hearing loss, adult onset	2.9
8	Refractive errors	2.7
9	HIV/AIDS	2.5
10	Diabetes mellitus	2.3
11	Neonatal infections and other[a]	1.9
12	Prematurity and low birth weight	1.9
15	Birth asphyxia and birth trauma	1.9
18	Diarrhoeal diseases	1.6

[a] This category also includes other non-infectious causes arising in the perinatal period apart from prematurity, low birth weight, birth trauma and asphyxia. These non-infectious causes are responsible for about 20% of DALYs shown in this category.

Figure 2.2. Ten leading causes of burden of disease, world, 2004 and 2030; reproduced from (8)

The burden of NCDs is increasing in Africa and the continent is off track in achieving the NCDs indicators according to the deadlines set by the WHO NCD Disease Global Action Plan 2013-2020 (17).

2.2. Risk factors for NCDs worldwide

Most NCDs are significantly associated and caused by four main behaviours: tobacco consumption, insufficient physical activity, unhealthy diet and the harmful use of alcohol. These behaviours result in four key metabolic risk factors for NCDs: HBP, excess body weight, raised blood sugar and raised cholesterol levels. HBP is responsible for 13% of global deaths, followed by tobacco consumption (9%), hyperglycemia (6%), insufficient physical activity (6%), and excess body weight (5%) (18).

2.2.1. Behavioral (modifiable) risk factors for NCDs

Tobacco consumption

Worldwide, the prevalence of tobacco smoking was 20% in 2016 (19). Tobacco use increases the risk of CVD, cancer, chronic respiratory disease and diabetes mortality, and is responsible for 6 million preventable deaths per year worldwide (4).

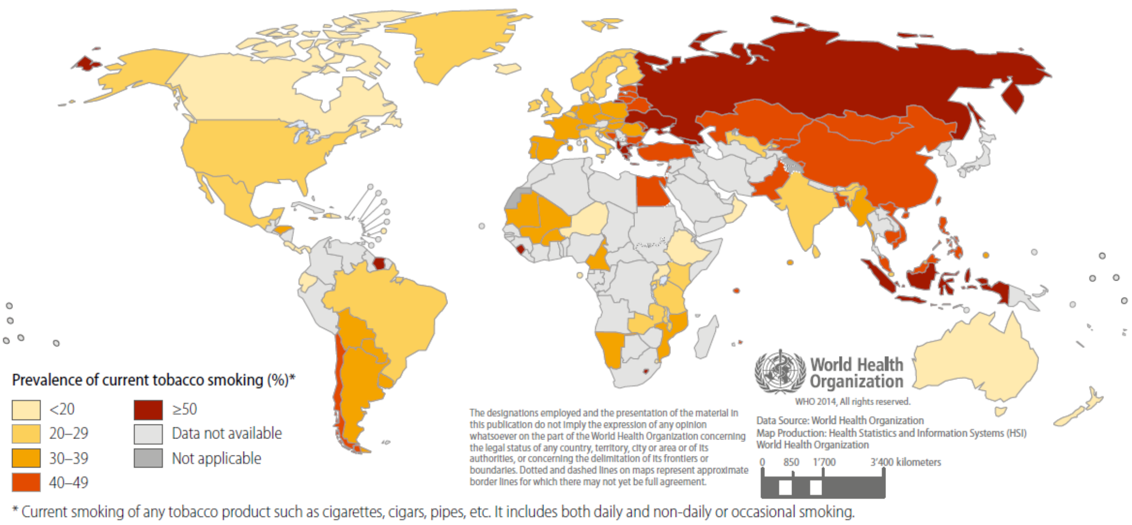

Figure 2.3. Age-standardized prevalence of current tobacco smoking in males aged 15 years and over, comparable estimates, 2012; reproduced from (4)

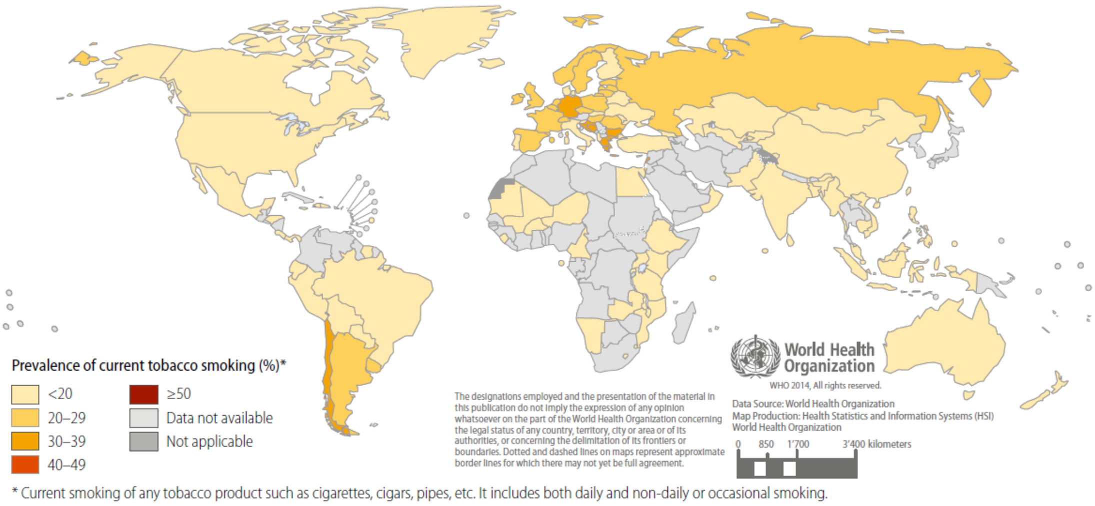

Figure 2.4. Age-standardized prevalence of current tobacco smoking in females aged 15 years and over, comparable estimates, 2012; reproduced from (4)

Harmful alcohol consumption

Harmful use of alcohol is associated with CVDs, cancer and liver diseases morbidity and mortality. It is estimated that alcohol consumption was responsible for 3.3 million deaths (5.9% of all deaths worldwide) in 2012, where more than half of them where NCD'related deaths (4).

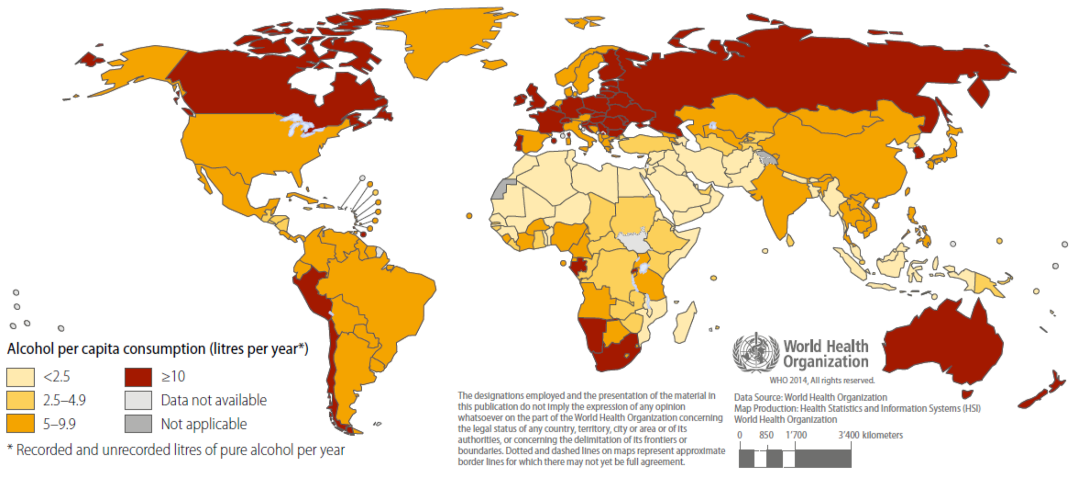

Figure 2.5. Total (recorded and unrecorded) alcohol consumption per capita (aged 15 years and over), in litres of pure alcohol within a calendar year, by WHO region, projected estimates for 2012; reproduced from (4)

Inadequate diet

Although unhealthy diet comprises many components, such as excessive caloric intake, increased consumption of refined sugars and saturated fatty acids, one of the best evaluated aspects is high salt consumption (more than 5 g per day) which contributes to HBP and increases the risk of heart disease and stroke. In 2010, 1.7 million annual deaths from CVDs have been attributed to excess salt/sodium intake worldwide (4).

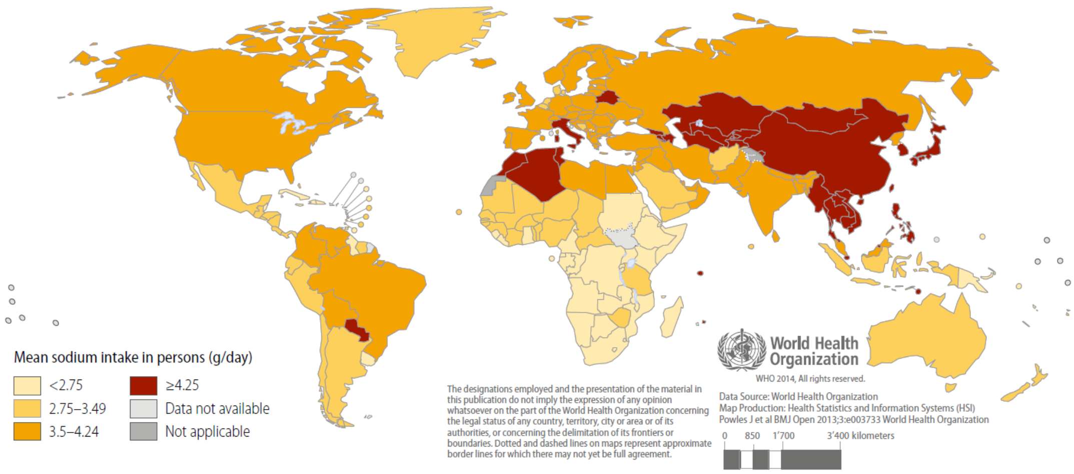

Figure 2.6. Mean sodium intake in persons aged 20 years and over, comparable estimates, 2010 reproduced from (4)

Data regarding food consumption trends is scarce (20). Approximately 1.7 million of deaths worldwide were attributable to low fruit and vegetable consumption in 2008 (21).

Physical inactivity

Insufficient physical activity increases the risk of all-cause mortality by 20-30% and regular physical activity reduces the risk of diabetes, breast and colon cancer, stroke and ischaemic heart diasease (4). In 2016, 28% of adults were physically inactive worlwide (19)

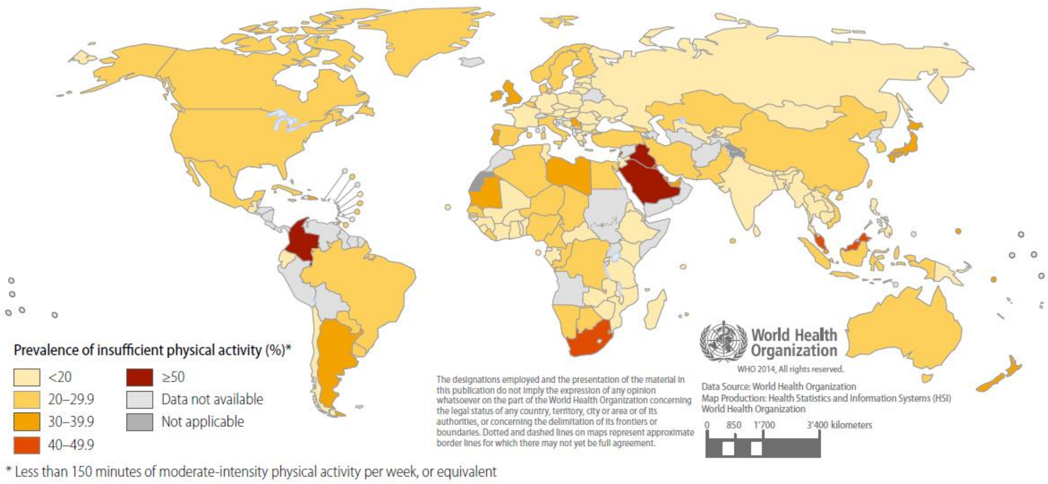

Figure 2.7. Age standardized prevalence of insufficient physical activity in men aged 18 years and over, comparable estimates, 2010; reproduced from (4)

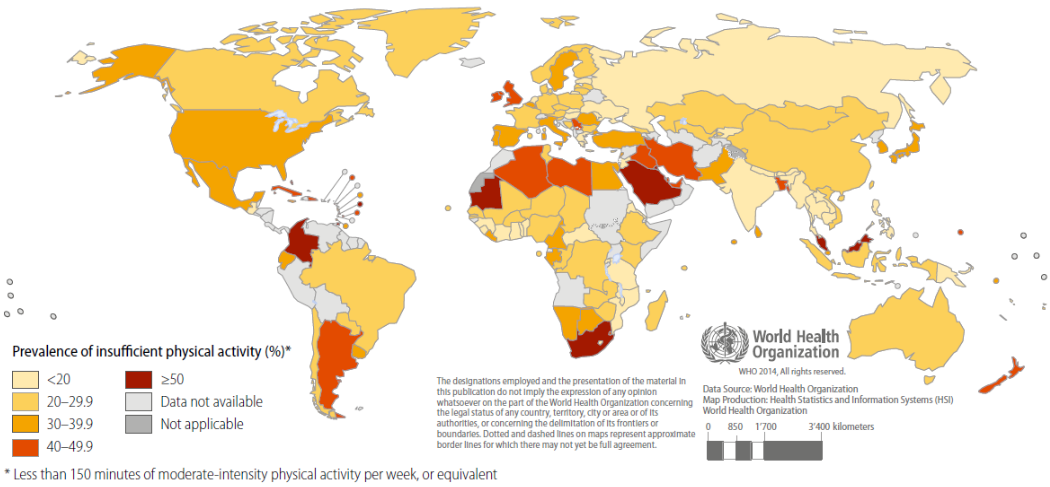

Figure 2.8. Age standardized prevalence of insufficient physical activity in women aged 18 years and over, comparable estimates, 2010; reproduced from (4)

2.2.2. Metabolic risk factors for NCDs

Raised blood pressure

Raised blood pressure caused around 9.4 million deaths and 7% of disease burden in 2010, being considered one of the leading risk factors for global mortality (4). In 2015, the prevalence of raised blood pressure was around 22% in adults 18 years old and above (4,19).

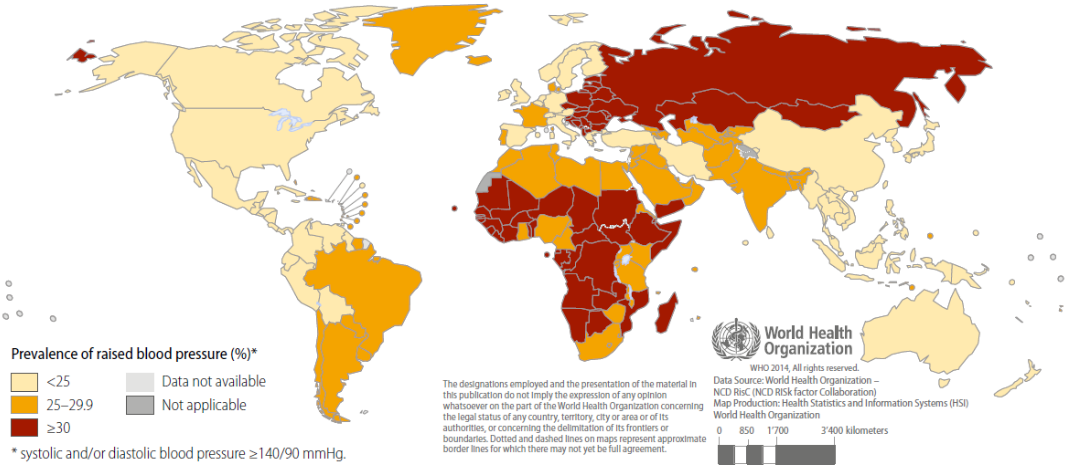

Figure 2.9. Age-standardized prevalence of raised blood pressure in males aged 18 years and over (defined as systolic and/or diastolic blood pressure equal to or above 140/90 mm Hg), comparable esti-mates, 2014; re-produced from (4)

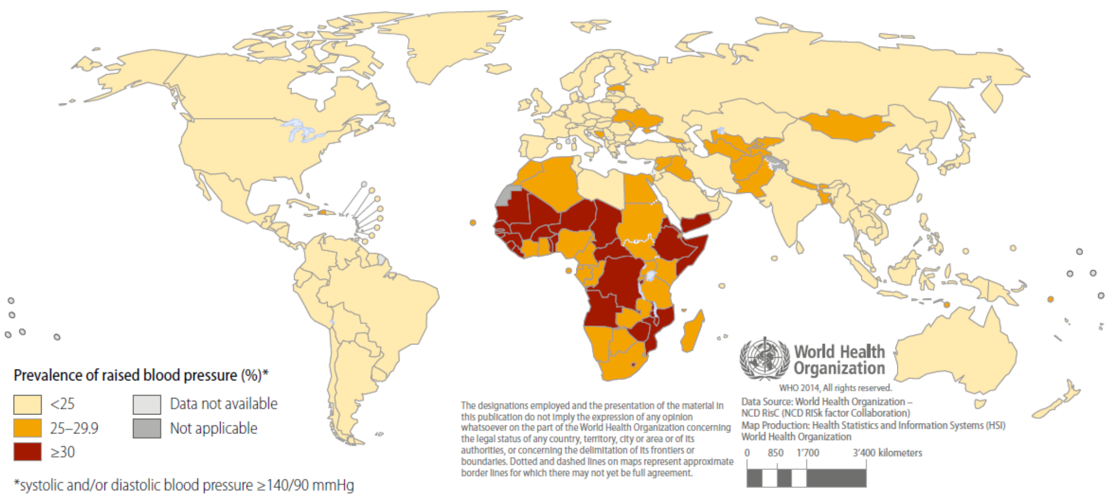

Figure 2.10. Age-standardized prevalence of raised blood pressure in females aged 18 years and over (defined as systolic and/or diastolic blood pressure equal to or above 140/90 mm Hg), comparable estimates, 2014; reproduced from (4)

Overweight and obesity

The prevalence of overweight among adults aged 18 years and above was 39% in 2014 globally. Worldwide, more than half a billion adults are classified as obese. The prevalence of obesity in adult men and women was around 11% and 15%, respectively in 2014 (4).

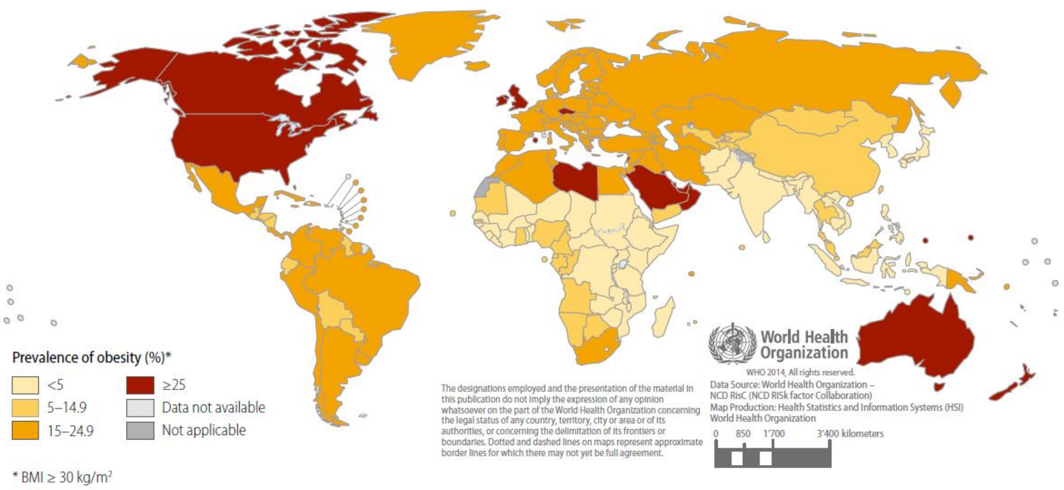

Figure 2.11. Age-standardized prevalence of obesity in men aged 18 years and over (BMI ≥30 kg/m2), 2014; reproduced from (4)

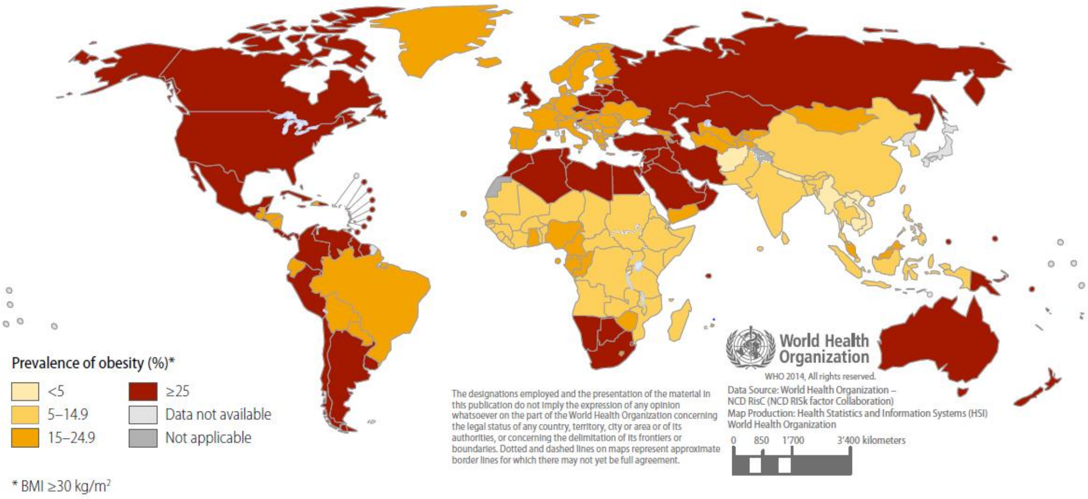

Figure 2.12. Age-standardized prevalence of obesity in women aged 18 years and over (BMI ≥30 kg/m2), 2014; reproduced from (4)

Hyperglycemia

People with impaired glucose tolerance and impaired fasting glycaemia are at risk of developing diabetes and CVD. The prevalence of diabetes was estimated to be 9% in 2014, being responsible for about 1.5 million deaths in 2012 (4).

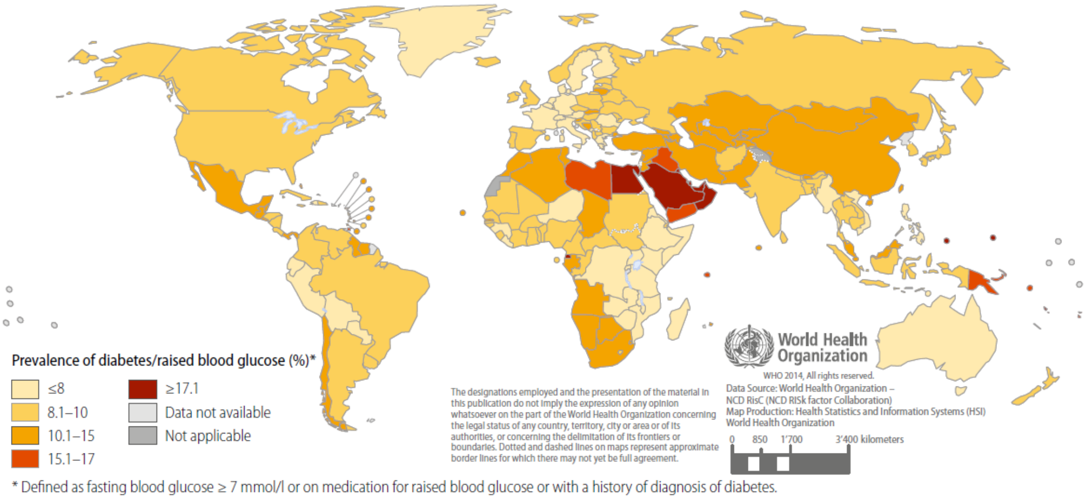

Figure 2.13. Age-standardized prevalence of diabetes, (Fasting glucose ≥ 7.0 mmol/L, or on medication for raised blood glucose or with a history of diagnosis of diabetes), in men aged 18 years and over, comparable estimates, 2014; reproduced from (4)

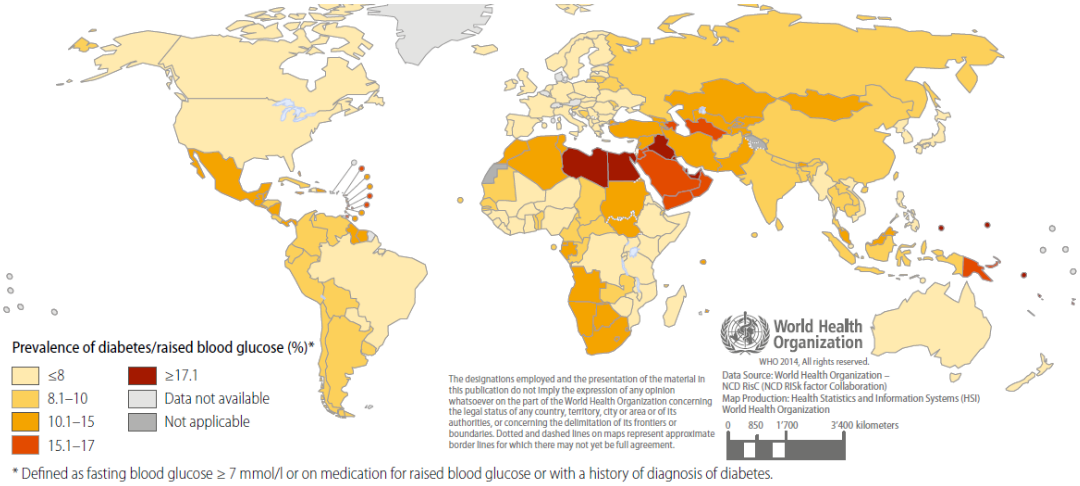

Figure 2.14. Age-standardized prevalence of diabetes, (Fasting glucose ≥ 7.0 mmol/L, or on medication for raised blood glucose or with a history of diagnosis of diabetes), in women aged 18 years and over, comparable estimates, 2014; reproduced from (4)

2.3. NCDs in Mozambique

Currently, NCDs are responsible for 28% of deaths in Mozambique (22). WHO estimates that the prevalence of premature NCD deaths (probability of dying from any CVD, DM, cancer or CRD between exact ages 30 and 70) was 17.3% and also estimated a total of 72,600 NCD deaths in 2012 in Mozambique (4).

The increasing rate of urbanization that characterizes the last two decades in Mozambique is causing a dramatic increase in sedentary lifestyle and its co-morbidities (9).

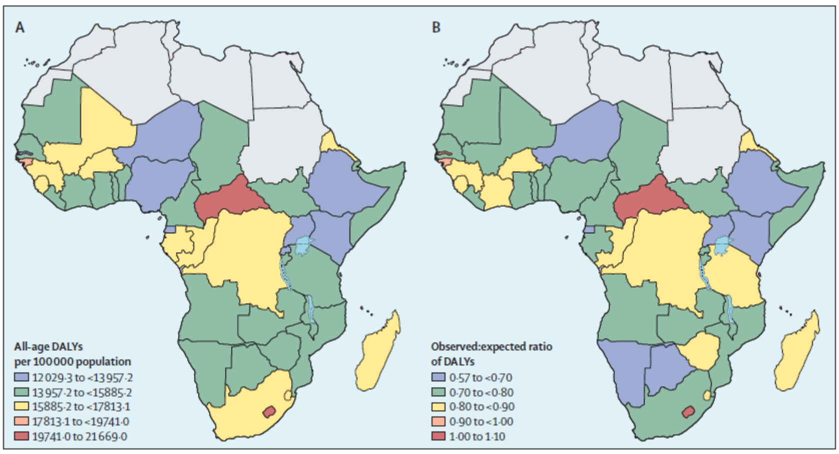

Figure 4: Burden of non-communicable diseases by country in sub-Saharan Africa, 2017
(A) All-age DALY rates for non-communicable diseases (per 100 000 population). (B) Ratio of observed to expected DALYs (according to the Socio-demographic Index) for all non-communicable diseases. DALY=disability-adjusted life-year.

Figure 2.15. Burden of non-communicable diseases by country in sub-Saharan Africa, 2017; reproduced from (16)

2.4. Risk factors for NCDs in Mozambique

Smoking, harmful alcohol consumption and inadequate nutrition are present in rural and also in urbanized environments in Mozambique. HBP, diabetes and other NCDs and their risk factors are present in Mozambique, but the majority of the population do not have access to proper diagnosis, care and treatment of those conditions (22).

Risk factors for chronic diseases have increased over the years, affecting young people resulting in high disability and early mortality, and disproportionately reaching the most disadvantaged segments of the Mozambican population (23).

Lifestyle changes, including the increased use of personal computers and video games, as well as the increase in the prevalence of overweight and obesity have been observed since the end of the civil war in Mozambique (24).

2.4.1. Behavioral (modifiable) risk factors for NCDs

The prevalence of tobacco consumption was around 18% in 2012 in people aged 15 and above in Mozambique according to the WHO (4).

The prevalence of alcohol consumption was around 2.5% in 2010 in people aged 15 and above in Mozambique, according to the WHO (4). The prevalence of insufficient physical activity was around 4.8% in 2010 in Mozambican adults according to the WHO (4).

2.4.2. Metabolic risk factors for NCDs

In 2005 and 2015 Mozambique implemented the Stepwise Approach to Chronic Disease Risk Factor Surveillance (STEPS) that showed an increase in the prevalence of HBP from 33% to 39% (25).

Overweight and obesity was estimated to affect 19.4% and 4.5% of adults in Mozambique in 2014, respectively (4). From 2005 to 2015 the prevalence of overweight increased from 18.3 to 30.5% in women and from 11.7 to 18.2% in men. For obesity, there was an increase from 7.0 to 13.0 % among women and from 2.3 to 5.0 % among men (26).

Raised blood glucose affected 5.7% of Mozambican adults in 2014 (4).

2.5. Equity, social determinants and NCDs

The prevalence of NCDs is rising rapidly in urban settings due to changes in diet and physical activity, exposure to air pollutants (including tobacco smoke) and harmful use of alcohol (6).

Evidence now shows that vulnerable populations present higher risk of premature death related to NCDs (27).

Many countries to not manage to implement interventions that are proven to reduce the exposure to risk factors for NCDs such as smoking regulations, regulations to limit the use of trans fats, protections against harmful consumption of alcohol, and urban planning to promote physical activity (6).

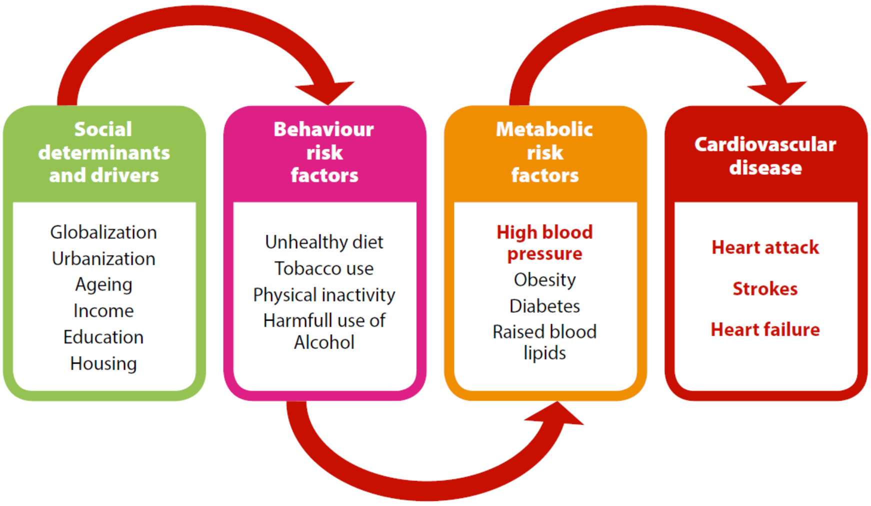

Figure 2.16. Main contributory factors to high blood pressure and its complications; reproduced from (4)

2.6. Impact of NCDs in country development

There is strong evidence for the correlation between a number of social determinants, especially education, and the prevalence of risk factors for NCDs (6).

The high rate of disability due to NCDs is a special burden on women. This can result in women who lose their main livelihood for their families, and families lose their stability.

In some countries, households with the lowest incomes have the highest levels of risk factors for NCDs, with negative consequences on household income. NCDs and their risk factors often prevent people from working or looking for a job (6).

2.7. Interventions and actions in the context of NCDs

Health systems require mechanisms to engage with communities, not only to continue to respond to health needs, but also to facilitate communities' ability to mobilize resources and to actively participate in the promotion and management of their health. The role of communities as an integral part of health systems is increasingly important in the context of the growing burden of NCDs (28).

Intensive action is currently required in each of the three strategic objectives: mapping the NCD epidemic and its causes; reduction of major risk factors through health promotion and primary prevention approaches; and strengthening health care for people already affected by NCDs (6).

One approach to develop the evidence base is through "community health laboratories". Essentially, within a tractable, geographically defined area, such as a county or district, innovations in health systems can be tested and monitored (29). Assuming that the entire population has been listed, and their health status and health systems interaction can be tracked over time, it becomes possible to measure the impact of health system innovations on various dimensions of system performance of health. Using these types of community settings, governments can look at implementation within real-life contexts and functional communities (30).

3. Rationale and Objectives

General Objective

This study aims to describe potential risk factors for NCDs and evaluate their association with the social determinants in a well defined population of a Health and Demographic Surveillance System in a peri-urban area of Maputo city.

3.1. Topic I : Physical inactivity and sedentarism

The impact of physical inactivity and sedentarism on public health has been growing over time in most regions, correlating with the degree of industrialization and technological development which is associated with growing morbidity and mortality associated with NCDs (31). Thus, the study of physical activity and sedentary behavior has become an important issue in public health (32).

Physical activity studies in Africa using accelerometers and pedometers in adult populations are very scarce (33). The majority of the studies on this continent that have used device-based measures of physical activity and/or sedentary behavior have been done in children and adolescents (34). In Mozambique in particular, studies using accelerometers or pedometers have been done exclusively in special populations (35) or school-aged children and youth (36). Meanwhile, there is strong evidence that physical inactivity is growing in African urban populations in the last decades, including Mozambique (24). This is being stressed as a major public health concern, since the prevalence of NCDs is also growing in African urban centers at the same time that transmissible diseases such has HIV, malaria and tuberculosis, maintain high incidence levels (37).

Considering this epidemiological framework and the lack of studies in adults using device-based measures of physical activity in Africa, and in Mozambique in particular, the present study has been carried out to describe physical activity behavior and its demographic associations in a peri-urban population from Mozambique, using device-based data.

Specific objectives of topic I :

- To determine the prevalence of physical inactivity and sedentarism ;
- To determine the social determinants associated with physical inactivity and sedentarism.

3.2. Topic II : Overweight and Obesity

The rationale described below has been pubished by Macicame el al (38):

The prevalence of overweight and obesity has doubled during the last three decades, which consequently increases the risk of CVDs, type 2 diabetes, certain cancers and other NCDs worldwide. (4).

In 2016, the prevalence of obesity was 6% in adult men and more than 12% in adult women from Africa (4), with a doubled the risk of dying from NCDs compared to obese adults from high-income countries (39).

Understanding the burden and the determinants of overweight and obesity in urban settings from low-income countries is critical for reaching the objectives of the Global Action Plan for the prevention and control of NCDs (40), but those evaluations are still scarce in low-income countries (41). Over the past decades, the prevalence of overweight and obesity among Mozambican youth (42) and adults (26) has increased. From 2005 to 2014, the prevalence of overweight increased more than 60% and the prevalence of obesity almost doubled in women, making one third of adult females overweight and more than one in every ten women obese. A higher prevalence of overweight and obesity was observed in urban than in rural areas (26,43), which makes crucial monitoring the prevalence of overweight and obesity and understanding their social and behavioral determinants in urban and peri-urban areas of Mozambique.

Specific objectives of topic II :

- To determine the prevalence of overweight and obesity ;
- To determine the association between overweight/obesity and social determinants.
- To determine the association between overweight/obesity and behavioral factors.

3.3. Topic III : Metabolic syndrome

Metabolic syndrome (MS) is a cluster of risk factors that are known to increase the risk of Cardiovascular Diseases (CVD) and diabetes due to abdominal obesity and insulin resistance (44–46). The prevalence of MS varies from less than 10% to more than 84% in populations worldwide, depending on the sociodemographic characteristic of the population and also depending on the criteria used to define MS (47,48).

There is a number of different definitions for MS. This together with the fact that it is unclear whether the diagnosis of MS provides more information (from a clinical point of view) than the sum of the individual factors might be a reason for MS being underdiagnosed (44,46). However, the early diagnosis of MS allows the physicians to manage the risk factors individually and integrate them in order to reduce the risk of cardiovascular complications (44) .

Epidemiological data related to MS in Africa is scarce and is mostly limited to small clinical studies from high risk groups (45).

A study of MS in children and adolescents from a rural area of Mozambique showed a low prevalence of MS of less than 2% (49).
We aimed to assess the prevalence of MS and risk factors associated with MS in a population of youths and adults of a peri-urban area of Maputo City – the capital of Mozambique.

Specific objectives of the topic III :

- To determine the prevalence of metabolic syndrome (MS) ;
- To determine the social and behavioral factors associated with MS.

4. Methods

4.1. Study setting and population

The study was implemented in a peri-urban area of Maputo city, the capital of Mozambique. The city has about 1 122 607 inhabitants and an area of 346 km^2, the life expectancy is approximately 62.6 years (50). The population of Maputo city is very young, with 65% between the 15 and 64 years of age. Xichangana, a local languange from the south region of Mozambique, is the mother tongue of 61.4% of the citizens of Maputo city, and the majority of the population do not speak Portuguese – the official language in Mozambique (50).

More than 60% of the population in Maputo city live in basic household conditions, but the majority (more than 95%) have access to electricity and safe water (50).

The study was conducted at the demographic surveillance area (DSA) of the first Health and Demographic Surveillance System (HDSS) in a peri-urban area of Maputo City, located in KaMaxaqueni district – the one out of the seven municipal districts with the higher population density (16 936 inhab/km^2), at Polana Caniço "A" and "B" neighbourhoods with populations of approximately 45,000 and 46,000 inhabitants, respectively (51).

By establishing an HDSS in a peri-urban area, where migration and mortality rates tend to be high, the National Institute of Health – *Instituto Nacional de Saúde* (INS), through Polana Caniço Health Research and Training Center (CISPOC), intends to obtain demographic and health data of the population in a well-defined geographical area, which is part of the intervention area of research activities of the Centre. The HDSS allows routine updates of the population-level data analyses, and provides information on health indicators for the same population.

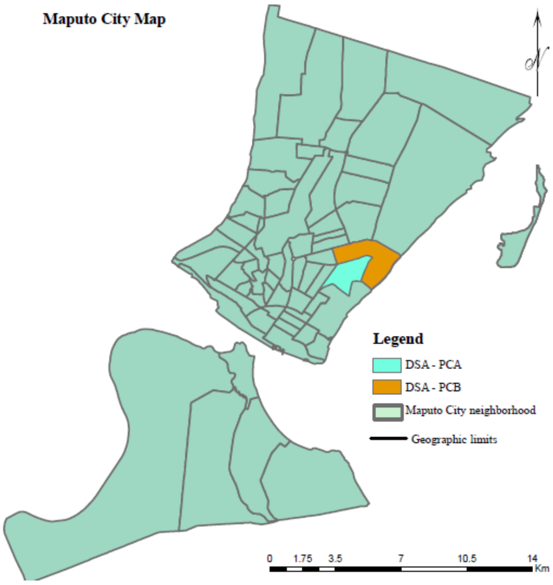

Figure 4.1. Maputo City map

For the first year of the stablishment of the HDSS Polana Caniço, 10 blocks from Polana Caniço A neighborhood and 10 blocks from Polana Caniço B neighborhood were randomly selected for household and household members enrollment procedures.

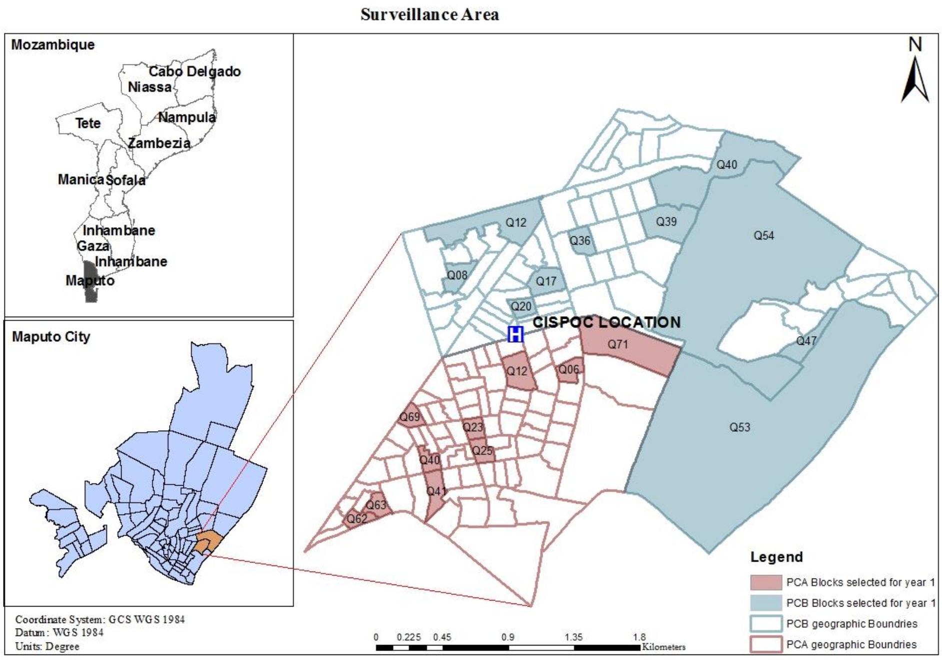

Figure 4.2. HDSS Polana Caniço DSA

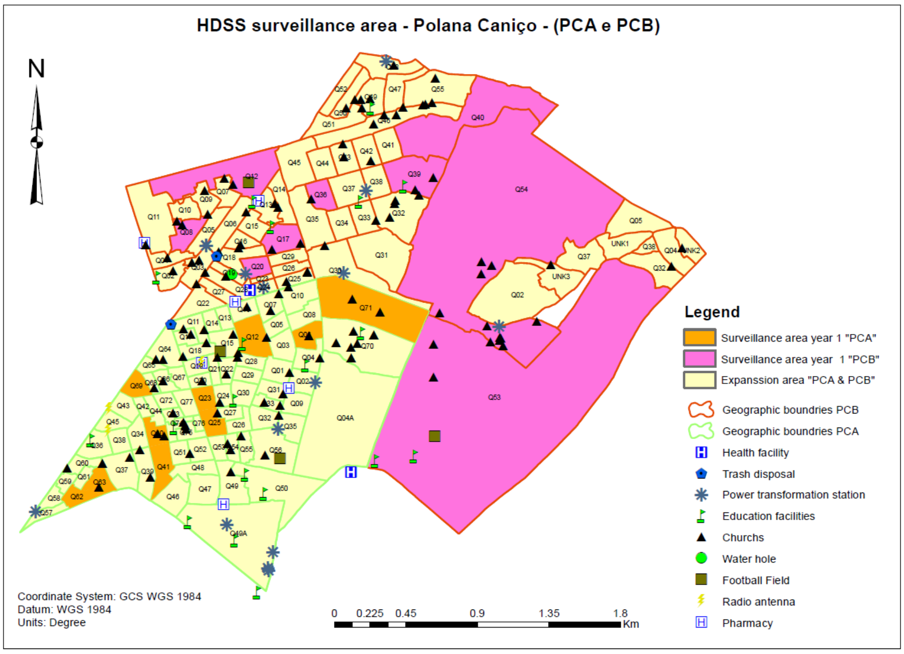

Figure 4.3. HDSS Polana Caniço DSA (mapped infrastructures)

4.2. Study design

This was a cross-sectional study where quantitative data regarding socio-economic status and risk factors for NCDs were collected at a household and individual level.

Figure 4.3 shows the conceptual framework, which was used to characterize the relationships of the four NCDs (cardiovascular diseases, diabetes, cancer and chronic respiratory disease) and the underlying risk factors, including non-modifiable, metabolic and behavioral risk factors as well as their broader environmental and social determinants.

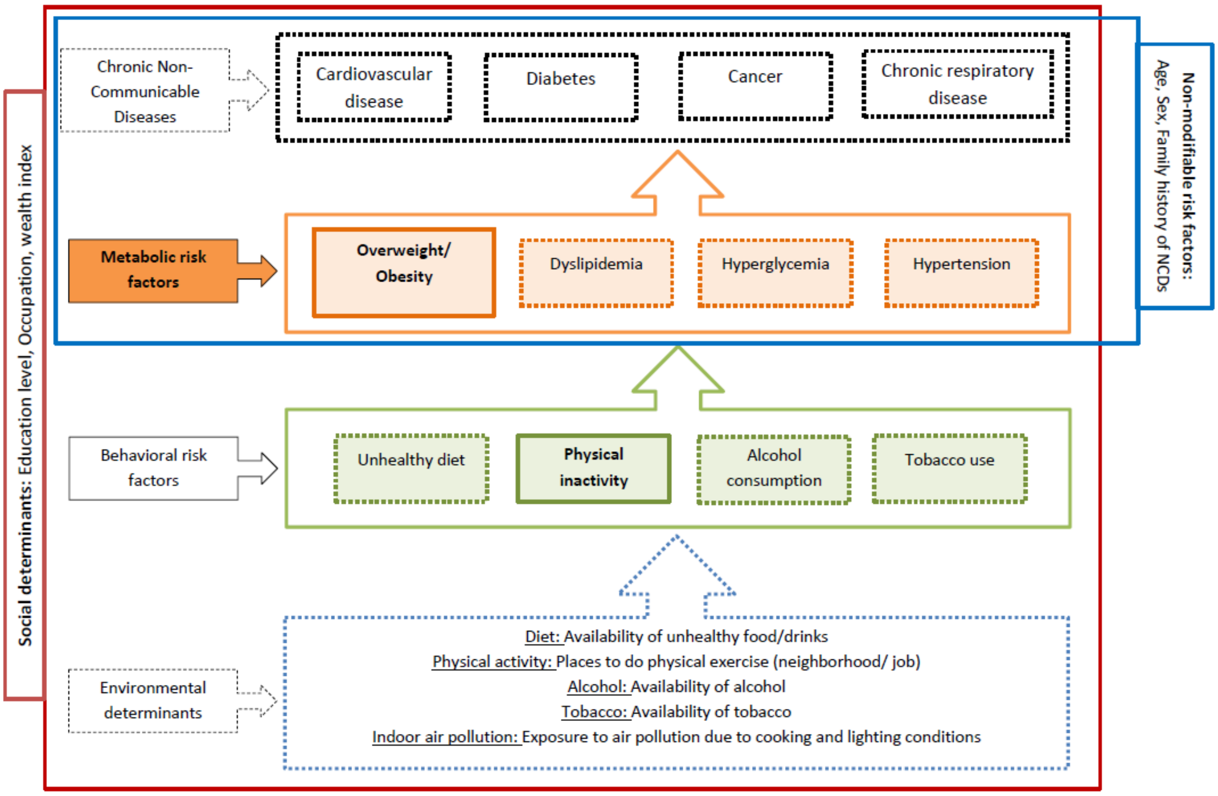

Figure 4.4. Conceptual framework - Social determinants and risk factors for NCDs in Maputo City, Mozambique

Inclusion criteria

- Both household and individual enrolled in the HDSS Polana Caniço
- Individual ≥ 15 and ≤ 64 years old

Exclusion criteria

- Currently pregnant

4.3. Sample size and study sampling

4.3.1. Sample size calculation

The prevalence of risk factors for the city of Maputo, and specifically for the Polana Caniço “A” and “B” neighborhoods were not known.

For this case of a prevalence determination study, the sample size was calculated based on a prevalence of 50% (to be assumed in the case where there is no information on the prevalence in the study area, assuming that the population of the referred area shows a normal distribution curve) for risk factors for NCDs, in a population of 92,000 inhabitants, corresponding to the population of the Polana Caniço “A” and Polana Caniço “B” neighborhoods according to the sample size determination formula for prevalence studies:

$$n = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1+\left(\frac{z^2 \times p(1-p)}{e^2 N}\right)}$$, where:

n= sample size

Z= Z statistics for confidence level

P= expected prevalence or proportion

e= margin of error

N= total population

$$n = \frac{\frac{(1.96)^2 \times 0.5(1-0.5)}{(0.05)^2}}{1+\left(\frac{(1.96)^2 \times 0.5(1-0.5)}{(0.05)^2 \times 92000}\right)}$$

According to the formula described above the required number of participants (n) is 383. Assuming that:

- Due to the potential differences (physiology/metabolism) between males and females, it is intended to make a disaggregated analysis by gender, which implies doubling the sample size: n = 383 * 2 = 766;
- Due to the study design (collection of data at the community level), blank responses and loss of quality of biological samples are to be expected, which implies an increase of 10% in the sample: n = 766 + 76.6 = 842,6.

It was thus estimated that about 843 individuals should be included in the study.

4.3.2. Sampling procedures

The sample was selected at the household level. The same number of households was selected for the Polana Caniço “A” and “B” neighborhoods.

Table 4.1. Number of HHs households in Polana Caniço "A" and Polana Caniço "B" neighbourhoods, Maputo City, Mozambique, 2016

	Households	Population		
Neighbourhood	**Total**	**Male**	**Female**	**Total**
Polana Caniço A	8 464	22 322	23 561	45 883
Polana Caniço B	8 764	22 554	23 630	46 184
Total	**17 228**	**44 876**	**47 191**	**92 067**

Source: National Institute of Statistics (INE) – 2016 (not published)

We found the average number of people per household by the proportion of the total population in each neighborhood to the total number of households in the same neighborhood. In this context, the average number of people per household in Polana Caniço "A" and "B" is about 5.4 and 5.3 people, respectively.

Considering that about half of the members of each household will present the inclusion criteria for the study, we assume that we will have a mean of three eligible members per household. To include about 422 participants per neighborhood, about 141 households per neighborhood had to be selected for the study.

The selection of households was made using the Geographic stratified random sampling technique, using Microsoft Excel 2013 (Microsoft Corporation, Redmond, WA). The selection of households was randomized, assuming that each household in each neighborhood is equally likely to be included in the study.

To address issues related to unavailability or refusal to participate of household members, an additional 282 households were randomly selected to serve as replacements.

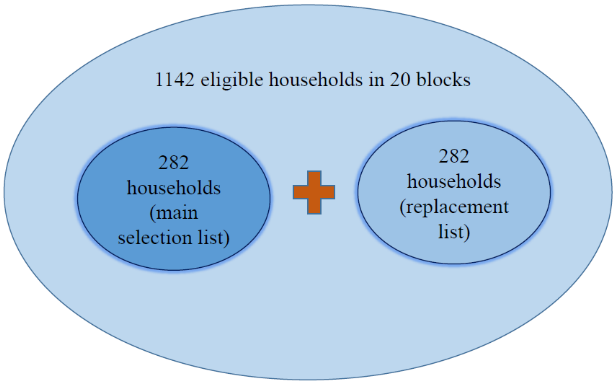

Figure 4.5. Number of household HHs to be selected for the study

n (Number of households per block)

To compute the number of households to select/enroll in each of the 20 blocks (n), the proportional distribution was used, that is, the number of households was determined by the proportion of households that each of the blocks represents in the total population of the households (N) based on the number of households mapped per block (X), given that each neighbourhood should enroll a minimum of 141 household (Z).

$$n = Z * \frac{X}{N}$$, where:

n= number of households to select/enroll per block

Z= minimum of households to be enrolled per block

X= households mapped per block

N= proportion of households that each of the blocks represents in the total population of the households

K (interval between each selected household)

Systematic sampling consists of identifying the elements constituting the sample by means of a constant which determines the interval between the first element randomly identified with the second element and so on (K). Each household from the HDSS has a unique ID. The arrangement of the household s was made randomly according to the unique IDs.

$$K = \frac{X}{n}$$

, where :

K= interval between each selected household per block

X= households mapped per block

n= number of households to select/enroll per block

Table 4.2. Number of HHs households per block to be enrolled and interval between each selected house-hold per block for Polana Caniço A

#	Name/number of the Block	Number of households mapped per block (X)	Number of households per block to be enrolled in the study (n)	Interval between each selected households (K)
1.	Block 25	72	8	9
2.	Block 23	62	7	7
3.	Block 71	434	53	8
4.	Block 06	83	10	8
5.	Block 48	99	12	8
6.	Block 63	66	8	8
7.	Block 69	75	9	8
8.	Block 12	102	12	8
9.	Block 02	77	9	8
10.	Block 40	72	8	9

4.4. Study procedures

4.4.1. Recruitment strategies

Three steps were followed to ensure high acceptance rates for the study enrolment:

1. Four meetings with community representatives to present the study objectives and procedures;
2. Six meetings with the community led by the community leaders to present the aim of the study to the household members from the HDSS Polana Caniço;
3. Door-to-door sensitization at the 20 blocks from the HDSS Polana Caniço by the study team aiming to present study overall objectives and schedule study visit.

After study sampling, community leaders scheduled the first visits to the selected households. In each selected household, all household members aged 15 to 64 years were eligible for enrolment into the study. If eligible individuals were not available after three attempted visits, surrogate households were approached.

4.4.2. Data collection

Socio-demographic data

Demographic data was collected on an individual level and the wealth index assessment was done based on a household level questionnaire. Both questionnaires were administered by trained interviewers in Portuguese or in a local language (XiChangana or Ronga)

The household questionnaire, based on Vyas and Kumaranayake (52), was filled by the head of household or his/her representative and included questions regarding household assets, type of hygiene facilities, construction materials and other relevant information to determine a setting-specific household wealth index. The individual questionnaire covered questions related to age, gender, birth place, level of education, mother tongue, knowledge of Portuguese and occupation.

Behavioral risk factors for NCDs questionnaire

Behavioral risk factors for NCDs (diet, tobacco and alcohol consumption and physical activity) were assessed individually based on the STEPwise Approach (53).

Physical activity

Physical activity was measured using pedometers SC-StepRx® (StepsCounts, Deep River, Canada) for seven consecutive days, which were removed by the study participants only when sleeping and while taking a bath.

Anthropometry

A measuring tape was used to measure abdominal circumference in cm.

A stadiometer (SECA 2013, SECA Group, Hamburg, Germany) and a weighing scale (OMRON HN289, OMRON HealthCare, Yangzhou, China) were used to measure height in centimeters and weight in kg, respectively. The body mass index (BMI) was calculated as weight in kg divided by height in meters squared.

Blood pressure

An automatic digital sphygmomanometer (OMRON M3 digital BPM HEM-7131-E, OMRON HealthCare, Kyoto, Japan) was used to measure blood pressure in mmHg. Two measurements were taken within two to three-minutes and the second measurement was the one registered. A third measurement was taken and considered as valid if the difference between the first and the second measurements was 10 mmHg or more.

Blood samples

We used a portable device (CardioChek Plus Professional Cholesterol/Glucose Analyzer, Polymer Technology Systems, Whitestown, USA) to perform glucose and lipid profile (total cholesterol, HDL cholesterol and triglycerides) rapid tests using capillary blood. Participants were sensitized to perform blood collection fasting, whenever possible.

4.4.3. Clinical management

All participants with overweight received counselling to reduce weight. Obese participants were referred to a health facility for nutritional counselling.

All participants with undiagnosed high blood pressure (≥140/90 mmHg), hyperglycemia ((> 6.3 mmol/l) and/or hypercholesterolemia (> 6.2 mmol/l) where referred to their preferred health facility for further care.

4.4.4. Quality control/ calibration of clinical equipments

The calibration of clinical devices (scale and sphygmomanometer) was carried out in accordance with the Standard Operating Procedures (SOP) for the clinical management of materials and equipment of CISPOC. The maintenance and quality control of the equipment for processing biological samples was carried out in accordance with the CISPOC laboratory SOPs developed and being implemented for this purpose.

The standardization of the calibration of pedometers was guaranteed by NIAFS, in accordance with its internal procedures for the management and quality control of electronic devices and equipment.

4.4.5. Pilot study

A pilot study was conducted in one block in Polana Caniço A that was not part of the HDSS Polana Caniço sample. The pilot eonrolled 10% of the sample size (85 individuals) with the aim of testing the study tools and procedures.

4.5. Data management

4.5.1. Data processing

All questionnaires were developed with the Open Data Kit (ODK) Collect 1.14.0 app (OpenRosa Consortium, University of Washington, Seattle, USA) and data were entered electronically using tablet computers (Samsung Galaxy TAB E 9.6 inches, Seoul, South Korea). Data weas exported to an ODK aggregate 1.4.13 server using a mysql 5.7.1 database. To maintain confidentiality, the devices and the database had restricted access, where only team members were registered as users and assigned a password after determining the level of access.

The database was not related to any other national or international institution or organization, and had a weekly electronic backup system of the information to safeguard the data in case of disasters and catastrophes.

4.5.2. Data cleaning

Data checking and cleaning was performed independently by a staff trained on quality assurance and control and by a statistician using Excel 2013 and R Studio version 3.4.2. Data was subsequently exported to Stata version 15.1 (StataCorp LLC, College Station, Texas, USA) for data analysis.

For physical activity (PA) variables, data cleaning, consistency and missing data analyses were carried out to ensure reasonable standards of data quality. For data cleaning, histograms for steps per day and time spent in moderate to vigorous physical activity (MVPA) were used to explore the underlying frequency distribution, the presence of outliers and skewness. Values above (or below) ±3 standard deviations of the mean have been removed from the analysis.

4.5.3. Data analysis

Descriptive statistics including medians and interquartile ranges (IQR) and means and their standard deviations (SD) and percentages were computed and listed by background characteristics, which include age, sex, religion, education level, marital status, occupation, and household wealth.

A household wealth index was generated using principal component analysis a modified approach to the one suggested by Filmer and Pritchett. The method combines variables related to household assets, household construction materials, water, sanitation and other variables into a single index, which is afterwards issued as quintiles (first (poorest), second, third, fourth and fifth (least poor)) (54,55).

The analysis was mostly determined a priori, based on the conceptual framework (Figure 4.3) and focused on non-modifiable and social determinants as well as behavioral risk factor as predictors of each output. With respect to behavioral risk factors, we focused on those for which the link with the output can be considered causal, i.e., an unhealthy diet, insufficient physical activity, alcohol consumption and tobacco use (56).

Chi-square testing was used to examine differences in sociodemographic characteristics, behavioral and metabolic risk factors for NCDs between males and females.

Data analysis for topic I (Physical activity and sedentarism) :

The estimation of MVPA is based on validated cut-points of 110 steps/minute for moderate- and 130 steps/minute for vigorous-intensity PA (57). For steps per day categories the proposal of Tudor-Locke and Bassett (2004) was followed (58). This classification defines five categories as follows: sedentary (<5,000 steps/day), low active (5,000–7,499 steps/day), somewhat active (7,500–9,999/day), active (10,000–12,499 steps/day) and highly active (≥ 12,500 steps/day). A second analysis was made using the cut off of 10 000 steps/day to classify the sample as inactive (<10 000 steps/day) or active (≥10 000 steps/day).

A simple bivariate analysis was carried out to explore the association between the outcome variables and respondent´s sociodemographic characteristics using Chi-square tests. Second, logistic regression was used to identify factors associated with being sedentary (<5,000 steps/day), physically inactive (<10,000 steps per day) and No MVPA (<1 min/day) using adjusted odds ratio (AOR) and 95% CI. Only factors associated at $p < 0.05$ from the bivariate analyses were included in the multivariable regression model.

For each of the logistic regression models, apart from AORs, figures related to how well the data fits the model are reported. These figures include the Hosmer and Lemeshow goodness-of-fit test, classification tables and Nagelkerke R^2.

Data analysis for topic II (Overweight and Obesity) :

BMI was categorized as underweight (<18.5 kg/m²), normal weight (18.5 - <25 kg/m²), overweight ((≥25 - <30 kg/m²), overweight+ (≥25 kg/m²) – which includes obese people, and obese (≥30 kg/m²), based on the WHO classification (59).

Associations of possible risk factors with the binary outcome overweight+ were analyzed using log-link binomial regression and Poisson regression (60,61) with robust variance estimates to adjust for within household clustering. Univariable and multivariable analysis for the overweight and obesity outcome were already described by Macicame et al: Factors associated with overweight+ with a p-value (*P*) $\leq$0.1 and *P* $\leq$0.2 for factors associated with obesity in the univariable regressions adjusted for age and gender were included into the multivariable models. The Akaike Information Criterion (AIC) and the most parsimonious model were the criteria used to decide which variables should be retained in these multivariable models. To adjust for potential confounding, gender, age and household wealth index were included in all multivariable models (38).

Data analysis for topic III (Metabolic syndrome) :

MS was defined based on the 2009 Harmonized criteria (62–64), a definition that allows comparison between different epidemiological studies and is also recommended for clinical practice (45). The selected criteria for the diagnosis of MS includes participants with any three or more of the five components described in Figure 4.6. The cut off used to define abdominal obesity was waist circunference > 102 cm for men or > 88 cm for women.

Measure	Categorical Cut Points
Elevated waist circumference*	Population- and country-specific definitions
Elevated triglycerides (drug treatment for elevated triglycerides is an alternate indicator†)	≥150 mg/dL (1.7 mmol/L)
Reduced HDL-C (drug treatment for reduced HDL-C is an alternate indicator†)	<40 mg/dL (1.0 mmol/L) in males; <50 mg/dL (1.3 mmol/L) in females
Elevated blood pressure (antihypertensive drug treatment in a patient with a history of hypertension is an alternate indicator)	Systolic ≥130 and/or diastolic ≥85 mm Hg
Elevated fasting glucose‡ (drug treatment of elevated glucose is an alternate indicator)	≥100 mg/dL

HDL-C indicates high-density lipoprotein cholesterol.

*It is recommended that the IDF cut points be used for non-Europeans and either the IDF or AHA/NHLBI cut points used for people of European origin until more data are available.

†The most commonly used drugs for elevated triglycerides and reduced HDL-C are fibrates and nicotinic acid. A patient taking 1 of these drugs can be presumed to have high triglycerides and low HDL-C. High-dose ω-3 fatty acids presumes high triglycerides.

‡Most patients with type 2 diabetes mellitus will have the metabolic syndrome by the proposed criteria.

Figure 4.6. Criteria for Clinical Diagnosis of the Metabolic Syndrome based on the 2009 harmonized criteria; repro-duced from (62)

The prevalence of MS was determined using two different denominators :

- The first prevalence was based on more strict criteria where only study participants who were fasting were included in the analysis, meaning that in all participants data on all five components that are used to define MS are available.
- The second prevalence relates to study participants in whom at least three of the the five components are available, which includes participants without data on fasting glucose and/or fasting triglycerides.

Associations of various potential risk factors with the binary outcome MS, were analyzed using log-link binomial regression or alternatively (if the log link models did not converge) Poisson regression (60,61) with robust variance estimates to adjust for within-household clustering. Uni-variable regressions were adjusted for age and gender to identify factors whose association with MS had a p-value (*P*) ≤0.1 to be considered for inclusion into multivariable models.

4.6. Ethical Considerations

This study was approved by the National Health Bioethics Committee of Mozambique, and was provided a waiver by the Ethics Board of the Faculty of Medicine of *Ludwig-Maximilians-Universität München, Germany* for PhD purposes.

All study procedures were conducted according to the ethical principles described in the Helsinki Declaration and its revisions (65). Prior to enrollment, all eligible household members aged 18 years and above and minor's legal representatives signed an informed consent form (Annex 9.6 and 9.7). Assent forms were applicable for individuals aged 15-17 years (Annex 9.8).

The questionnaires were administered individually, in a place of residence chosen by the member of the household, where it could take place in private. Study interviewers were trained to explain to study participants about the importance of interviews individually and privately. Even in the case of collection of physical parameters (BP, weight, height, waist circumference, physical activity) in groups, the dissemination of abnormal results was made in private (except for cases of children under 18, whose abnormal results were disclosed in the presence of their representatives).

The content of the forms and any additional information that was collected was treated confidentially and considered strictly confidential. The information contained in the database continues to be kept confidential and its access is restricted to authorized individuals, using passwords incorporated in the computer program in use.

Participants did not receive any financial or material compensation.

5. Results

In total, 1223 individuals living in 367 households (mean of 3.3 subjects per household, with a minimum of one and a maximum of 13 adults per household) were approached, of whom 1174 persons (96%) were eligible for inclusion in the study. Among those eligible individuals, 963 (82%) – at least one member of the 367 households –consented to participate. Reasons for non-eligibility and for not consenting are presented in Figure 5.1.

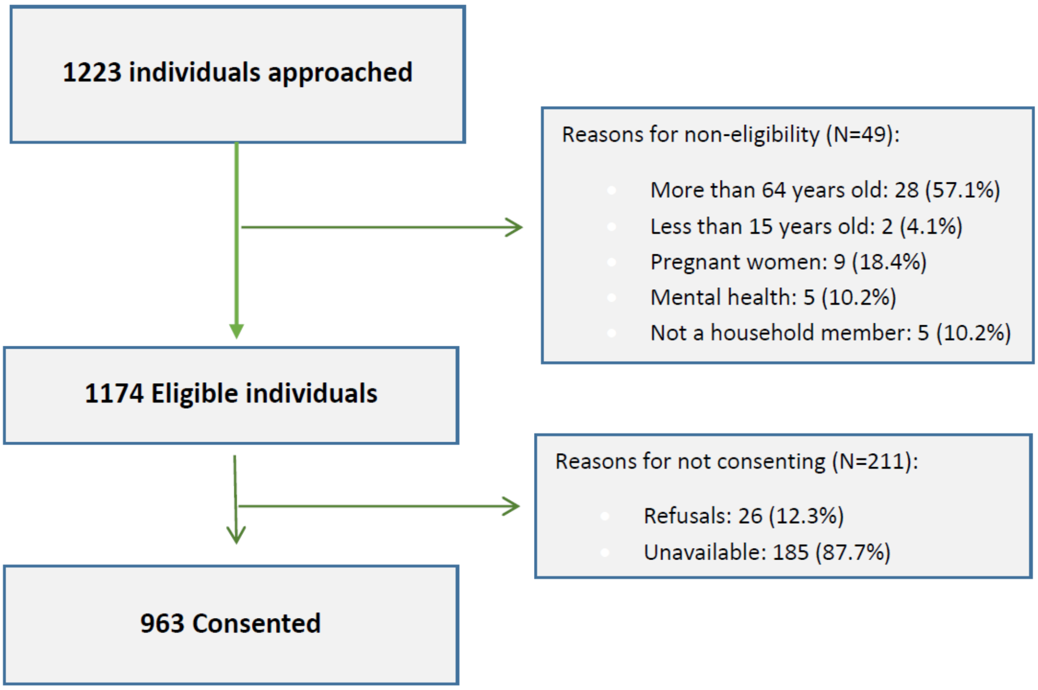

Figure 5.1. Screening and enrolment of participants

Table 5.1 presents the socio-demographic characteristics of study participants, where the majority were females (57.7%), almost two thirds of the enrolled participants were below the age of 35 (median age of 28 (IQR : 21, 41)) years and half of the study participants (51%) were single. More than half of the participants (53.6%) had at least a secondary level of education and 54.2% were employed. Portuguese, the official language in Mozambique, was considered as their mother tongue by more than one quarter of the participants and 88% reported that they can speak, write and read Portuguese.

Table 5.1. Socio-demographic characteristics of study participants (N=931)

Characteristics	Total (N=931)		Male (n=394)		Female (n=537)	
	N	**%**	**n**	**%**	**n**	**%**
Age, years; median (IQR)	28 (21, 41)		27 (20, 38)		29 (21, 43)	
Age, years	922		391		531	
15-24	372	(40.4)	165	(42.2)	207	(39.0)
25-34	223	(24.2)	104	(26.6)	119	(22.4)
35-44	133	(14.4)	57	(14.6)	76	(14.3)
45-54	121	(13.1)	39	(10.0)	82	(15.4)
55-64	73	(7.9)	26	(6.7)	47	(8.5)
Religion	869		364		505	
Muslim	30	(3.5)	16	(4.2)	13	(2.5)
Zion	132	(15.2)	42	(11.1)	82	(15.6)
Christian Catholic	168	(19.3)	78	(20.7)	86	(16.3)
Christian Protestant	474	(54.6)	175	(46.4)	293	(55.6)
No religion	65	(7.5)	39	(10.3)	25	(4.7)
Marital status	923		391		532	
Single	471	(51.0)	216	(55.2)	255	(47.9)
Marriage/ Consensual union	393	(42.6)	165	(42.2)	228	(42.9)
Divorced/ widowed	59	(6.4)	10	(2.6)	49	(9.2)
Mother tongue	922		390		532	
Portuguese	262	(28.4)	116	(29.7)	146	(27.4)
Bitonga	25	(2.7)	11	(2.8)	14	(2.6)
Xichangana	458	(49.7)	169	(43.3)	289	(54.3)
Xisena	4	(0.4)	1	(0.3)	3	(0.6)
Xirhonga	20	(2.2)	7	(1.8)	13	(2.4)
Xichope	6	(0.7)	1	(0.3)	5	(0.9)
Xitshwa	35	(3.8)	19	(4.9)	16	(3.0)
Ndau	22	(2.4)	16	(4.1)	6	(1.1)
Other	90	(9.8)	50	(12.8)	40	(7.5)
Education	922		391		531	
Primary or lower	428	(46.4)	149	(38.1)	279	(52.5)
Secondary or higher	494	(53.6)	242	(61.9)	252	(47.5)
Speak, write and read Portuguese	864		380		484	
Yes	760	(88.0)	352	(92.6)	408	(84.3)
No	104	(12.0)	28	(7.4)	76	(15.7)

Characteristics	Total (N=931)		Male (n=394)		Female (n=537)	
	N	%	n	%	n	%
Occupation	830		362		468	
Unemployed/ retired	183	22.1	54	14.9	129	27.6
Housewife	51	6.1	0	0	51	10.9
Full-time Student	146	17.6	56	15.5	90	19.2
Employed	450	54.2	252	69.9	198	42.3
Household wealth index score, quintiles	819		346		473	
Lowest	109	13.3	55	15.9	54	11.4
Low	147	18.0	61	17.6	86	18.2
Medium	174	21.3	76	22.0.	98	20.7
High	192	23.4	78	22.5	114	24.1
Highest	197	24.1	76	22.0	121	25.6

Table 5.2 shows that one out of four participants (25.6%) reported having an NCD, with women reporting higher frequencies of NCDs in general (31%; *P*<0.001), high blood pressure (HBP) (25.5%; *P*<0.001), cancer (8.4%; *P*=0.021) and family history of HBP (58%; *P*=0.005) compared to men.

Table 5.2. Personal and family history of chronic diseases of study participants (N=924)

	Total		Male		Female		
Characteristics	**N**	**%**	**n**	**%**	**n**	**%**	**p-value**
HIV self-report	924		385		539		
Yes	41	4.4	16	4.2	25	4.6	0.726
No	883	95.6	369	95.8	514	95.4	
Self-report of any NCD	844		354		490		
Yes	216	25.6	64	18.1	152	31.0	<0.001
No	558	66.1	267	75.4	291	59.4	
Don't know	70	8.3	23	6.5	47	9.6	
HBP self-report	915		382		533		
Yes	187	20.4	51	13.4	136	25.5	<0.001
No	712	77.8	322	84.3	390	73.2	
Don't know	16	1.8	9	2.4	7	1.3	
Diabetes self-report	215		64		151		0.215
Yes	7	3.3	0	0	7	4.6	

Characteristics		Total N	Total %	Male n	Male %	Female n	Female %	p-value
	No	163	75.8	50	78.1	113	74.8	
	Don't know	45	20.9	14	21.9	31	20.5	
Cancer self-report		915		381		534		
	Yes	60	6.6	15	39	45	8.4	0.021
	No	835	91.3	356	93.4	479	89.7	
	Don't know	20	2.2	10	2.6	10	1.8	
Family history of HBP		915		382		533		
	Yes	489	53.4	180	47.1	309	58.0	0.005
	No	303	33.1	146	38.2	157	29.4	
	Don't know	123	13.4	56	14.7	67	12.6	
Family history of Diabetes		903		376		527		
	Yes	117	13.0	38	10.1	79	15.0	0.024
	No	655	72.5	273	72.6	382	72.5	
	Don't know	131	14.5	65	17.3	66	12.5	

Behavioral risk factors for NCDs of study participants are presented in Table 5.3. More than half of the participants (55.2%) reported consuming vegetables regularly but only 20.2% reported eating fruits on a regular basis. Almost three quarter (73.9%) of the participants never ate processed food or did so less than once a week. There were no statistically significant differences regarding diet patterns between females and males. Males reported consuming more alcohol and tobacco than females (P<0.0001), with a general prevalence of daily tobacco and alcohol consumption of 5.6% and 5.4% respectively. Females engaged less in physical activity than males (P<0.0001). Of those who correctly used pedometers to measure physical activity (i.e. over seven days and throughout the day), 64.6% walked less than the recommended 10000 steps per day, with a median of 8136 (IQR : 5409, 11638) steps per day, and 67% spent less than 60 minutes of MVPA per day, with a median of 18 (IQR : 6.2, 35) minutes of MVPA per day.

Table 5.3. Behavioral characteristics of participants (N=931)

Characteristics	Total (931)		Male (394)		Female (523)		p-value (chi2)
	N	%	n	%	n	%	
Consumption of fruit per week, days	922		389		533		
Median (IQR)	2 (0, 3)		2 (0, 3)		2 (0, 3)		
Never	248	26.9	107	27.5	141	26.5	0.4284
1-3 days a week	488	52.9	197	50.6	291	54.6	
4-7 days a week	186	20.2	85	21.9	101	19.0	
Consumption of vegetables per week, days	892		372		520		
Median (IQR)	4 (3, 6.5)		4 (3, 6)		4 (3, 7)		
Never	15	1.7	10	2.7	5	1.0	0.1107
1-3 days a week	385	43.2	164	44.1	221	42.5	
4-7 days a week	492	55.2	198	53.2	294	56.5	
Consumption of processed foods per week	921		390		531		
Never	311	33.8	132	33.9	179	33.7	0.0867
Less than once per week	369	40.1	145	37.2	224	42.2	
1-4 times per week	175	19.0	76	19.5	99	18.6	
Daily/ Almost daily	66	7.2	37	9.5	29	5.5	
Consumption of soft drinks per week	894		373		521		
Never	507	56.7	202	54.2	305	58.5	0.0080
Less than once per week	187	20.9	71	19.0	116	22.3	
1-4 times per week	145	16.2	66	17.7	79	15.2	
Daily/ Almost daily	55	6.2	34	9.1	21	4.0	
Tobacco consumption	923		390		533		
Never consumes	835	90.5	319	81.8	516	96.8	<0.0001
Consumes weekly	36	3.9	28	7.2	8	1.5	
Consumes daily	52	5.6	43	11.0	9	1.7	
Alcohol consumption	922		390		532		
Never consumed alcohol	397	43.1	113	29.0	284	53.4	<0.0001
Did not consume alcohol last year	95	10.3	34	8.7	61	11.5	
Consumes less than once per week	380	41.2	205	52.6	175	32.9	
Consumes daily to at least once per week	50	5.4	38	9.7	12	2.3	
Number of steps per day	537		228		309		
Median (IQR)	8136 (5409, 11638)		10166 (6668, 13866)		6819 (4634, 9897)		
<10000	347	64.6	110	48.3	237	76.7	<0.0001

Characteristics	Total (931)		Male (394)		Female (523)		p-value (chi2)
	N	%	n	%	n	%	
≥10000	190	35.4	118	51.7	72	23.3	
Time spent in MVPA per day, minutes	537		228		309		
Median (IQR)	18,0 (6.2, 35.0)		24.8 (10.2, 46.5)		14.0 (3.8, 28.7)		
<60	360	67.0	128	56.1	232	75.1	<0.0001
≥60	177	33.0	100	43.9	77	24.9	

The median BMI and waist width in the study population was 22.5kg/m^2 (IQR : 20.1 kg/m^2, 26.2 kg/m^2) and 76cm (70cm; 86.6cm), respectively, with women presenting a statistically significantly (*P*<0.0001) higher prevalence of overweight+ and abdominal obesity (42.5% and 43.8%, respectively), compared to men (16.3% and 7%, respectively) (Table 5.4). Women also presented a higher prevalence of low HDL cholesterol (31.4%) compared to men (22.3%), *P*=0.003. In contrast, men had a higher prevalence of hyperglycemia (61.1%), compared to women (47.3%), *P*=0.048. Overall, 19.8% and 14.1% of the study participants presented HBP and hypertriglyceridemia, with no statistically significant differences between genders.

Table 5.4. Metabolic risk factors for NCDs on study participants (N=931)

Characteristics	Total		Male		Female		p-value
	N	%	n	%	n	%	
BMI; median (IQR)	22.5 (20.1, 26.2)		21.2 (19.3, 23.6)		23.7 (20.8, 28.3)		<0.0001
BMI	931		394		537		
Less than 18.5	91	9.8	57	14.4	34	6.3	
18.5-24.9	552	59.3	277	70.3	275	51.2	
25.0-29.9	171	18.4	47	13.0	124	23.1	
>=30	117	12.6	13	3.3	104	19.4	
Waist circumference; median (IQR)	76 (70, 86.6)		73.4 (69.3, 80.6)		78.1 (71, 90.5)		<0.0001
Waist circumference	920		384		536		
Normal	658	71.5	357	93.0	301	56.2	
Wide	262	28.5	27	7.0	235	43.8	
Systolic blood pressure; median (IQR)	119 (109, 131)		121 (112, 135)		115 (106, 128)		0,742
Diastolic blood pressure; median (IQR)	74 (66, 84)		74 (66, 83)		75 (67, 84)		

Characteristics	Total N	Total %	Male n	Male %	Female n	Female %	p-value
HBP	920		384		536		
No	738	80.2	310	80.7	428	79.9	
Yes	182	19.8	74	19.3	108	20.1	
Fasting glucose; median (IQR)	5.1 (4.7, 5.7)		5.2 (4.8, 5.8)		5.1 (4.7, 5.6)		0,048
Fasting glucose	207		95		112		
Normal	96	46.4	37	38.9	59	52.7	
High	111	53.6	58	61.1	53	47.3	
Fasting triglycerides; median (IQR)	1.1 (0.8, 1.6)		1.0 (0.8, 1.5)		1.1 (0.8, 1.7)		0,581
Fasting triglycerides	206		95		111		
Normal	177	85.9	83	87.4	94	84.7	
High	29	14.1	12	12.6	17	15.3	
HDL cholesterol; median (IQR)	1.5 (1.1, 2.0)		1.4 (1.0, 2.0)		1.6 (1.2, 2.1)		0,003
HDL cholesterol	924		385		539		
Normal	669	72.4	299	77.7	370	68.7	
Low	255	27.6	86	22.3	169	31.3	

5.1. Results from Topic I (Physical activity and sedentarism)

Of the 963 participants who consented to participate in the study, 580 (60.2%) provided valid PA measurements based on the use of pedometers.

The distribution of the average number of steps per day and average time spent per day in MVPA are shown in Figures 5.2 and 5.3, respectively. The distribution of steps/day was slightly skewed to the right, and the skewness is more pronounced in females than males (see Figure 5.2). There was greater skewness observed in the distribution of MVPA in both genders.

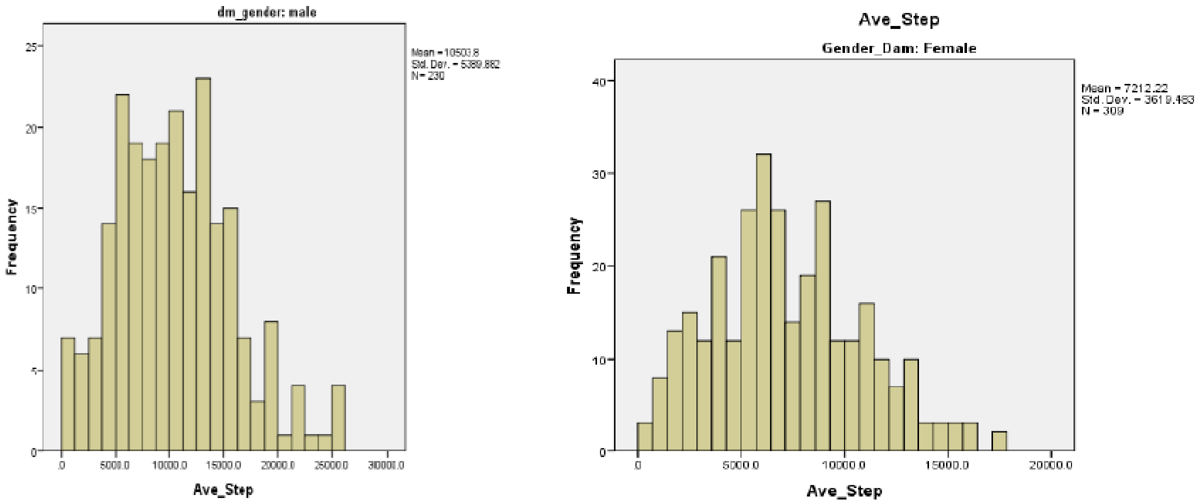

Figure 5.2. Distribution of average number of steps per day for males (a) and females (b)

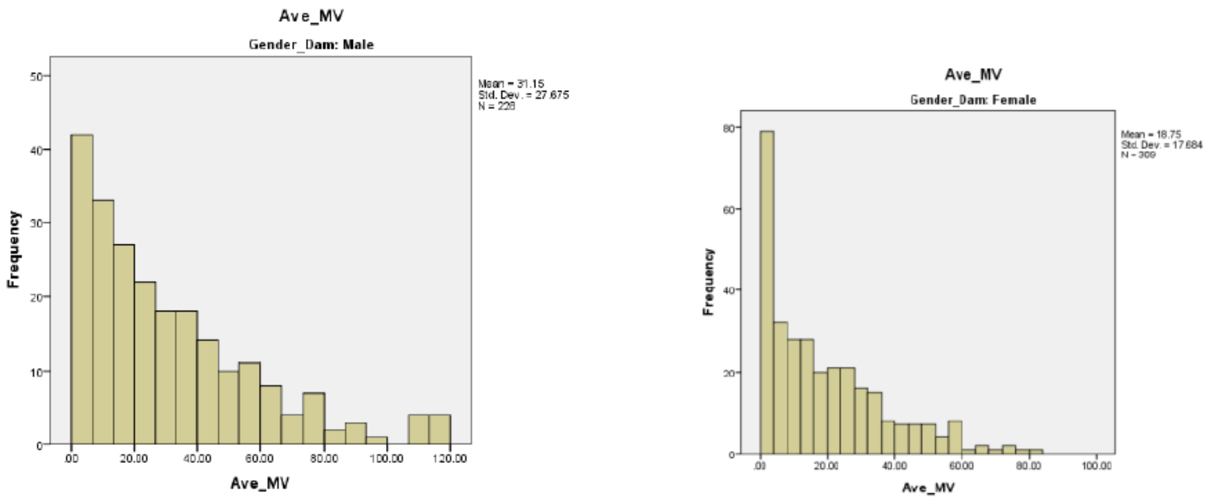

Figure 5.3. Distribution of average time (minutes) spent in moderate-to-vigorous physical activity per day for males (a) and females (b)

The proportion of participants by activity categories is shown in Table 5.5. The percentage of sedentary subjects (<5,000 steps per day) was 14.7% for males and 26.8% for females while when considering the cut-off value of 10,000 steps/day there were 35.2% of the sample that would be considered active (males=51.3%; females=23.3%) and 64.8% inactive (males=48.7%; females=76.7%. Subjects spending one or more than one hour in MVPA were 8.7% (males=15.2%; females=3.8%).

Table 5.5. Proportion of subjects by physical activity categories

Characteristic	Total		Male		Female	
	N	%	n	%	n	%
Steps/day*						
Sedentary	118	21.7	34	14.7	84	26.8
Low Active	132	24.3	41	17.8	91	29.0
Somewhat Active	102	18.8	37	16.1	65	20.7
Active	80	14.7	37	16.1	43	13.7
Highly Active	111	20.4	81	35.2	30	9.5
<10000 steps/day	352	64.8%	112	48.7%	240	76.7%
≥10000 steps/day	191	35.2%	118	51.3%	73	23.3%
MVPA						
No MVPA	49	9.0%	13	5.7%	36	11.5%
1-29.9 min.	320	58.9%	120	52.2%	200	63.9%
30-59.9 min	127	23.4%	62	27.0%	65	20.8%
≥60 min	47	8.7%	35	15.2%	12	3.8%

*see text for definitions of steps per day categories.

Associations of various factors with being sedentary (<5,000 steps/day) are presented in table 5.6, where age, education, religion, marital status and BMI do not show any significant association. The proportion of sedentary females is higher than males (males=18.8%; females=26.8%; *P*=0.001). Occupation was a second significant factor (*P*=0.02) showing employees (16%) and students (23.7%) with lower proportion of sedentary subjects than housewives (29%) and unemployed (28.7%).

Table 5.6. Bivariate analysis of factors associated with being sedentary (less than 5000 steps/day)

Characteristics		Sedentary (%)	Chi-square	p-value
Gender	Male	14.8	11.3	0.001
	Female	26.8		
Age	15-24	24.0	3.5	0.47
	25-34	21.2		
	35-44	14.8		
	45-54	18.7		
	55-64	26.5		
Education	Primary or lower	21.1	0.076	0.78
	Secondary or higher	22.0		
Occupation	Employed	16.0	9.47	0.02

Characteristics		Sedentary (%)	Chi-square	p-value
	Housewife	29.0		
	Unemployed	28.7		
	Student	23.7		
Religion	Atheist	23.1	10.0	0.074
	Christian Catholic	28.8		
	Christian protestant	16.9		
	Muslim	23.5		
	Zion	20.9		
Marital status	Married	21.7	0.76	0.68
	Single	22.5		
	Widow-divorced	16.2		
SES	Very Low	24.6	1.78	0.77
	Low	18.8		
	Medium	20.6		
	Medium-high	23.9		
	Highest	18.4		
BMI	<18.5	23.5	1.21	0.74
	18.5_24.9	19.8		
	25_29.9	20.6		
	>=30	25.7		

When 10,000 steps/day is considered as the cut-off that discriminates inactive and active subjects, gender, occupation and SES are significant factors while age, education, religion, marital status and BMI do not show any significant association (table 5.7). Females are more inactive than males (76.7% vs 48.7%), unemployed (73.9%) more than employed (57.8%) and the highest (72.8%) and mid-high SES (73.5%) groups have a high proportion of inactivity than very low (49.2%) and low (58.8%) groups.

Table 5.7. Bivariate analysis of factors associated with inactivity (<10 000 steps/day)

Characteristics		Inactive[a](%)	Chi-square	p-value
Gender	Male	48.7	45.5	<0.001
	Female	76.7		
Age	15-24	68.0	2.7	0.59
	25-34	61.4		

Characteristics		Inactive[a](%)	Chi-square	p-value
	35-44	60.7		
	45-54	68.0		
	55-64	61.2		
Education	Primary or lower	62.3	1.7	0.28
	Secondary or higher	66.8		
Occupation	Employed	57.8	11.2	0.01
	Housewife	71.0		
	Unemployed	73.9		
	Student	69.9		
Religion	Atheist	61.5	3.5	0.62
	Christian Catholic	64.4		
	Christian protestant	65.0		
	Muslim	58.8		
	Zion	61.2		
Marital status	Married	62.7	3.4	0.17
	single	67.8		
	Widow-divorced	54.1		
SES	Very Low	49.2	15.7	0.003
	Low	58.8		
	Medium	61.1		
	Medium-high	73.5		
	Highest	72.8		
BMI	<18.5	56.9	2.8	0.42
	18.5 – 24.9	63.9		
	25.0 – 29.9	68.8		
	≥ 30	68.9		

Bivariate analysis only found significance for gender for No MVPA, where the portion of inactivity was higher in females than in males (females=11.5%; males=5.7%; *P*=0.01). All the other factors are not significant (table 5.8).

Table 5.8. Bivariate analysis of factors associated with no time spent in MVPA (NO MVPA)

Characteristics		NO MVPA (%)	Chi-square	p-value
Gender	Male	5.7	5.5	0.01
	Female	11.5		
Age	15-24	6.7	6.6.	0.15
	25-34	11.4		
	35-44	4.9		
	45-54	14.7		
	55-64	10.2		
Education	Primary or lower	9.7	0.41	0.51
	Secondary or higher	8.1		
Occupation	Employed	7.8	1.87	0.59
	Housewife	9.7		
	Unemployed	11.3		
	Student	11.8		
Religion	Atheist	12.3	5.5	0.23
	Christian Catholic	8.5		
	Christian protestant	9.4		
	Muslim	0		
	Zion	3		
Marital status	Married	9.2	0.04	0.97
	Single	9.0		
	Widow-divorced	8.1		
Household wealth index	Very Low	5.0	3.4	0.48
	Low	4.7		
	Medium	7.9		
	Medium-high	12		
	Highest	8.3		
BMI	Less than 18.5	5.9	3.8	0.27
	18.5 – 24.9	8.4		
	25 – 29.9	8.3		
	>=30	14.9		

Logistic regression was performed with variables that were significant in the bivariate analyses. Females are more sedentary (<5,000 steps/day) than males (OR=1.9) and unemployed (OR=1.8) more than employed (Table 5.7). When using the less than 10,000 steps per day as a criterion to classify inactivity, females (OR=3.2) are more inactive than males. There are no statistically significant differences between occupational groups and only high SES subjects are statistical more inactive (OR=2.2) than the low SES group. Furthermore, the odds of NO MVPA was higher in females (OR=2.1) than males as is shown in Table 5.9.

Table 5.9. Factors associated with being sedentary (<5 000 steps/day), physically inactive (<10 000 steps/day), and not participating in MPVA

Variable	Sedentary*	Inactive**	No MVPA***
Gender			
Male	1	1	1
Female	1.9 (1.2-3.2)	3.2 (2.1-4.8)	2.1 (1.1-4.1)
Occupation			
Employed	1	1	
Housewife	1.5 (0.6-3.6)	1.2 (0.4-2.9)	
Unemployed	1.8 (1.1-3.1)	1.6 (0.9-2.7)	
Student	1.4 (0.8-2.6)	1.2 (0.7-2.1)	
Household wealth index			
Very Low		1	
Low		1.2 (0.6-2.9)	
Mid		1.4 (0.7-2.7)	
Mid-high		2.0 (1.0-4.0)	
High		2.2 (1.1-4.6)	

Data is presented as Odds Ratio

* NSH-Hosmer Lemeshow test 0.32 p=0.98 classification Table 78.8%; R^2=0.05

** NSH-Hosmer lemeshow test 5.0 p=0.75 classification Table 67.3%; R^2=0.15

*** Classification Table 91%; R^2=0.02

5.2. Results from Topic II (Overweight and Obesity)

Out of 963 household members who had consented to participate, 32 (3.3%) were excluded from this analysis because no BMI data were abailable.

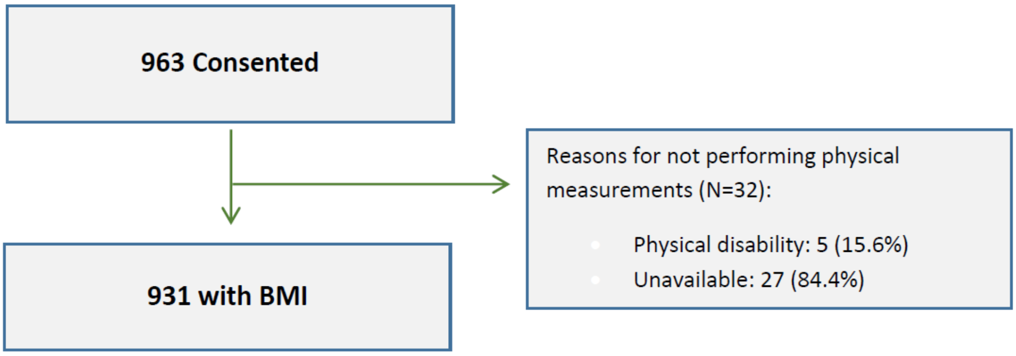

Figure 5.4. Reasons for not enrolling consented participants into the overweigh/obesity analysis

Figure 5.5 presents the BMI distribution, which shows that almost one third [(31.0%) (95% CI: 28.0, 33.9)] and 12.6% (95% CI: 10.4, 14.7) of the study participants were overweight+ and obese, respectively, with females presenting a higher prevalence of overweight and obesity (42.5% overweight+ and 19.4% obese) compared to males (*P*<0.0001).

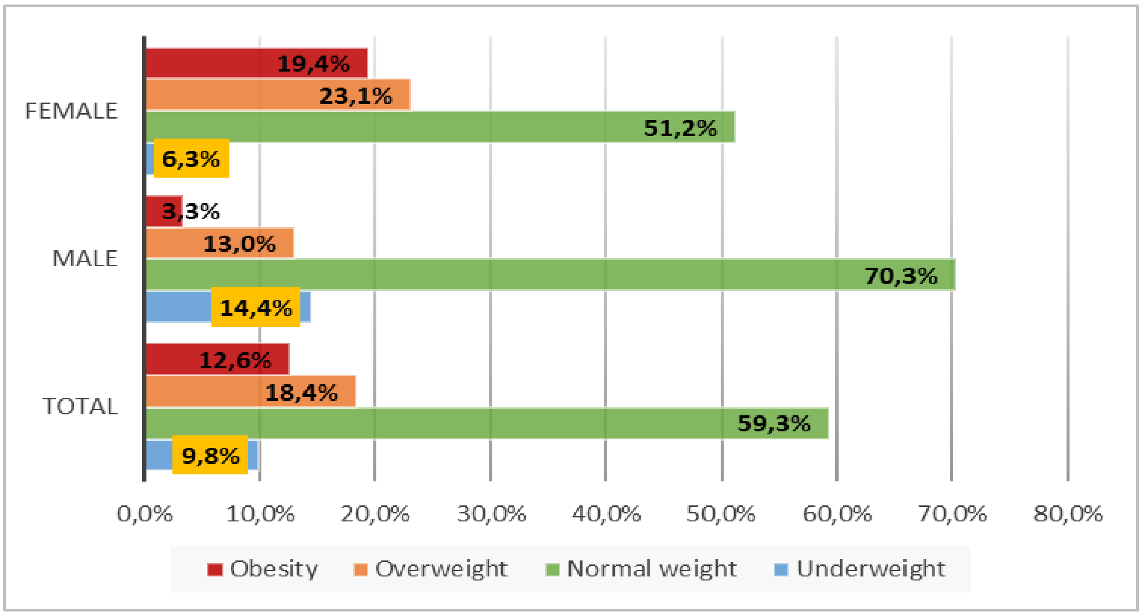

Figure 5.5. BMI distribution among study participants

Table 5.10 presents the findings of the univariable modelling describing the association of overweight+ with socioeconomic and behavioral factors. After adjusting for age, women were 2.57 times (95% CI: 2.02 to 3.27) more likely than men to be overweight+ and after adjusting for gender the risk of being overweight+ increased 1.03 times (95% CI: 1.03 to 1.04) with each year of age. Compared with lowest household wealth index category, the highest household wealth index was associated with a 1.92 fold (95% CI: 1.32 to 2.79, *P*=0.0006) increased risk of being overweight+. Married and employed individuals were 1.45 (95% CI: 1.13 to 1.87) and 1.51 (95% CI: 1.19 to 1.92) times more likely to be overweight+ than singles and unemployed participants, respectively. After adjusting for gender and age, having Portuguese as mother language, being able to speak, write and read Portuguese and the level of education did not show a statistically significant association with overweight+.

With respect to behavioral risk factors, the consumption of fruits was associated with a 1.07 (95% CI: 1.03 to 1.11) times increased risk of overweight+ for each additional day (*P*=0.0004), while the consumption of soft drinks and processed foods showed no association with overweight+. Tobacco consumption was associated with reduced risk of being overweight+ (*P*=0.0049), while alcohol consumption and physical activity were not significantly associated with overweight+.

Table 5.10. Associations of overweight+ (BMI>=25) with socioeconomic and behavioral characteristics, uni-variable models and models adjusted for gender and age

				Univariable (*)			Adj. for gender & age		
Covariate	**N**	**Evts.**	**% Evts.**	**RR**	**95% CI**	**p-value**	**RR**	**95% CI**	**p-value**
Gender (N=922)									
Male	391	59	15.09	1.00	- -	-	1.00	- -	-
Female	531	223	42.00	2.78	(2.18 to 3.56)	<0.0001	2.57	(2.02 to 3.27)	<0.0001
Age (per year)	-	-	-	1.04	(1.03 to 1.04)	<0.0001	1.03	(1.03 to 1.04)	<0.0001
Household wealth index score, quintiles (N = 818)									
Very low	109	26	23.85	1.00	- -	-	1.00	- -	-
Low	146	40	27.40	1.15	(0.72 to 1.83)	0.5622	1.20	(0.78 to 1.86)	0.4127

					Univariable [*]			Adj. for gender & age	
Covariate	**N**	**Evts.**	**% Evts.**	**RR**	**95% CI**	**p-value**	**RR**	**95% CI**	**p-value**
Medium	174	48	27.59	1.16	(0.75 to 1.78)	0.5093	1.23	(0.83 to 1.83)	0.2997
Medium/high	192	58	30.21	1.27	(0.82 to 1.96)	0.2906	1.35	(0.90 to 2.01)	0.1421
Highest	197	83	42.13	1.77	(1.18 to 2.65)	0.0062	1.92	(1.32 to 2.79)	0.0006
Education (N = 921)									
Primary or lower	427	171	40.05	1.00	- -	-	1.00	- -	-
Secondary or higher	494	110	22.27	0.56	(0.45 to 0.68)	<0.0001	1.03	(0.81 to 1.30)	0.8250
Marital status (N = 922)									
Single	471	92	19.53	1.00	- -	-	1.00	- -	-
Married	392	159	40.56	2.08	(1.63 to 2.65)	<0.0001	1.45	(1.13 to 1.87)	0.0035
Divor-ced/widow(ed)	59	31	52.54	2.69	(1.96 to 3.70)	<0.0001	1.18	(0.84 to 1.66)	0.3517
Occupation (N = 922)									
Unemployed/retired	183	50	27.32	1.00	- -	-	1.00	- -	-
Housewife	51	19	37.25	1.36	(0.87 to 2.14)	0.1758	1.10	(0.73 to 1.68)	0.6445
Student	146	21	14.38	0.53	(0.32 to 0.85)	0.0095	0.94	(0.57 to 1.54)	0.8058
Employed	449	159	35.41	1.30	(0.99 to 1.70)	0.0623	1.51	(1.19 to 1.92)	0.0008
Missing data	93	33	35.48	1.30	(0.89 to 1.89)	0.1715	1.48	(1.05 to 2.07)	0.0236
Can speak, write and read Portuguese (N = 922)									
No	103	40	38.83	1.00	- -	-	1.00	- -	-
Yes	760	218	28.68	0.74	(0.56 to 0.97)	0.0299	1.20	(0.93 to 1.56)	0.1627
Missing data	59	24	40.68	1.05	(0.72 to 1.53)	0.8109	0.76	(0.53 to 1.09)	0.1344
Portuguese as the mother language (N = 922)									
No	660	232	35.15	1.00	- -	-	1.00	- -	-
Yes	262	50	19.08	0.54	(0.42 to 0.71)	<0.0001	0.89	(0.67 to 1.19)	0.4469
Consumption of Fruit per week (N = 919)									
(per number of days of the week)	-	-	-	1.04	(1.00 to 1.09)	0.0647	1.07	(1.03 to 1.11)	0.0004

				Univariable (*)			Adj. for gender & age		
Covariate	**N**	**Evts.**	**% Evts.**	**RR**	**95% CI**	**p-value**	**RR**	**95% CI**	**p-value**
Consumption of Fruit per week (N = 919)									
Never	247	72	29.15	1.00	- -	-	1.00	- -	-
1-3 days a week	486	146	30.04	1.03	(0.81 to 1.31)	0.8041	1.18	(0.95 to 1.47)	0.1365
4-7 days a week	186	64	34.41	1.18	(0.89 to 1.56)	0.2484	1.44	(1.11 to 1.86)	0.0052
Consumption of Vegetables per week (N = 891)									
(per number of days of the week)	-	-	-	1.02	(0.98 to 1.07)	0.3134	1.00	(0.95 to 1.04)	0.8330
Consumption of Vegetables per week (N = 891)									
Never	15	2	13.33	1.00	- -	-	1.00	- -	-
1-3 days a week	385	118	30.65	2.30	(0.63 to 8.33)	0.2050	1.91	(0.54 to 6.77)	0.3142
4-7 days a week	491	160	32.59	2.44	(0.67 to 8.92)	0.1761	1.84	(0.51 to 6.57)	0.3495
Consumption of Processed food per week (N = 919)									
Never	310	96	30.97	1.00	- -	-	1.00	- -	-
Less than once per week	368	126	34.24	1.11	(0.89 to 1.38)	0.3708	1.13	(0.91 to 1.39)	0.2686
1-4 times per week	175	49	28.00	0.90	(0.68 to 1.21)	0.4969	1.15	(0.88 to 1.51)	0.3055
Daily/almost daily	66	10	15.15	0.49	(0.26 to 0.92)	0.0266	0.80	(0.44 to 1.45)	0.4567
Consumption of Soft drinks per week (N = 893)									
Never	507	174	34.32	1.00	- -	-	1.00	- -	-
Less than once per week	186	58	31.18	0.91	(0.72 to 1.15)	0.4237	1.02	(0.82 to 1.25)	0.8863
1-4 times per week	145	33	22.76	0.66	(0.48 to 0.92)	0.0152	0.86	(0.64 to 1.16)	0.3345
Daily/almost daily	55	14	25.45	0.74	(0.47 to 1.17)	0.2005	1.08	(0.69 to 1.70)	0.7249
Tobacco consumption (N = 920)									
Never consumed	833	270	32.41	1.00	- -	-	1.00	- -	-
Consumes weekly	36	8	22.22	0.69	(0.38 to 1.24)	0.2113	0.95	(0.55 to 1.63)	0.8462
Consumes daily	51	4	7.84	0.24	(0.10 to 0.57)	0.0013	0.27	(0.11 to 0.68)	0.0049
Alcohol consumption (N = 919)									
Never consumed alcohol	396	121	30.56	1.00	- -	-	1.00	- -	-
Did not consume	94	37	39.36	1.29	(0.97 to 1.72)	0.0841	1.16	(0.91 to 1.48)	0.2304

					Univariable (*)			Adj. for gender & age	
Covariate	**N**	**Evts.**	**% Evts.**	**RR**	**95% CI**	**p-value**	**RR**	**95% CI**	**p-value**
alcohol last year									
Consumes less than once per week	379	116	30.61	1.00	(0.80 to 1.25)	0.9883	1.23	(1.00 to 1.50)	0.0485
Consumes daily to at least once per week	50	8	16.00	0.52	(0.25 to 1.09)	0.0825	0.90	(0.45 to 1.79)	0.7663
Mean of steps per day (N = 895)									
10000 or less	347	117	33.72	1.00	- -	-	1.00	- -	-
Above 10000	189	52	27.51	0.82	(0.62 to 1.08)	0.1562	0.96	(0.75 to 1.24)	0.7779
Missing data	359	111	30.92	0.92	(0.74 to 1.14)	0.4350	0.95	(0.78 to 1.15)	0.5783
Mean of MVPA per day (N = 895)									
60 minutes or less	359	117	32.59	1.00	- -	-	1.00	- -	-
Above 60 minutes	177	52	29.38	0.90	(0.70 to 1.17)	0.4296	1.16	(0.91 to 1.49)	0.2245
Missing data	359	111	30.92	0.95	(0.77 to 1.18)	0.6298	1.00	(0.82 to 1.22)	0.9966

N = number of patients/observations; Evts. =number of overweight and obese patients (BMI>=25);

% Evts. = percentage of overweight and obese patients; RR = risk ratio

(*) Associations analyzed using log-link binomial regression with robust variance estimates to adjust for within household clustering

In table 5.11 the associations of obesity with socioeconomic and behavioral characteristics are shown. Similar associations to those described for overweight+ were observed, with statistically significant associations between obesity and age, gender and household wealth index and no significant associations for diet, physical activity and tobacco.

Table 5.11. Associations of obesity (BMI>=30) with socioeconomic and behavioral characteristics, univariable models and models adjusted for gender and age

				Univariable			Adj. for gender & age		
Covariate	**N**	**Evts.**	**% Evts.**	**RR**	**95% CI**	**p-value**	**RR**	**95% CI**	**p-value**
Gender (N = 922)									
Male	391	12	3.07	1.00	- -	-	1.00	- -	-
Female	531	102	19.21	6.26	(3.53 to 11.09)	<0.0001	5.59	(3.17 to 9.86)	<0.0001
Age (per year)	-	-	-	1.05	(1.04 to 1.06)	<0.0001	1.05	(1.03 to 1.06)	<0.0001
Household wealth index, quintiles (N = 818)									
Very low	109	5	4.59	1.00	- -	-	1.00	- -	-
Low	146	21	14.38	3.14	(1.22 to 8.06)	0.0176	3.34	(1.35 to 8.27)	0.0093
Medium	174	24	13.79	3.01	(1.22 to 7.42)	0.0169	3.24	(1.35 to 7.77)	0.0085
Medium/high	192	17	8.85	1.93	(0.73 to 5.08)	0.1829	2.11	(0.84 to 5.31)	0.1136
Highest	197	35	17.77	3.87	(1.59 to 9.42)	0.0028	4.34	(1.84 to 10.21)	0.0008
Education (N = 921)									
Primary or lower	427	82	19.20	1.00	- -	-	1.00	- -	-
Secondary or higher	494	32	6.48	0.34	(0.23 to 0.50)	<0.0001	0.75	(0.47 to 1.19)	0.2256
Marital status (N = 922)									
Single	471	35	7.43	1.00	- -	-	1.00	- -	-
Married	392	66	16.84	2.27	(1.57 to 3.27)	<0.0001	1.34	(0.91 to 1.97)	0.1377
Divorced/ widow(ed)	59	13	22.03	2.97	(1.75 to 5.03)	<0.0001	0.88	(0.48 to 1.62)	0.6768
Occupation (N = 922)									
Unemployed/retired	183	25	13.66	1.00	- -	-	1.00	- -	-
Housewife	51	6	11.76	0.86	(0.37 to 2.00)	0.7282	0.66	(0.29 to 1.50)	0.3159
Student	146	4	2.74	0.20	(0.07 to 0.56)	0.0021	0.44	(0.16 to 1.23)	0.1196
Employed	449	68	15.14	1.11	(0.74 to 1.67)	0.6219	1.41	(0.96 to 2.06)	0.0771
Missing data	93	11	11.83	0.87	(0.44 to 1.69)	0.6728	1.00	(0.54 to 1.88)	0.9879

					Univariable			Adj. for gender & age	
Covariate	**N**	**Evts.**	**% Evts.**	**RR**	**95% CI**	**p-value**	**RR**	**95% CI**	**p-value**
Can speak, write and read Portuguese (N = 922)									
No	103	16	15.53	1.00	- -	-	1.00	- -	-
Yes	760	86	11.32	0.73	(0.44 to 1.19)	0.2090	1.46	(0.90 to 2.36)	0.1230
Missing data	59	12	20.34	1.31	(0.68 to 2.53)	0.4221	0.85	(0.45 to 1.59)	0.6069
Portuguese as the mother language (N = 922)									
No	660	99	15.00	1.00	- -	-	1.00	- -	-
Yes	262	15	5.73	0.38	(0.23 to 0.62)	0.0001	0.78	(0.45 to 1.36)	0.3802
Consumption of Fruit per week (N = 919)									
(per number of days of the week)	-	-	-	1.01	(0.93 to 1.10)	0.7643	1.05	(0.98 to 1.13)	0.1720
Consumption of Fruit per week (N = 919)									
Never	247	34	13.77	1.00	- -	-	1.00	- -	-
1-3 days a week	486	54	11.11	0.81	(0.55 to 1.18)	0.2656	0.97	(0.66 to 1.41)	0.8635
4-7 days a week	186	26	13.98	1.02	(0.64 to 1.61)	0.9481	1.35	(0.86 to 2.13)	0.1938
Consumption of Vegetables per week (N = 891)									
(per number of days of the week)	-	-	-	1.03	(0.96 to 1.12)	0.4059	0.99	(0.91 to 1.08)	0.8507
Consumption of Vegetables per week (N = 891)									
Never	15	1	6.67	1.00	- -	-	1.00	- -	-
1-3 days a week	385	47	12.21	1.83	(0.28 to 12.04)	0.5289	1.39	(0.23 to 8.45)	0.7190
4-7 days a week	491	65	13.24	1.99	(0.29 to 13.48)	0.4827	1.31	(0.21 to 8.15)	0.7735
Consumption of Processed food per week (N = 919)									
Never	310	43	13.87	1.00	- -	-	1.00	- -	-
Less than once per week	368	51	13.86	1.00	(0.68 to 1.47)	0.9964	1.01	(0.69 to 1.48)	0.9599
1-4 times per week	175	18	10.29	0.74	(0.45 to 1.23)	0.2479	1.02	(0.64 to 1.63)	0.9301
Daily/almost daily	66	2	3.03	0.22	(0.05 to 0.89)	0.0341	0.45	(0.11 to 1.78)	0.2547
Consumption of Soft drinks per week (N = 893)									
Never	507	70	13.81	1.00	- -	-	1.00	- -	-
Less than once per week	186	23	12.37	0.90	(0.57 to 1.41)	0.6314	1.05	(0.68 to 1.62)	0.8157
1-4 times per week	145	16	11.03	0.80	(0.47 to 1.35)	0.4031	1.17	(0.72 to 1.90)	0.5361

Covariate	N	Evts.	% Evts.	Univariable RR	95% CI	p-value	Adj. for gender & age RR	95% CI	p-value
Daily/almost daily	55	3	5.45	0.40	(0.13 to 1.19)	0.0991	0.71	(0.24 to 2.07)	0.5267
Tobacco consumption (N = 920)									
Never consumed	833	110	13.21	1.00	- -	-	1.00	- -	-
Consumes weekly	36	1	2.78	0.21	(0.03 to 1.49)	0.1183	0.41	(0.07 to 2.40)	0.3221
Consumes daily	51	3	5.88	0.45	(0.16 to 1.22)	0.1157	0.65	(0.22 to 1.93)	0.4343
Alcohol consumption (N = 919)									
Never consumed alcohol	396	48	12.12	1.00	- -	-	1.00	- -	-
Did not consume alcohol last year	94	21	22.34	1.84	(1.16 to 2.92)	0.0093	1.64	(1.07 to 2.50)	0.0228
Consumes less than once per week	379	43	11.35	0.94	(0.63 to 1.38)	0.7404	1.28	(0.89 to 1.86)	0.1849
Consumes daily to at least once per week	50	2	4.00	0.33	(0.08 to 1.29)	0.1114	0.85	(0.23 to 3.22)	0.8156
Mean of steps per day (N = 536)									
(per 10000 units)	-	-	-	1.00	(1.00 to 1.00)	0.0835	1.00	(1.00 to 1.00)	0.4598
Mean of MVPA per day (N = 536)									
(per 10 units)	-	-	-	0.99	(0.98 to 1.00)	0.1949	1.00	(0.99 to 1.01)	0.8432
Mean of steps per day (N = 895)									
10000 or less	347	51	14.70	1.00	- -	-	1.00	- -	-
Above 10000	189	23	12.17	0.83	(0.52 to 1.31)	0.4227	1.02	(0.65 to 1.61)	0.9160
Missing data	359	39	10.86	0.74	(0.50 to 1.09)	0.1305	0.77	(0.53 to 1.12)	0.1678
Mean of MVPA per day (N = 895)									
60 minutes or less	359	52	14.48	1.00	- -	-	1.00	- -	-
Above 60 minutes	177	22	12.43	0.86	(0.55 to 1.33)	0.4941	1.24	(0.80 to 1.94)	0.3311
Missing data	359	39	10.86	0.75	(0.51 to 1.10)	0.1424	0.81	(0.56 to 1.17)	0.2701

N = number of patients/observations; Evts. =number of obese patients (BMI>=30);

% Evts. = percentage of overweight and obese patients; RR = risk ratio

(*) Associations analyzed using log-link binomial regression with robust variance estimates to adjust for within household clustering

Table 5.12 presents the results for the final multivariable models for overweight+. These show that females were 2.38 times (95% CI: 1.84 to 3.06) more likely than males to be overweight+ and that the risk of being overweight+ increased 1.03 times (95% CI: 1.02 to 1.03) with every additional year of age. With respect to household wealth, only the highest wealth index category was significantly associated with overweight+, with a 1.98 times (95% CI: 1.38 to 2.83) increased risk of overweight+ compared to the lowest household wealth index category. Being employed and being married were associated with 1.33 times (95% CI: 1.04 to 1.69) and 1.45 times (95% CI: 1.13 to 1.86) the risk of overweight+, respectively. Consumption of fruit was associated with a 1.05 times (95% CI: 1.01 to 1.09) increased risk of overweight+ while daily tobacco consumption was associated with a reduced risk of being overweight+.

Table 5.12. Multivariable association between overweight+ and socioeconomic and behavioral characteris-tics in Maputo city, Mozambique (N=817)

				Univariable			Multivariable		
Covariate	**N**	**Evts.**	**% Evts.**	**RR**	**95% CI**	**p-value**	**RR**	**95% CI**	**p-value**
Gender									
Male*	345	55	15.94	1.00	- -	-	1.00	- -	-
Female	472	200	42.37	2.66	(2.06 to 3.43)	<0.0001	2.38	(1.84 to 3.06)	<0.0001
Age									
(per year	-	-	-	1.03	(1.03 to 1.04)	<0.0001	1.03	(1.02 to 1.03)	<0.0001
Household wealth index, quintiles									
Very low*	109	26	23.85	1.00	- -	-	1.00	- -	-
Low	146	40	27.40	1.15	(0.72 to 1.83)	0.5622	1.29	(0.86 to 1.95)	0.2161
Medium	174	48	27.59	1.16	(0.75 to 1.78)	0.5093	1.30	(0.89 to 1.89)	0.1758
Medium/high	192	58	30.21	1.27	(0.82 to 1.96)	0.2906	1.35	(0.92 to 1.98)	0.1206
Highest	196	83	42.35	1.78	(1.18 to 2.67)	0.0058	1.98	(1.38 to 2.83)	0.0002
Marital status									
Single*	402	81	20.15	1.00	- -	-	1.00	- -	-
Married	357	143	40.06	1.99	(1.54 to 2.56)	<0.0001	1.45	(1.13 to 1.86)	0.0033
Divorced/widow(ed)	58	31	53.45	2.65	(1.92 to 3.66)	<0.0001	1.21	(0.87 to 1.68)	0.2557
Occupation									
Retired/unemployed*	160	47	29.37	1.00	- -	-	1.00	- -	-
Housewife	45	16	35.56	1.21	(0.74 to 1.97)	0.4412	0.96	(0.61 to 1.52)	0.8737
Student	132	19	14.39	0.49	(0.30 to 0.81)	0.0054	0.87	(0.52 to 1.45)	0.5956
Employed	402	142	35.32	1.20	(0.91 to 1.60)	0.2020	1.33	(1.04 to 1.69)	0.0217

Covariate	N	Evts.	% Evts.	RR (Univariable)	95% CI (Univariable)	p-value (Univariable)	RR (Multivariable)	95% CI (Multivariable)	p-value (Multivariable)
Missing data	78	31	39.74	1.35	(0.93 to 1.96)	0.1108	1.54	(1.12 to 2.12)	0.0084
Consumption of Fruit per week (per number of days of the week)	-	-	-	1.04	(1.00 to 1.09)	0.0602	1.05	(1.01 to 1.09)	0.0175
Tobacco consumption									
Never consumed*	743	244	32.84	1.00	- -	-	1.00	- -	-
Consumes weekly	31	8	25.81	0.79	(0.44 to 1.40)	0.4127	0.89	(0.52 to 1.51)	0.6584
Consumes daily	43	3	6.98	0.21	(0.08 to 0.59)	0.0032	0.25	(0.09 to 0.72)	0.0102

N = number of observations; Evts. = number of events; % Evts. = (N-events/N)*100; RR = risk ratio; 95% CI = 95% confidence interval

* reference stratum

** Uni- and multi-variable Poisson regression results; using robust variance estimates adjusted for clustering by household

In table 5.13 the results for the final multivariable models for obesity are shown. Similar to overweight, female gender, increasing age and a higher household wealth index were associated with an increased risk of obesity. Higher levels of education were associated with a significantly reduced risk of being obese.

Table 5.13. Multivariable association between obesity and socioeconomic and behavioral characteristics in Maputo city, Mozambique (N=817)

Covariate	N	Evts.	% Evts.	RR (Univariable)	95% CI (Univariable)	p-value (Univariable)	RR (Multivariable (**))	95% CI (Multivariable (**))	p-value (Multivariable (**))
Gender									
Male*	346	11	3.18	1.00	- -	-	1.00	- -	-
Female	471	91	19.32	6.08	(3.36 to 11.00)	<0.0001	5.67	(3.14 to 10.23)	<0.0001
Age									
(per year	-	-	-	1.05	(1.04 to 1.06)	<0.0001	1.03	(1.02 to 1.05)	<0.0001
Household wealth index score, quintiles									

Very low*	108	5	4.63	1.00	- -	-	1.00	- -	-
Low	146	21	14.38	3.11	(1.21 to 7.98)	0.0185	3.56	(1.44 to 8.82)	0.0061
Medium	174	24	13.79	2.98	(1.21 to 7.35)	0.0178	3.50	(1.46 to 8.36)	0.0049
Medium/high	192	17	8.85	1.91	(0.73 to 5.03)	0.1888	2.33	(0.93 to 5.86)	0.0709
Highest	197	35	17.77	3.84	(1.58 to 9.33)	0.0030	5.17	(2.19 to 12.20)	0.0002
Education									
Primary or lower	380	74	19.47	1.00	- -	-	1.00	- -	-
Secondary or higher	437	28	6.41	0.33	(0.22 to 0.50)	<0.0001	0.60	(0.38 to 0.97)	0.0361
Occupation									
Retired/unemployed*	160	24	15.00	1.00	- -	-	1.00	- -	-
Housewife	44	5	11.36	0.76	(0.30 to 1.89)	0.5514	0.58	(0.24 to 1.40)	0.2247
Student	132	4	3.03	0.20	(0.07 to 0.56)	0.0022	0.49	(0.18 to 1.37)	0.1748
Employed	403	59	14.64	0.98	(0.64 to 1.48)	0.9094	1.36	(0.93 to 1.97)	0.1106
Missing data	78	10	12.82	0.85	(0.43 to 1.71)	0.6561	1.04	(0.56 to 1.95)	0.8933

N = number of observations; Evts. = number of events; % Evts. = (N-events/N)*100; RR = risk ratio; 95% CI = 95% confidence interval

* reference stratum

** Uni- and multi-variable Poisson regression results; using robust variance estimates adjusted for clustering by household

5.3. Results from Topic III (Metabolic syndrome)

Figure 5.6 describes the number of participants approached, enrolled and those who performed specific procedures related to physical measurements and blood collection. Only 21.5% of the participants that consented were fasting during blood sample collection.

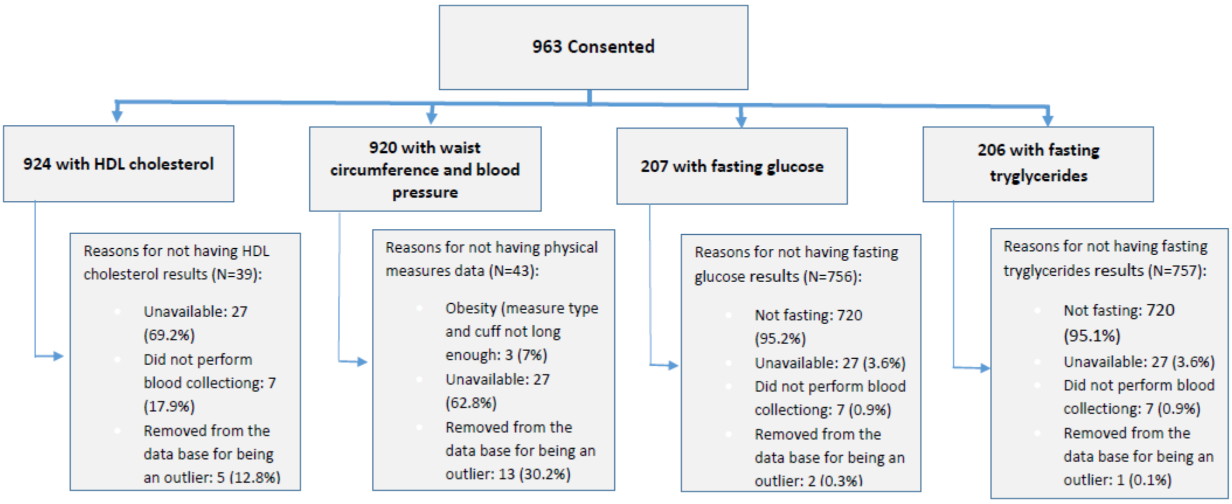

Figure 5.6. Enrolment of participants on specific procedures related to physical measurements and blood collection

Figure 5.7 describes the prevalence of MS by gender and by age group. Using the more strict criteria to define the prevalence of MS, 28 out of 207 participants had MS, which gives a prevalence of MS of 13.5% (95%CI: 8.8, 18.2). Female participants presented a higher prevalence of MS (21.4% (95%CI: 13.7, 29.1), compared to male participants (4.2% (95%CI: 0.9, 8.3), *P*<0.001.

We found 49 out of 916 participants with MS, which gives an overall prevalence of MS of 5.6% (95%CI: 4.1, 7.1), using the more relaxed criteria, with females presenting a higher prevalence of MS 8.2% (95%CI: 5.8, 10.5), compared to males 2.1% (95%CI: 0.6, 3.5), *P*<0.001.

Participants aged 45-54 years presented with the highest prevalence of MS using both stricted (34.8%) and relaxed (18.7%) criteria to determine the prevalence of MS.

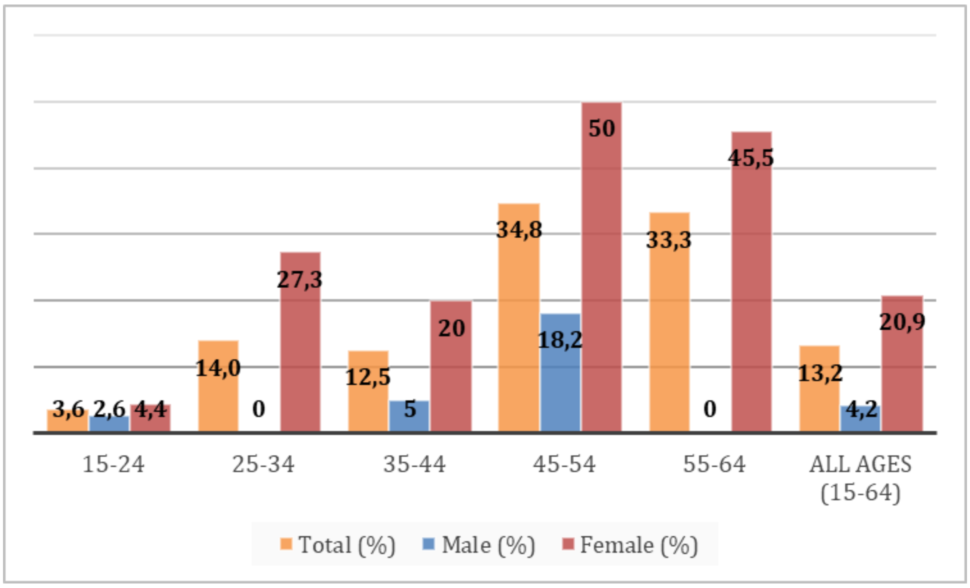

Figure 5.7. Prevalence of Metabolic Syndrome (by gender and age-group) in youth and adults from Maputo city, Mozambique (N=207)

In general, fasting hyperglycemia was the most common component of MS presented in this study population (53.6%), followed by abdominal obesity (28.5%). The least common component was hypertriglyceridemia (14.1%) – figure 5.8.

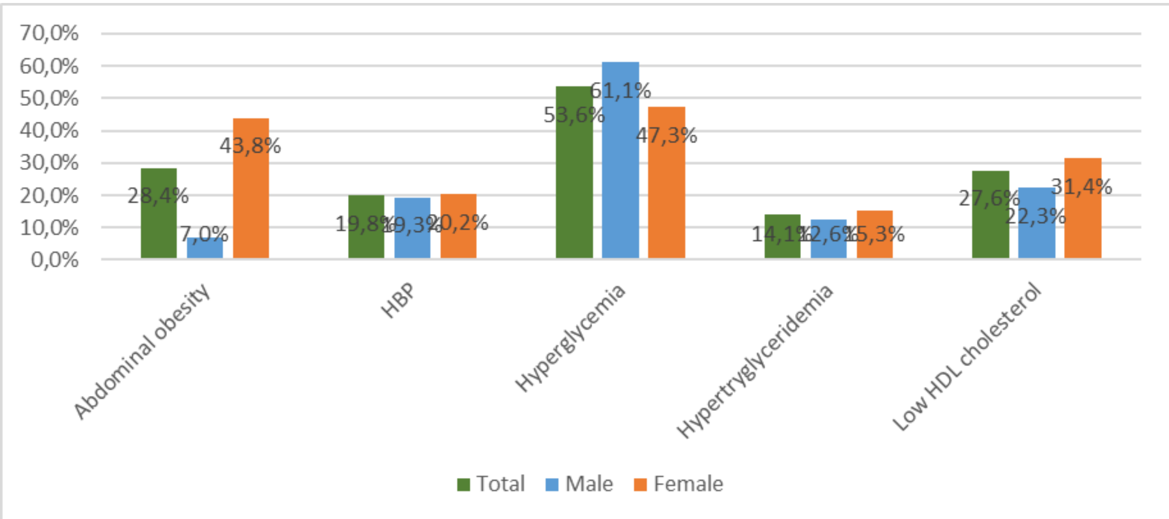

Figure 5.8. Prevalence of metabolic risk factors using the 2009 Harmonized criteria cut off for MS defini-tion among male and female from Maputo city, Mozambique (N=924)

Tables 5.14 and 5.15 present the factors associated with MS using a sample size of 207 and 916, repectively. After adjusting for gender and age, the results show that females have a 4.3 and 3.2 times higher risk of having MS compared to males using both strict and relaxed definition of MS, respectively, and that the risk of developing MS increases by 5-6% with every year of age (*P*<0.001). Behavioral risk factors (diet, physical activity, alcohol consumption) were not significantly associated with MS. BMI was associated with the risk of MS in this study, with an increase of 9% (95% CI: 5%, 12%) per kg/m^2 using a bigger denominator of 916 participants. HBP, low HDL cholesterol, hyperglycemia and hypertriglyceridemia increases 9.6 (95% CI: 5, 18.6), 7 (95% CI: 3.9, 12.5), 3.5 (95% CI: 1.7, 7.3) and 2.4 (95% CI: 1.3, 4.5) times the risk of presenting MS, respectively, after adjusting for age and gender.

Table 5.14. Associations of metabolic syndrome (MS) with socio-economic, behavioral and metabolic characteristics, univariable models and models adjusted for gender and age (N=207)

Covariate	N	Evts.	% Evts.	Univariable RR	Univariable 95% CI	Univariable p-value	adj. for Sex & Age RR	adj. for Sex & Age 95% CI	adj. for Sex & Age p-value
Gender									
Male	95	4	4.2	1.00	- -	-	1.00	- -	-
Female	110	23	20.9	4.97	(1.81 to 13.63)	0.0019	4.25	(1.53 to 11.80)	0.0055
Age									
(per year)	-	-	-	1.05	(1.03 to 1.08)	<0.0001	1.05	(1.03 to 1.07)	<0.001
Household wealth index score, quintiles									
Very low	28	3	10.7	1.00	- -	-	1.00	- -	-
Low	44	4	9.1	0.85	(0.21 to 3.40)	0.8165	0.99	(0.28 to 3.52)	0.9879
Medium	45	7	15.6	1.45	(0.42 to 5.02)	0.5558	1.79	(0.55 to 5.82)	0.3330
Medium/high	40	7	17.5	1.63	(0.47 to 5.63)	0.4368	2.14	(0.70 to 6.49)	0.1794
Highest	34	4	11.8	1.10	(0.31 to 3.95)	0.8862	1,25	(0.38 to 4.15)	0.7125
Education									
Primary or lower	95	20	21.1	1.00	- -	-	1.00	- -	-
Secondary or higher	110	7	6.4	0.30	(0.13 to 0.68)	0.0038	0.73	(0.29 to 1.84)	0.5098
Marital status									
Single	80	6	7.5	1,00	- -	-	1.00	- -	-
Married	112	17	15.2	2.02	(0.86 to 4.74)	0.1041	0.88	(0.40 to 1.90)	0.7372
Widow(ed)/divorced	13	4	30.8	4.10	(1.32 to 12.72)	0.0145	0.53	(0.18 to 1.56)	0.2457
Occupation									
Retired/unemployed	24	1	4.17	1.00	- -	-	1.00	- -	-
Housewife	17	1	5.88	1.41	(0.09 to 21.27)	0.8032	1.17	(0.07 to 19.53)	0.9113
Student	27	1	3.70	0.89	(0.06 to 12.96)	0.9313	2.07	(0.11 to 38.21)	0.6260
Employed	102	17	16.67	4.00	(0.56 to 28.74)	0.1683	5.48	(0.74 to 40.69)	0.0966
Missing data	35	7	20.00	4.80	(0.62 to 36.97)	0.1321	4.44	(0.57 to 34.60)	0.1549

Covariate	N	Evts.	% Evts.	RR	Univariable 95% CI	p-value	RR	adj. for Sex & Age 95% CI	p-value
Can speak, write and read Portuguese									
No	33	10	30.30	1.00	- -	-	1.00	- -	-
Yes	160	16	10.00	0.33	(0.16 to 0.67)	0.0022	0.68	(0.35 to 1.30)	0.2391
Missing data	12	1	8.33	0.27	(0.04 to 1.94)	0.1958	0.16	(0.02 to 1.35)	0.0927
Portuguese as the mother language									
No	148	25	16.89	1.00	- -	-	1.00	- -	-
Yes	57	2	3.51	0.21	(0.05 to 0.83)	0.0268	0.44	(0.10 to 1.92)	0.2754
Consumption of Fruit per week (per number of days of the week)	-	-	-	1.07	(0.94 to 1.23)	0.3041	1.17	(1.05 to 1.30)	0.0053
Consumption of Vegetables per week (per number of days of the week)	-	-	-	1.05	(0.88 to 1.25)	0.5845	0.98	(0.84 to 1.14)	0.7647
Diet counselling by a health professional									
No	157	17	10.83	1.00	- -	-	1.00	- -	-
Yes	48	10	20.83	1.92	(0.93 to 3.97)	0.0765	1.48	(0.79 to 2.80)	0.2239
Tobacco consumption									
Never consumed	188	27	14.36	1.00	- -	-	1.00	- -	-
Consumes weekly	7	0	0.00	0.00	(0.00 to 0.00)	0.0000	0.00	(0.00 to 0.00)	<0.0001
Consumes daily	10	0	0.00	0.00	(0.00 to 0.00)	0.0000	0.00	(0.00 to 0.00)	<0.0001
Alcohol consumption									
Never consumed alcohol	101	15	14.85	1.00	- -	-	1.00	- -	-
Did not consume alcohol last year	8	1	12.50	0.84	(0.13 to 5.55)	0.8578	0.94	(0.12 to 7.03)	0.9488
Consumed less than once per week	83	9	10.84	0.73	(0.33 to 1.61)	0.4372	0.96	(0.47 to 1.97)	0.9189
Consumed daily to at least once per week	13	2	15.38	1.04	(0.31 to 3.49)	0.9546	1.79	(0.56 to 5.70)	0.3263
Advised to stop alcohol consumption by a health professional									
No	91	12	13.19	1.00	- -	-	1.00	- -	-
Yes	13	0	0.00	0.00	(0.00 to 0.00)	0.0000	0.00	(0.00 to 0.00)	<0.0001
Mean of steps per day									
10000 or less	71	8	11.27	1.00	- -	-	1.00	- -	-
Above 10000	56	7	12.50	1.11	(0.43 to 2.89)	0.8320	1.40	(0.63 to 3.15)	0.4107
Missing data	76	12	15.79	1.40	(0.58 to 3.37)	0.4506	1.63	(0.74 to 3.59)	0.2236
Mean of MVPA per day									
60 minutes or less	79	8	10.13	1.00	- -	-	1.00	- -	-
Above 60 minutes	48	7	14.58	1.44	(0.55 to 3.79)	0.4597	2.01	(0.82 to 4.90)	0.1265
Missing data	76	12	15.79	1.56	(0.65 to 3.73)	0.3176	1.85	(0.86 to 3.96)	0.1130

N = number of patients/observations; Evts. =number of participants with MS;

% Evts. = percentage of participants with MS; RR = risk ratio

(*) Associations analyzed using log-link binomial regression with robust variance estimates to adjust for within household clustering

Table 5.15. Associations of metabolic syndrome (MS) with socio-economic, behavioral and metabolic characteristics, univariable models and models adjusted for gender and age (N=916)

Covariate	N	Evts.	% Evts.	RR	Univariable 95% CI	p-value	RR	adj. for Sex & Age 95% CI	p-value
Gender									
Male	383	8	2.09	1.00	- -	-	1.00	- -	-
Female	533	41	7.69	3.68	(1.75 to 7.74)	0.0006	3.20	(1.52 to 6.73)	0.0022
Age									
(per year)	-	-	-	1.06	(1.04 to 1.08)	<0.0001	1.06	(1.04 to 1.07)	<0.001
Household wealth index score, quintiles									
Very low	109	5	4.59	1.00	- -	-	1.00	- -	-
Low	147	7	4.76	1.04	(0.35 to 3.04)	0.9456	1.13	(0.39 to 3.26)	0.8176
Medium	174	10	5.75	1.25	(0.45 to 3.47)	0.6646	1.40	(0.51 to 3.87)	0.5131
Medium/high	193	11	5.70	1.24	(0.45 to 3.46)	0.6776	1.42	(0.52 to 3.88)	0.4910
Highest	202	12	5.94	1.30	(0.50 to 3.38)	0.5969	1.52	(0.59 to 3.89)	0.3866
Education									
Primary or lower	426	35	8.22	1.00	- -	-	1.00	- -	-
Secondary or higher	489	14	2.86	0.35	(0.19 to 0.62)	0.0004	0.93	(0.46 to 1.88)	0.8476
Marital status									
Single	469	16	3.41	1.00	- -	-	1.00	- -	-
Married	387	27	6.98	2.05	(1.15 to 3.63)	0.0147	1.07	(0.56 to 2.05)	0.8468
Widow(ed)/divorced	60	6	10.00	2.93	(1.20 to 7.15)	0.0181	0.73	(0.29 to 1.84)	0.4999
Occupation									
Retired/unemployed	181	3	1.66	1,00	- -	-	1.00	- -	-
Housewife	51	3	5.88	3.55	(0.73 to 17.16)	0.1151	2.86	(0.58 to 14.13)	0.1981
Student	145	1	0.69	0.42	(0.04 to 3.96)	0.4456	1.14	(0.11 to 11.53)	0.9134
Employed	447	35	7.83	4.72	(1.47 to 15.21)	0.0093	5.53	(1.74 to 17.56)	0.0037
Missing data	92	7	7.61	4.59	(1.20 to 17.58)	0.0261	5.23	(1.42 to 19.21)	0.0127
Can speak, write and read Portuguese									
No	104	11	10.58	1.00	- -	-	1.00	- -	-
Yes	754	32	4.24	0,40	(0.21 to 0.78)	0.0068	0.79	(0.39 to 1.62)	0.5240
Missing data	58	6	10.34	0.98	(0.38 to 2.51)	0.9632	0.63	(0.24 to 1.67)	0.3563
Portuguese as the mother language									
No	655	46	7.02	1.00	- -	-	1.00	- -	-
Yes	261	3	1,15	0.16	(0.05 to 0.51)	0.0018	0.36	(0.11 to 1.16)	0.0876
Consumption of Fruit per week									
(per number of days of the week)	-	-	-	1.01	(0.89 to 1.15)	0.8465	1.06	(0.95 to 1.19)	0.2786

Covariate	N	Evts.	% Evts.	RR	Univariable 95% CI	p-value	RR	adj. for Sex & Age 95% CI	p-value
Consumption of Vegetables per week (per number of days of the week)	-	-	-	1.10	(0.96 to 1.26)	0.1604	1.05	(0.92 to 1.20)	0.4465
Diet counselling by a health professional									
No	721	32	4.44	1.00	- -	-	1.00	- -	-
Yes	194	17	8.76	1.97	(1.13 to 3.45)	0.0172	1.35	(0.79 to 2.32)	0.2723
Tobacco consumption									
Never consumed	827	48	5.80	1.00	- -	-	1.00	- -	-
Consumes weekly	36	0	0.00	0.00	(0.00 to 0.00)	<0.0001	0.00	(0.00 to 0.00)	<0.001
Consumes daily	52	1	1.92	0.33	(0.05 to 2.38)	0.2717	0.34	(0.05 to 2.41)	0.2809
Alcohol consumption									
Never consumed alcohol	394	26	6.60	1.00	- -	-	1.00	- -	-
Did not consume alcohol last year	94	3	3.19	0.48	(0.15 to 1.57)	0.2275	0.41	(0.13 to 1.29)	0.1284
Consumed less than once per week	374	18	4.81	0,73	(0.41 to 1.30)	0.2845	0.94	(0.53 to 1.67)	0.8371
Consumed daily to at least once per week	52	2	3.85	0.58	(0.15 to 2.22)	0.4292	1.13	(0.31 to 4.08)	0.8524
Advised to stop alcohol consumption by a health professional									
No	445	21	4.72	1.00	- -	-	1.00	- -	-
Yes	74	2	2.70	0.57	(0.14 to 2.37)	0.4418	0.52	(0.13 to 2.13)	0.3620
Mean of steps per day									
10000 or less	352	18	5.11	1.00	- -	-	1.00	- -	-
Above 10000	190	10	5.26	1.03	(0.48 to 2.21)	0.9411	1.16	(0.57 to 2.35)	0.6875
Missing data	360	21	5.83	1.14	(0.60 to 2.16)	0.6865	1.17	(0.63 to 2.15)	0.6193
Mean of MVPA per day									
60 minutes or less	365	17	4.66	1.00	- -	-	1.00	- -	-
Above 60 minutes	177	11	6.21	1.33	(0.63 to 2.83)	0.4515	1.96	(0.95 to 4.02)	0.0678
Missing data	360	21	5.83	1.25	(0.66 to 2.39)	0.4961	1.38	(0.74 to 2.56)	0.3118
BMI (per unit)	-	-	-	1.13	(1.10 to 1.15)	<0.0001	1.09	(1.05 to 1.12)	<0.001
Waist circumference									
Normal	656	2	0.31	1.00			1.00		
Wide	256	46	17.96	58.94	(14.42 to 240.90)	<0.0001	46.24	(8.29 to 257.82)	<0.001
HBP									
No	732	12	1.64	1.00	- -	-	1.00	- -	-
Yes	180	37	20.56	12.54	(6.79 to 23.15)	<0.0001	9.61	(4.97 to 18.57)	<0.001
Fasting glucose									
Normal	127	9	7.09	1.00	- -	-	1.00	- -	-
High	78	18	23.08	3.26	(1.53 to 6.95)	0.0023	3.49	(1.67 to 7.30)	0.0009
Fasting triglycerides									
Normal	175	17	9.71	1.00	- -	-	1.00	- -	-
High	29	10	34.48	3.55	(1.87 to 6.73)	<0.0001	2.38	(1.26 to 4.49)	0.0073
HDL cholesterol									

Covariate	N	Evts.	% Evts.	Univariable RR	Univariable 95% CI	Univariable p-value	adj. for Sex & Age RR	adj. for Sex & Age 95% CI	adj. for Sex & Age p-value
Normal	664	14	2.11	1.00	- -	-	1.00	- -	-
Low	252	35	13.89	6.59	(3.60 to 12.06)	<0.0001	6.99	(3.91 to 12.49)	<0.001

N = number of patients/observations; Evts. =number of participants with MS;

% Evts. = percentage of participants with MS; RR = risk ratio

(*) Associations analyzed using log-link binomial regression with robust variance estimates to adjust for within household clustering

The multivariable model presented in table 5.16, with a sample size of only participants that were fasting during sample collection, shows that the risk of having MS increased 3% (95% CI: 1.00 to 1.06) with every additional year of age and increased 13% (95% CI: 1.07 to 1.19) with every additional unit of BMI.

Table 5.16. Multivariable associations of metabolic syndrome (MS) with socio-economic and physiological characteristics, (N=190)

Covariate	N	Evts.	% Evts.	Univariable e^Coef.	Univariable 95% CI	Univariable p-value	Multivariable e^Coef.	Multivariable 95% CI	Multivariable p-value
Household wealth index score, quintiles									
Very low*	28	3	10.71	1.00	- -	-	1.00	- -	-
Low	43	3	6.98	0.65	(0.15 to 2.89)	0.5724	0.77	(0.23 to 2.57)	0.6667
Medium	45	7	15.56	1.45	(0.42 to 5.02)	0.5558	0.69	(0.20 to 2.40)	0.5555
Medium /high	40	7	17.50	1.63	(0.47 to 5.63)	0.4369	1.60	(0.58 to 4.42)	0.3660
Highest	34	4	11.76	1.10	(0.31 to 3.95)	0.8862	0.84	(0.30 to 2.32)	0.7290
Occupation									
Reti-red/unemployed*	21	1	4.76	1.00	- -	-	1.00	- -	-
Housewife	17	1	5.88	1.24	(0.08 to 18.51)	0.8784	0.85	(0.08 to 9.11)	0.8905
Student	26	1	3.85	0.81	(0.06 to 11.69)	0.8755	2.44	(0.14 to 42.26)	0.5388
Employed	95	15	15.79	3.32	(0.46 to 23.89)	0.2342	3.81	(0.47 to 30.77)	0.2089
Missing data	31	6	19.35	4.06	(0.52 to 31.78)	0.1814	3.99	(0.52 to 30.31)	0.1812
Gender									
Male*	89	4	4.49	1.00	- -	-	1.00	- -	-
Female	101	20	19.80	4.41	(1.59 to 12.21)	0.0044	2.48	(0.84 to 7.29)	0.0996
Age									
(per unit)	-	-	-	1.05	(1.03 to 1.08)	0.0000	1.03	(1.00 to 1.06)	0.0274
BMI									
(per unit)	-	-	-	1.15	(1.11 to 1.19)	0.0000	1.13	(1.07 to 1.19)	0.0000

Using a more relaxed definifion of MS prevalence (Table 5.17), the multivariable model shows that beyond age and BMI, gender and occupation are also significantly related to the prevalence of MS, with females presenting 2.3 times more risk of having MS compared to males (*P*<0.001) and employed youth and adults presenting 6.3 times more risk of having MS compared to retired/unemployed participants (*P*=0.0120).

Table 5.17. Multivariable associations of metabolic syndrome (MS) with socio-economic and physiological characteristics, (N=817)

				Univariable			Multivariable		
Covariate	**N**	**Evts.**	**% Evts.**	**e^Coef.**	**95% CI**	**p-value**	**e^Coef.**	**95% CI**	**p-value**
Household wealth index score, quintiles									
Very low*	109	5	4.59	1.00	- -	-	1.00	- -	-
Low	146	6	4.11	0.90	(0.30 to 2.71)	0.8459	0.83	(0.26 to 2.66)	0.7546
Medium	173	10	5.78	1.26	(0.45 to 3.49)	0.6565	1.36	(0.50 to 3.66)	0.5489
Medium /high	192	11	5.73	1.25	(0.45 to 3.47)	0.6702	1.25	(0.46 to 3.40)	0.6614
Highest	197	12	6.09	1.33	(0.51 to 3.46)	0.5619	1.37	(0.53 to 3.52)	0.5182
Occupation									
Reti-red/unemployed*	160	2	1.25	1.00	- -	-	1.00	- -	-
Housewife	45	3	6.67	5.33	(0.91 to 31.16)	0.0630	4.70	(0.82 to 27.12)	0.0832
Student	132	1	0.76	0.61	(0.06 to 6.56)	0.6803	2.11	(0.18 to 24.05)	0.5483
Employed	402	32	7.96	6.37	(1.54 to 26.41)	0.0108	6.31	(1.50 to 26.58)	0.0120
Missing data	78	6	7.69	6.15	(1.25 to 30.18)	0.0251	8.41	(1.82 to 38.87)	0.0064
Gender									
Male*	345	8	2.32	1.00	- -	-	1.00	- -	-
Female	472	36	7.63	3.29	(1.55 to 6.96)	0.0019	2.31	(1.02 to 5.21)	0.0441
Age									
(per unit)	-	-	-	1.06	(1.04 to 1.08)	0.0000	1.03	(1.01 to 1.06)	0.0036
BMI									
(per unit)	-	-	-	1.13	(1.10 to 1.16)	0.0000	1.08	(1.04 to 1.12)	0.0000

6. Discussion

6.1. Discussion of Topic I (Physical activity and sedentarism)

The recorded average time in MVPA in this study was 22.7 minutes per day, thus 158,9 minutes per week, which is slightly above the current WHO physical activity guidelines (150 minutes per week).

The average number of steps per day was 8,616, being higher in males (10,503) than in females (7,212). Results of previous studies describing average number of steps of different populations show variability across different settings and regions. A study in South African adults utilized pedometers in a convenience sample and found an average of 7,476 steps/day for males and 5,765 for females. These results are lower than the peri-urban Mozambicans from the present sample (66). However, it is not clear if the results from the South African study are representative of the general population.

Based on previous results in Mozambican adults which suggested high levels of physical activity (67), we expected higher levels of activity in the present study. However, most data available for adults were collected by questionnaire and not by objective device-based assessments (68). Studies among urban adults conducted with accelerometers were mainly done in special populations and small samples which could be limited for comparisons (35). Moreover, changes in activity habits in Maputo were observed to be fast and trending towards sedentary lifestyles in children and adolescents, which could also be true for adults (24).

Using the cut-off value of 5,000 steps/day, the prevalence of sedentary subjects was 21.7% (males=14.7%, females=26.8%). This threshold has been considered appropriate to discriminate sedentary persons from those who did some activity, based on the assumption that “some physical activity is better than none” (69,70). Studies done with the same criterion have found different results. One study done in US adults (18-65 years old) (71) found 44% subjects were classified as sedentary. Another North-American study of adults (average age of 44 years) found that 33% of the sample had <5000 steps/day (72).

When 10,000 steps per day is used to classify the sample, 48.7% of males and 79.7% of females would be considered as inactive. The results of a previous studs in Mozambique showed lower levels of inactivity (67). The main issue to be considered when comparing both studies is that the previous one was done with questionnaires and did not collect objective data.

The present study was done with a peri-urban population which is very important, due to the fast urbanization rate of Mozambique and all African countries. Our results suggest that secular trends which have been observed in urban school-aged populations trending towards an abrupt reduction in physical activity (24), may also be expected in adult populations. Unfortunately, there are no data available that can confirm this statement.

Studies that compare physical activity between males and females are normally consistent in observing lower levels of activity and higher sedentarism among urban females compared to males (73,74). In the present study, the average time spent in MVPA was also higher in males (31.1 minutes per day) than females (18.7 minutes per day). This trend has been consistent in more developed countries as well as in African countries (75). In the case of the African continent there is still a strong sexual division of labor, and some household tasks may not be able to be detected by motion sensors. Household tasks in the peri-urban African context are still manual which requires specific research and data collection instruments. This hypothesis was not confirmed by the few studies done in African women using movement sensors, such as the study of 544 urban and rural Camaroonese that showed lower levels of activity and time spent in MVPA in both urban and rural women (75).

Occupational status has also been associated with physical activity, but the results are not consistent. When formal employees are compared with other occupational groups, the prevalence of inactivity has been found to be either higher or lower. Although difficult to generalize, due to the few studies available that used device-based measurements of physical activity, it may be hypothesized that sociocultural differences between developed and non-developed regions and the resulting different types of employment may account for this discrepancy. The present results, where those who are employed are less sedentary and inactive than those who are unemployed, match with other African studies done in Uganda and Cameroon (68,75). It may be necessary to conduct a specific study to test this hypothesis across a range of countries and socioeconomic conditions.

Socioeconomic status is a complex concept, particularly in Africa where informal economies are dominant. In developed areas the impact of recreational activities and the absence of manual labor makes the high-income classes more active (72) which does not seem to be the case in the Sub-Saharan African population. Migration from active rural areas to dense urban areas seems to imply a change from an active lifestyle to a sedentary way of life due to the fact that survival activities in urban centers are mostly not as energy demanding. Furthermore, access to physically active recreational activities are rare and expensive in lower socioeconomic strata.

Our study did not find a significant association between age and physical inactivity. This was not expected since studies that used device-based measures for physical activity have shown age-trends for activity in both high and low income countries (71,72,75) which is also true for studies that have used questionnaires (67,68). It must be taken into account that the trend to reduced activity is mostly observed in the older ages where the present study has fewer subjects. Indeed, our sample has no subjects over 64 years of age.

We did not find a statistically significant association between BMI and any of the indicators of physical activity analyzed. This was not expected since associations between physical activity levels and overweight and obesity have been well established (76). Studies using pedometers are consistent in finding a negative association between BMI and physical activity levels both in developed and non-developed countries, including African countries (66–68,75). We do not have an explanation for this result, but it may be speculated that, in this context, the range of steps/day may not discriminate levels of body weight in this population, and it may take longer for obesity to develop as a result of long-term energy imbalance as dietary trends change with continuing economic transitions.

The strengths and limitations of this study segment warrant discussion. A major strength of the study includes the focus on adults in a developing country in Africa, for which there is very limited information on physical activity. Further, the use of a large population-based sample is another marked strength of the study. One limitation of this study is the lack of cross-cultural validity of pedometers to be sensitive in all types of energy demanding activities in the context of a peri-urban African population. There is a lack of studies that have verified in how counts and steps recorded express whole-body energy expenditure in this population. Some activities could be culturally specific and not record by the pedometers.

6.2. Discussion of Topic II (Overweight and Obesity)

The overweight and obesity results from this study have been already discussed by Macicame et al (38), where a high prevalence of overweight among youth and adults from the peri-urban area of Maputo city was found, specially in women (more than 40% of women has a BMI>=25kg/m^2). Additionally, approximatelly one in every 10 youths and adults from this study population was obese or underweight.

Other studies related to BMI in Mozambique (26,42,43) and in other SSA countries (77–82) also describe high prevalences of overweight and obesity, confirming that those low-income countries are facing the double burden of malnutrition (83).

Being female and being older was found to be strongly associated with the risk of being overweight and obese, which was similar to findings from other studies from Mozambique (26,43) and from other African countries (78,79,82,84–86). There are cultural, behavioral and biological reasons that explain the high BMI among women compared to men (87).

Living in a household of the highest wealth index quintile showed to be a strong predictor of overweight and obesity. This finding was expected based on results from previous studies in Africa, including in Mozambique (26,43,78,79,83,84,88,89).

We confirm previous studies from SSA that married individuals are more likely than singles to be overweight (81,90).

Those with higher levels of education are less likely to be obese compared to those with lower levels of education. This finding is in accordance with results from a previous study performed in other countries of SSA (81). In contrast, our study showed that employed individuals are more likely than unemployed subjects to be overweight. This could be explained by the higher exposition of employed to high-energy foods, althought our study did not find any association between high BMI and unhealthy diet as we were expecting (91,92).

Our study also documents the frequency of “junk food” consumption. This can serve as a baseline for monitoring changes in diet and thus provide the evidence for the development of policies aiming to reduce the consumption of saturated fatty acids and trans-fats in Mozambique (93).

Although physical activity is usually considered a protective factor against overweight and obesity (94), confirmed in previous studies also from SSA (78), we did not observe any association between physical activity and BMI, despite the high levels of physical inactivity and sedentarism and high BMI, especially among women. Other determinants such as daily routine, and environmental conditions to practice physical activity in urban areas should be considered when describing the relationship between BMI and physical inactivity (95).

In previous studies from other African countries the perception of ideal body image was addressed. It was generally shown that overweight individuals are perceived as healthier, wealthier and/or prettier (86,90,96,97), a finding that adds complexity to the problem. It is crucial to understand the social and behavioral function of overweight and obesity and its predictors in the local context for designing and implementing interventions to reduce the prevalence of overweight and obesity and thus to prevent NCDs. This holds true in Mozambique but also in other developing countries. For the time being, studies evaluating cultural factors, beliefs and perceptions about body weight are required. This is the basis for developing new policies and for adapting existing ones to the local context, which will then allow to achieve the goals stated in the Global Action Plan for NCDs and the Sustainable Development Goals (38).

The cross sectional design of the study is one of its major limitations as does not allow us to evaluate causality. Furthermore, 32 participants (3.3%) were excluded as no anthropometric measurements were available. However, it is unlikely this has a significant influence on our effect estimates. Another limitation relates to the fact that we did not collect information on parity,as previous studies found multiparous women to be at a higher risk for overweight and obesity (98). Finally, the dietary evaluation in our study also has some limitations: first, the consumption of fruit and vegetables was measured per number of days consuming these items and not per unit (this was due to the difficulty of the participants to recall this in detail); second, our study lacks information regarding the consumption of saturated fatty acids, source of protein (animal or plant) and carbohydrates as this was not a dietary survey. Thus, important elements of the diet of t our study population remain unknown (99).

Nevertheless, this study reports substantial and robust BMI data from participants of a peri-urban setting in a developing country. Such peri-urban settings will constitute the majority of populations in countries like Mozambique in the near future due to rapid urbanization (100). Although this thesis focuses on overweight and obesity, our results also show that underweight persists as a problem in adults (one in every 10 adults was underweight). This is primarily due to the high burden of HIV and tuberculosis (101). Another strength of the study relates to its methodology: a large sample size allows comparison of subgroups; wealth index quintiles were computed based in the specificities of the study area, using robust analysis; data collection was based on validated tools from the STEPS survey and were adapted to the local context; and finally with application of pedometers and accelerometers objective measurements were used to describe physical activity.

6.3. Discussion of Topic III (Metabolic syndrome)

The prevalence of MS in this population was significantly higher in women and the risk of MS increased with age.

Although the general prevalence of MS in this study was lower than 10%, this prevalence is higher than shown in previous studies from Mozambique (49) and from other African countries (45). Being older, obese and being female have previously been shown to increase the risk of MS (47,63), which is consistent with the findings from our study.

A previous study from South Africa found that women were more at risk of developing MS compared to men (102) which confirms the findings from out study where women had a significantly higher prevalence of MS than men.

Our study shows that abdominal obesity and HBP were the risk factors with stronger association with MS compared to the other risk factors that composes the definition of MS. This finding aligns with previous literature where the same risk factors were more appropriate to predict cardiovascular disease among females (103) and with other studies that describe the relationship between the pathophysiology of MS and abdominal obesity (45,63,104).

Although the literature in general describes an influence of physical activity (PA) on the risk reduction of MS in adolescents (103) and in adults (45) from Africa, our study did not find any association between MS and PA which is in line with a local study in children and adolescents from a rural setting of Mozambique (49) .

The definition of MS is still controversial, and the cut offs used for the different factors that compose this syndrome vary between different studies (44,103) , which complicates comparison between this study and others from the region and from other parts of the world. Additionally, cut offs used in the different definitions of MS, including those selected for this study are based on European populations. Despite this limitation, this study used the most recent definition of MS, which allows for comparability with most recent studies.

Only approximately one quarter of the study population were able to collect blood while fasting, which might reduce the power of the study or produce bias. We were not able to screen the participants for HIV, which is known to increase the risk of developing diabetes and CVD, and to capture antiretroviral therapy for HIV positive participants, which is known to increase the risk of MS (105,106). Nonetheless, according to our findings self reported HIV infection was not associated with MS.

Due to the requirement of using fasting glucose and fasting triglyceride data for the 2009 Harmonized criteria for MS definition, the sample size for both variables were lower compared to the other metabolic risk factors that comprises the MS definition.

7. Conclusions

- The prevalence of physical inactivity and sedentarism of this peri-urban African city population were not much lower than the global prevalence. Being sedentary and an inactive lifestyle seem to be associated with both modifiable (occupation) and non-modifiable (gender) social determinants. NCD prevention and control measures to promote physical activity should be focused in children and youths, with special attention to females, in order to instill healthier individual lifestyles for future adults and elders.
- High BMI should be considered a public health concern in Maputo City given the high prevalence of overweight and obesity. This metabolic risk factor for NCDs should be addressed by appropriate interventions, such as education and dissemination of information about the link between overweight/ obesity and NCDs. Such interventions should specially address women and wealthier families from peri-urban areas of Maputo City, Mozambique. Although being older was associated with high BMI, interventions to prevent overweight and obesity should reach all ages, including children and youths.
- Metabolic syndrome, a combination of risk factors for NCDs, is becoming a public health concern with the increased prevalence of behavioral and metabolic risk factors in Mozambique, with higher prevalence in women. Although our study did not find an association between MS and behavioral risk factors for NCDs (diet and physical activity), a clinical and public health approach to reduce the risk of cardiovascular events in those patients should be prioritized.
- Non-modifiable social determinants such as gender and age seem to play a bigger role in the exposure to both behavioral and metabolic risk factors for NCDs in this peri-urban

area of Maputo city, compared to modifiable social determinants such as housing, living and working conditions, which might mean that risk factors for NCDs are present in all social groups. Therefore, public health interventions to reduce NCDs in such environments should target the general population.

- To establish an association between both behavioral and metabolic risk factors for NCDs and determinants of health in urban areas of Mozambique and other African cities, adjusted models should be tested in order to consider the context of double burden of disease, including poverty-related diseases and scenarios in such environments.

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9. Annex

9.1. List of Publications

Macicame I, Prista A, Parhofer KG, Cavele N, Manhiça C, Nhachungue S, Saathoff E, Rehfuess E. **Social determinants and behaviors associated with overweight and obesity among youth and adults in a peri-urban area of Maputo City, Mozambique**. J Glob Health. 2021 Mar 27;11:04021. doi: 10.7189/jogh.11.04021. PMID: 33868672; PMCID: PMC8038757.

MARTINS Helder F B, LOQUIHA Osvaldo, HANSINE Rogers, **MACICAME Ivalda**, MAURE Genito A, MARRUFO Tatiana J, SACARLAL Jahit, ABACASSAMO Fátima, MUCAVELE Helio and SAÚTE Francisco C M (2020)**. Covid 19 Morbidity and Case Fatality Rate: An Analysis of Possible Confounding Factors**. Journal of Infectious Diseases and Case Reports SRC/JIDSCR-127. DOI: https://doi.org/10.47363/ JIDSCR /2020(1)117

Agbessi Amouzou, Almamy Kante, **Ivalda Macicame**, Adriano Antonio, Eduardo Gudo, Pedro Duce, Robert E Black. (2020) **National Sample Vital Registration System: A sustainable platform for COVID-19 and other infectious diseases surveillance in low and middle-income countries.** Journal of Global Health. doi: 10.7189/jogh.10.020368

Cumbane V, Imbach M, Chissumba RM, **Macicame I**, Eller LA, Lawlor J, Milazzo M, Li Q, Crowell T, Mutombene M, Guiliche O, Viegas E, Nwoga C, Yates A, Michael N, Robb M, Polyak CS, Jani IV, Bhatt N. (2020). **Determining hematological, biochemical and immunological reference values in healthy adults with high-risk for HIV acquisition in Mozambique**. PLoS ONE 15(4): e0232018. https://doi.org/10.1371/journal.pone.0232018

John Nkengasong, Eduardo Gudo, **Ivalda Macicame**, Xadreque Maunze, Agbessi Amouzou, Kathryn Banke, Scott Dowell, Ilesh Jani (2019) **Improving birth and death data for African decision making. The Lancet Global Health**. https://doi.org/10.1016/S2214-109X(19)30397-3

Macicame I, Bhatt N, Matavele Chissumba R, Eller LA, Viegas E, Araújo K, et al. (2019) **HIV prevalence and risk behavior among male and female adults screened for enrolment into a vaccine preparedness study in Maputo, Mozambique.** PLoS ONE 14(9): e0221682. https://doi.org/10.1371/journal.pone.0221682

Ivalda Macicame, Amílcar Magaço, Marta Cassocera, Celeste Amado, Américo Feriano, Sérgio Chicumbe, Jorge Jone, Quinhas Fernandes, Kátia Ngale, Emilia Vignola, Caroline De Schacht, Timothy Roberton, **Intervention heroes of Mozambique from 1997 to 2015: estimates of maternal and child lives saved using the Lives Saved Tool**, Journal of Global Health 2018, 8 (2): 021202

Raquel Matavele Chissumba, Eduardo Namalango, Vânia Maphossa, **Ivalda Macicame**, Nilesh Bhatt,Christina Polyak, Merlin Robb, Nelson Michael, Ilesh Jani, and Luc Kestens, **Helios + Regulatory T cell frequencies are correlated with control of viral replication and recovery of absolute CD4 T cells counts in early HIV-1 infection**, BMC Immunol 2017 Dec 16. doi: 10.1186/s12865-017-0235-7

9.2. Statement on Pre-release and Contribution

One article resulting from this project has been published:

1. **Social determinants and behaviors associated with overweight and obesity among youth and adults in a peri-urban area of Maputo City, Mozambique**

   Submission: Yes (published) | **Journal:** Journal of Global Health

   Aim: A cross-sectional study to determine the prevalence of overweight and obesity and its risk factors in male and non-pregnant female from 15 to 64 years old.

   Role of PhD candidate : Conception and design of the study, data acquisition, analyses and interpretation of data, drafting of manuscript.

Additionally, at least three more are being written from the data collected from this project:

2. **Prevalence and risk factors associated with Metabolic Syndrome in youth and adults in Maputo City, Mozambique**

   Submission: No (Under internal review) | **Journal:** To be determined

   Aim: A cross-sectional study in individuals aged 15-64 years to determine the prevalence of metabolic syndrome and its risk factors.

   Role of PhD candidate : Conception and design of the study, data acquisition, analyses and interpretation of data, drafting of manuscript.

3. **Physical activity measured by pedometer in a peri-urban Mozambican population**

   Submission: No (Under internal review) | **Journal:** Journal of Physical Activity and Health

   Aim: A cross-sectional study in youth and adults to describe physical activity behavior and its demographic associations, using device-based data.

   Role of PhD candidate : Conception and design of the study, data acquisition, analyses and interpretation of data, drafting of manuscript.

4. **Prevalence and socio-demographic and behavioral factors associated with High Blood Pressure in a peri-urban area of Maputo City**

   Submission: No (Under writing) | **Journal:** To be determined

Aim: A cross-sectional study to determine the prevalence of High Blood Pressure and its sociodemographic and behavior risk factors in individuals aged 15-64 years.

Role of PhD candidate : Conception and design of the study, data acquisition, analyses and interpretation of data, drafting of manuscript.

Note: Teams from *Instituto Nacional de Saúde* (INS), Research Group for Physical Activity and Health (NIAFS) and LMU actively supported all steps described above. Supervisors provided close support in all steps of the project.

9.3. Acknowledgments

This project would not be possible without the commitement and dedication of the HDSS Polana Caniço team at CISPOC, INS – I could not ask for a better team.

The funders of this project (INS, Centers for Disease Control and Prevention, Flemish Government through BICMINS project: ‘Building Institutional Capacity at the Mozambique INS’ and the Ministry of Science and Technology in Mozambique) played a crucial role for the implementation of HDSS Polana Caniço and the Risk factors for NCDs study.

I would like to acknowledge the continuous support of my supervisors during this journey:

Professor Prista – for the kindness, the wisdom and for becoming not only a supervisor, but an idol and a mentor in science and in life.

Professor Klaus – for the guidance, the unconditional support and kindness from you and your entire family.

Dr. Elmar – for the gift of teaching, tolerance and guidance toward a new field of science for me.

Professor Eva – for being such an inspiration as a woman in science. Your scientific journey and wisdom will always inspire me to become a better professional.

I would like to thank all my family and closed friends for the social support. Special thanks to my mother, my father and sister for the unconditional love, for the guidance and for being my bigger supporters. Thank you to my husband for accepting the challenge of being part of this journey. My daughter Larissa Nzuri, thank you for becoming my inspiration and my strength – might this work also guide and inspire you one day.

9.4. Affidavit

Ivalda Benigna Macicame

Name

Street

1001, Maputo City

Zip code, town

Mozambique

Country

I hereby declare, that the submitted thesis entitled

Determinants and Exposure to Risk Factors for Chronic Non-Communicable Diseases in a Peri-urban Setting of Maputo City, Mozambique

is the result of my own work. I have only used the sources indicated and have not made unauthorised use of services of a third party. Where the work of others has been quoted or reproduced, the source is always given.

The submitted thesis or parts thereof have not been presented as part of an examination degree to any other university.

I further declare that the electronic version of the submitted thesis is congruent with the printed version both in content and format.

Maputo, 31st May 2021

Place, Date

Ivalda Macicame

Signature of PhD Candidate

9.5. Confirmation of congruency between printed and electronic version of the doctoral thesis

Ivalda Benigna Macicame

Name

Street

1001, Maputo City

Zip code, town

Mozambique

Country

I hereby declare that the electronic version of the submitted thesis, entitled

Determinants and Exposure to Risk Factors for Chronic Non-Communicable Diseases in a Peri-urban Setting of Maputo City, Mozambique

is congruent with the printed version both in content and format

Maputo, 31st May 2021

Place, Date

Ivalda Macicame

Signature of PhD Candidate

9.6. Study informed consent form for adults

INFORMED CONSENT FOR ADULTS (18 YEARS OLD AND MORE)

SOCIAL DETERMINANTS AND EXPOSURE TO RISK FACTORS FOR CHRONIC NON-COMMUNICABLE DISEASES IN A PERI-URBAN SETTING OF MAPUTO CITY, MOZAMBIQUE

INTRODUCTION

The National Institute of Health (*Instituto Nacional de Saúde* - INS), through the Polana Caniço Health Research and Training Center (CISPOC), aims to identify the life and health conditions and the risk of acquiring NCDs such as diabetes, heart diseases and cancers in families living in the neighbourhoods of Polana Caniço "A" and "B" in Maputo city.

By identifying the risk factors for NCDs such as unhealthy diet, physical inactivity, overweight/obesity and high blood glucose, and the health and living conditions related to these risk factors in individuals between 15 and 64, CISPOC will be able to contribute to the implementation of strategies to control NCDs in the area of Polana Caniço.

About 843 inhabitants from Polana Caniço "A" and "B" neighbourhoods, corresponding to about 135 families per neighbourhood, will be invited to participate in this study,

You are invited to participate in this study. Your participation in this study is voluntary.

REASONS TO IMPLEMENT A STUDY ON NCDs IN HDSS

To get to know the risk factors for NCDs and understand their relationship with age, gender, education level, family income, access to health care and other factors in the neighborhood of Polana Caniço A and Polana Caniço B in Maputo city.

INCLUSION CRITERIA

- Families and individuals living in the neighbourhoods of Polana Caniço "A" and "B";
- Individual aged between 15 and 64 years.

EXCLUSION CRITERIA

- Pregnant woman

PROCEDURES

Members of CISPOC will gather information related to age, education level and occupation, household income, among other questions related to the family's living conditions and of each individual. You will be asked about tobacco and alcohol consumption, type of diet and physical exercise, and also on stress. The measurement of blood pressure, weight, height and waist circumference will be made, whenever possible after the administration of questionnaires, in a more private and peaceful environment inside the house or in your yard, chosen by you. If we find values considered abnormal during the measurements, we will provide a reference guide to the Health Unit of your choice.

An instrument called a pedometer or accelerometer will be given to each family member included in the study, and he/she will be oriented to walk accompanied by this same instrument for 7 consecutive days to measure the amount of exercise to practice on a day-to-day.

5-8 ml of blood (a little over half a tablespoon) will be collected to measure the levels of sugar and fats in the blood.

The visits will have the duration of 60 to 90 minutes depending on the number of family members. A second visit will be made to collect the pedometer and accelerometer and to finalize the procedures that may have not been completed on the first visit.

An additional visit will be made of up to one (1) month after blood collection for the delivery of results (levels of sugar and fat) for the cases in which values are not considered normal. If you do not receive the results of blood it means that the results were normal.

Quick visits to confirm/correct information may be made by the study team supervision.

POSSIBLE RISKS BY PARTICIPATING IN THE SURVEILLANCE SYSTEM

There is minimal risk of pain, bruising, infection and, in rare cases, fainting associated with needle stick. To minimize these risks, only trained professionals from the Research Centre will perform the blood collection. In addition, all participants will be sitting or lying during blood collection.

There is minimal risk associated with discomfort when the family member is asked about family income and possession of goods and materials and other stress-related data.

BENEFITS FOR TAKING PART IN THE STUDY

Family members will not receive direct benefits for participating in the study, although they may benefit indirectly by being more exposed to information about their health and medical examinations. In addition, the reports generated from the study can positively influence policies to improve the well-being of the families and the community.

CONFIDENTIALITY

Interviews will be done individually, in a place of residence chosen by you, where you can answer questions in private, if you prefer. If you present some results considered abnormal (high pressure, high levels of blood glucose, among other results), they will be disclosed to you in private (conversation in quiet surroundings, and a guide for the Health Unit may be given to you).

Each household member and each residence will be identified by codes, whose relationship with the member's personal data will be filed by the Research Centre team.

Each form and laboratory samples will be identified only by the member or residence code and the information collected will be shared only by authorized members of the team.

VOLUNTARY PARTICIPATION

Your inclusion, by signing the study informed consent form is completely voluntary. You can decide to refuse or give up your participation in the study at any time, without this influencing your participation in programs or studies that CISPOC and INS are involved and will not influence your care and treatment in public and private services in Mozambique.

COSTS

There will be no cost (you do not have to pay) to take part in this study.

QUESTIONS/POINTS OF CONTACT

If you have any questions, please ask and we will do our best to answer. If you have additional questions or need to discuss some other aspect of the study, you can contact:

Name	Institution	Role	Telephone number
Dr.Ivalda Macicame	Instituto Nacional de Saúde	Principal Investigator	+258-82-14 03 868 +258-82-58 02 221
Mrs.Cristina Chissico	National Bioethics Com-	Secretary of the Na-	+258-21 427131/4 ou

	mittee for Health	tional Bioethics Committee for Health	+258 82 4066350

If there is any aspect of this consent that you did not understand, please ask before signing it. You will receive a copy of the signed informed consent form.

DECLARATION OF HOUSEHOLD MEMBER

I was asked to be part of this study. The Principal Investigator, Dr.. Ivalda Macicame or her representative explained the importance, procedures, risks and benefits of being part of this study. I was given the opportunity to ask any questions about the study. All my questions were answered satisfactorily. If I have other questions about the study can I contact the investigators and the National Bioethics Committee for Health, the telephone numbers listed above.

I understand that my enrolment in the study is voluntary and that consent can be withdrawn by me at any time without any extra consequences for me or my family. Sign below to indicate my consent to be included in the study,

______________________________ ____/____/______ ____: _____

Signature (or digital fingerprint) Date Hour

____

Print name

____________________________________ ____/____/______ ____: ____

Signature of the Person Administering the Consent Date Hour

____

Print Name of the Person Administering the Consent

____________________________________ ____/____/______ ____: ____

Signature of the witness (in case volunteer doesn’t read or write) Date Hour

____

Print name of the witness

9.7. Study informed consent form for 15 to 17 years old

INFORMED CONSENT FOR 15 to 17 YEARS OLD

SOCIAL DETERMINANTS AND EXPOSURE TO RISK FACTORS FOR CHRONIC NON-COMMUNICABLE DISEASES IN A PERI-URBAN SETTING OF MAPUTO CITY, MOZAMBIQUE

INTRODUCTION

The National Institute of Health (*Instituto Nacional de Saúde* - INS), through the Polana Caniço Health Research and Training Center (CISPOC), aims to identify the life and health conditions and the risk of acquiring NCDs such as diabetes, heart diseases and cancers in families living in the neighbourhoods of Polana Caniço "A" and "B" in Maputo city.

By identifying the risk factors for NCDs such as unhealthy diet, physical inactivity, overweight/obesity and high blood glucose, and the health and living conditions related to these risk factors in individuals between 15 and 64, CISPOC will be able to contribute to the implementation of strategies to control NCDs in the area of Polana Caniço.

About 843 inhabitants from Polana Caniço "A" and "B" neighbourhoods, corresponding to about 135 families per neighbourhood, will be invited to participate in this study,

Your family member between 15 and 17 years is invited to participate in this study.

REASONS TO IMPLEMENT A STUDY ON NCDs IN HDSS

To get to know the risk factors for NCDs and understand their relationship with age, gender, education level, family income, access to health care and other factors in the neighborhood of Polana Caniço A and Polana Caniço B in Maputo city.

INCLUSION CRITERIA

- Families and individuals living in the neighbourhoods of Polana Caniço "A" and "B";

- Individual aged between 15 and 64 years.

EXCLUSION CRITERIA

- Pregnant woman

PROCEDURES

Members of CISPOC will gather information related to age, education level and occupation, household income, among other questions related to the family's living conditions and of each individual. You will be asked about tobacco and alcohol consumption, type of diet and physical exercise, and also on stress. The measurement of blood pressure, weight, height and waist circumference will be made, whenever possible after the administration of questionnaires, in a more private and peaceful environment inside the house or in your yard, chosen by the family member. If we find values considered abnormal during the measurements, we will provide a reference guide to the Health Unit of your choice.

An instrument called a pedometer or accelerometer will be given to each family member included in the study, and he/she will be oriented to walk accompanied by this same instrument for 7 consecutive days to measure the amount of exercise to practice on a day-to-day.

5-8 ml of blood (a little over half a tablespoon) will be collected to measure the levels of sugar and fats in the blood.

The visits will have the duration of 60 to 90 minutes depending on the number of family members. A second visit will be made to collect the pedometer and accelerometer and to finalize the procedures that may have not been completed on the first visit.

An additional visit will be made of up to one (1) month after blood collection for the delivery of results (levels of sugar and fat) for the cases in which values are not considered normal. If your under 18 years old family member do not receive the results of blood it means that the results were normal.

Quick visits to confirm/correct information may be made by the study team supervision.

POSSIBLE RISKS BY PARTICIPATING IN THE SURVEILLANCE SYSTEM

There is minimal risk of pain, bruising, infection and, in rare cases, fainting associated with needle stick. To minimize these risks, only trained professionals from the Research Centre will perform the blood collection. In addition, all participants will be sitting or lying during blood collection.

There is minimal risk associated with discomfort when the family member is asked about family income and possession of goods and materials and other stress-related data.

BENEFITS FOR TAKING PART IN THE STUDY

Family members will not receive direct benefits for participating in the study, although they may benefit indirectly by being more exposed to information about their health and medical examinations. In addition, the reports generated from the study can positively influence policies to improve the well-being of the families and the community.

CONFIDENTIALITY

Interviews will be done individually, in a place of residence chosen by the family member, where he/she can answer questions in private, if he/she prefers. If he/she presents some results considered abnormal (high pressure, high levels of blood glucose, among other results), they will be disclosed to him/her, in your presence, and a guide for the Health Unit may be given to you for him/her to be followed.

Each household member and each residence will be identified by codes, whose relationship with the member's personal data will be filed by the Research Centre team.

Each form and laboratory samples will be identified only by the member or residence code and the information collected will be shared only by authorized members of the team.

VOLUNTARY PARTICIPATION

Your decision in including the less than 18 years old member, by signing the study informed consent form is completely voluntary. You can decide to refuse or give up your family member's participation in the study at any time, without this influencing his/her participation in programs or studies that CISPOC and INS are involved and will not influence his/her care and treatment in public and private services in Mozambique.

COSTS

There will be no cost (you do not have to pay) for your under 18 years old family member to take part in this study.

QUESTIONS/POINTS OF CONTACT

If you or your family member have any questions, please ask and we will do our best to answer. If you have additional questions or need to discuss some other aspect of the study, you can contact:

Name	Institution	Role	Telephone number
Dr.Ivalda Macicame	Instituto Nacional de Saúde	Principal Investigator	+258-82-14 03 868 +258-82-58 02 221
Mrs.Cristina Chissico	National Bioethics Committee for Health	Secretary of the National Bioethics Committee for Health	+258-21 427131/4 ou +258 82 4066350

If there is any aspect of this consent that you did not understand, please ask before signing it. Each representative from the less than 18 years old member will receive a copy of the signed informed consent form.

DECLARATION OF HOUSEHOLD MEMBER

I was asked allow my household member between 15 and 17 years old to be part of this study. The Principal Investigator, Dr. Ivalda Macicame or her representative explained the importance, procedures, risks and benefits of being part of this study. I was given the opportunity to ask any questions about the study. All my questions were answered satisfactorily. If my less than 18 years old family member or I have other questions about the study we can contact the investigators and the National Bioethics Committee for Health, the telephone numbers listed above.

I understand that the enrolment of my family member in the study is voluntary and that consent can be withdrawn by me at any time without any extra consequences for him/her or my family. Sign below to indicate my consent to be included in the study,

I sign below to indicate my consent to allow my household member between 15 and 17 years old provide personal information.

Has the 15 to 17 years old female household member signed the assent form? Yes☐ No ☐

Print name of the minor: ____

________________________________ ____/____/______ ____: _____

Signature (or digital fingerprint) of the legal representative of the minor — Date — Hour

____

Print name of the legal representative of the minor

_______________________________________ ____/____/______ ____: ____

Signature of the Person Administering the Consent — Date — Hour

____

Print Name of the Person Administering the Consent

_______________________________________ ____/____/______ ____: ____

Signature of the witness (in case representative doesn't read or write) — Date — Hour

____

Print name of the witness

9.8. Study assent form for 15 to 17 years old

ASSENT FORM FOR 15-17 YEARS OLD

SOCIAL DETERMINANTS AND EXPOSURE TO RISK FACTORS FOR CHRONIC NON-COMMUNICABLE DISEASES IN A PERI-URBAN SETTING OF MAPUTO CITY, MOZAMBIQUE

Key issues to remember about the study:

- Your guardian consented your participation in this study related to risk factors for chronic non-communicable diseases (NCDs); however, we would like to know if you accept to be part of the study and if you are interested in answering the questions and perform the study procedures.
- We will make questions related to your history of alcohol and tobacco, your diet and physical activity and related to personal or family history of NCDs such as diabetes, cancer and heart disease. We will measure your weight, your height, your waist and your blood pressure. We will collect an amount of blood from your arm equivalent to a little more than half a tablespoon to measure the sugar and fat levels. Additionally, you will receive a device for measuring the amount of exercise that you should use for 7 days.
- You can choose the location of the house that you feel more comfortable answering questions and making measurements.
- If you have an abnormal result you will be referred to a health facility for a better evaluation.
- All information and all data provided are confidential.

Your participation in this study is completely voluntary. If you decide not to sign this assent you will not lose any benefits in any program or study that CISPOC and INS are participating and will continue with the same benefits in any public institution in Mozambique.

Declaration of assent:

I accept part of this study and to be following the procedures related thereto;

My participation is voluntary and I can decide stop my participation at any time;

If I decide not to be part of this study I will not lose any benefits in any program or study tiat CISPOC and INS are participating;

I was given the opportunity to ask any questions about the importance and the study procedures. All my questions were answered satisfactorily. If I have any questions about the study my representative and I can contact the study investigators and the National Bioethics Committee for Health;

I sign below to indicate my consent to be included in the study and to provide personal information

Subjects signature	Witness	Investigator
(Name and date)	(Name and date)	(Name and date)
______________________	______________________	______________________
______________________	______________________	______________________