The Epidemiology of Non-Communicable Diseases Lifestyle Risk Factors in Tanzanian Population Groups

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Dekan der Philosophisch-Naturwissen schaftlichen Fakultät

Dedicated to my dear parents

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Summary

Background. The burden of non-communicable diseases (NCDs) is a global public health concern which so far has claimed more than 36 million lives worldwide. Four key lifestyles namely insufficient fruit and vegetable (FV) intake, insufficient physical activity (PA), harmful alcohol use and tobacco smoking are responsible for majority of the NCD disability adjusted life years (DALYs) (52.1%), whereas the rest are attributed to genetic and occupational risks. Low and middle income countries (LMIC) like Tanzania succumb to almost the entire NCD burden (>90%), while still being overwhelmed by the burden of communicable diseases amidst a debilitated health care system. Moreover, epidemiological evidence for aiding NCD interventions is least available in LMIC. In the absence of effective responses, the death toll may reach 44 million by 2020. This study is in line with the global call to address lifestyle risks through the "25 x 25" risks by the WHO coordinated leadership of "The Lancet NCD Action Group and NCD Alliance". The "25 x 25" risks seeks to reduce 25% of lifestyle risks by the year 2025. Hence this study explores a semi-urban setting in Southern Tanzania to describe how far unhealthy practices have manifested different socio-demographic population groups and its relevance to the burden of NCDs; and from that proposes suitable public health responses.

Methods. This study employed a cross sectional design from the MZIMA open community cohort round 1 (2012-2013) and round 2 (2013-2014). The MZIMA cohort is lodged into the Ifakara Urban Health and Demographic Surveillance System (IU-HDSS). The WHO STEPS tool was adopted to answer questions on how often fruits and vegetables (FV) were consumed, in what portions and by whom and this information eventually was used to describe patterns of FV insufficiency. This work was able to describe fruit intake and vegetable intake patterns individually and thereby establish the respective intake limitations and importance in the overall population FV insufficiency. Furthermore, the study was also able to explore patterns of physical activity under the domain activities of "work", "travel" and "recreation or leisure". Moreover, intensities of activities described as "vigorous" and

"moderate" were deduced and thereby the overall population moderate to vigorous physical activity (MVPA) was also deduced in a gender specific manner. In addition, the WHO STEPS tool was also used to establish alcohol use patterns in respect to frequency of alcohol consumption, amount of alcohol consumed, and type of alcohol consumed in different population groups with special interest on understanding the burden of heavy episodic drinking (HED) and use of local brew. Patterns of tobacco smoking captured as never, ever and daily smokers were useful in establishing associations with other lifestyle risks. Logistic regression models assessed the relation between NCD risky lifestyles and specific contextual factors also defined as social determinants.

Results. This study found that FV insufficiency was widely prevalent (82%), with vegetables being consumed daily by almost half of the population but in small portions, and with youth being most deprived. Use of fruits was found to be limited by indicators of low social economic status (SES). We also found that three quarters of the population were active enough, but majority among them were active to moderate intensity (59.5%) only. In a resource poor semi-urban setting were farming is still the most prevalent economic activity, dominance of moderate over vigorous intensity physical activity should be given closer monitoring because it could be a signal of a population becoming less active. It is such subtle changes in physical activity that eventually may lead to drop in the overall MVPA and consequently risk of insufficient PA and sedentary lifestyle. In addition, gender specific influence of age on physical activity was clear and statistically relevant. Young men were more likely to be more active than young women, but in old age the opposite was true. Moreover, people with high SES were more likely to be insufficient in PA than those with low SES. This study also found that HED was widespread (91.3%) among all drinkers with no significant gender or SES difference. Local brew (47.9%) was no longer the most popular alcoholic drink when compared to previous studies. Moreover, more women and youth binge drinkers consumed commercial alcoholic beverages. Furthermore, 25% of drinkers were also smokers which is an important predisposition to head and neck cancers.

Conclusion. This study contributes evidence to the global and national NCD research agenda, suggesting that the burden of NCD risky lifestyle in Southeastern Tanzania is substantial and highly complex within its context. This includes widespread insufficient FV, predominant moderate MVPA and alarming patterns of alcohol abuse that are further aggravated by the burden of smoking. These are quantitative findings which can be further strengthened by qualitative explorations to shed light on mechanization of NCD risky lifestyles in the study setting. The lifestyle profiles observed in this study demand urgent public health responses particularly targeting the specific needs of those socio-economically deprived as a matter of priority. Targeted public health action and priority setting and against specific risky lifestyles should further consider gender and age difference in vulnerability. These findings emphasis the need for active health education campaigns on the public health importance of NCDs and WHO lifestyle recommendations while promoting and facilitating environments for easy access to healthy choices. A string of promotional environments to strengthen specific healthy choices have been proposed. This includes introduction of indigenous vegetables into mainstream marketing and evidence-based farming to improve vegetable consumption. It is also proposed to explore the possibility of replacing expensive fruits with nutrient rich herbs and spices locally available and accessible to the majority at affordable prices. Others include infrastructural and policy adjustments necessary to support more population physical activity and FV intake. The study also proposes ways of strengthening the political environment for more successful implementation of the NCD policies, NCD regulations and the NCD research agenda. In addition, the study also describes the potential for using the existing national revenue collection system, health system, police, social welfare offices, law firms and others as platforms for monitoring patterns of healthy choices and its health and social impact across different geographic settings and population groups country wide.

Chapter One

This chapter provides an overview of the study subject and defines the rationale of carrying out the study

1.0 Overview of the NCD burden and risky lifestyles

The burden of NCDs is relatively a new public health concern. It is very aggressive in causing mortalities and morbidities and hence needs urgent public health response. Scientific evidence shows that out of 54.9 million lives lost globally in 2013, an estimated 38.3 million were attributed to NCDs (Collaborators, 2015). These figures convert to more than 70% of total mortalities (Collaborators, 2015). The situation is more of concern to low and middle income countries (LMIC) who take in excess of three quarters of the burden, and with almost 40% being between the age of 30 and 69 years which is the productive age (WHO, 2017). Generally, all NCDs lead to low productivity at work through absenteeism and presentism as well as potential loss of employment (Chaker et al., 2015; Jan et al., 2018; McIntyre et al., 2006). In return this diminishes income and quality of life (McIntyre et al., 2006). It also accumulates a big burden of debts which also contribute to expenditure for health (Alam & Mahal, 2014; Brinda, Andres, & Enemark, 2014).

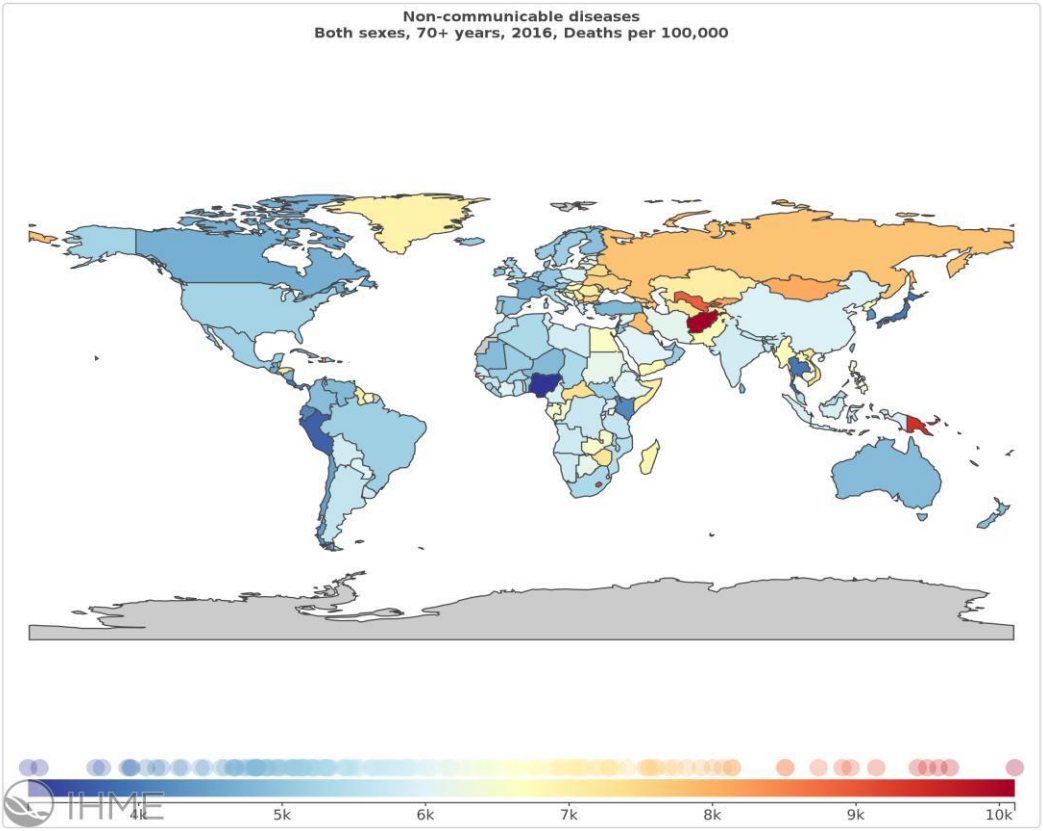

Figure 1: Map shows NCD mortality infiltration into LMIC. Mortalities ('000) per 100,000 by country in 2016 (IHME, 2018).

Without any counteracting response, trends in NCD mortalities are projected to reach 44 million by year 2020 (Murray & Lopez, 1997). It is now clear that NCDs are no longer diseases of the rich and at a global level it is in fact the poor that carry most of the burden (Collaborators, 2015; Hosseinpoor et al., 2012) (Fig 1). The ongoing geographic shift of NCD epidemiology from high income to low and middle income countries is increasing rapidly (Habib & Saha, 2010). High rates of hypertension reported in Tanzania (Unwin et al., 2001) and in Democratic of the Congo, Nigeria, Ethiopia and South Africa than high income countries (Abegunde, Mathers, Adam, Ortegon, & Strong, 2007) is proof that NCDs are manifesting Sub-Saharan Africa (SSA). Moreover, according to WHO by 2004 already a quarter of the deaths in SSA were attributed to NCDs (WHO, 2018). Although currently all-cause mortalities are still mostly attributed to infectious disease but years lost due to disability are mostly attributed to non-communicable disease (Tab 1)(IHME, 2018). Table 1 shows how DALYs are more attributed to NCDs than communicable diseases which in contrast account for more mortalities.

Table 1: Mortality and DALYs for 15 most prevalent diseases in Sub Saharan Africa in 2016

Mortality	DALYs
Diarrhea	Other NCDs
HIV/AIDS	Mental disorder
CVDs	Musco-skeletal
Neonatal disorders	Nutritional deficiency
NTD & Malaria	Neurological disorder
Neoplasm	NTD & Malaria
Diabetes	Diabetes
Unintentional injuries	Diarrhea
Nutritional deficiency	Unintentional injuries
Other NCDs	HIV7AIDS
Transport injury	COPD
Digestive disease	CVDs
COPD	Neonatal disorders

The most important NCDs include Cardiovascular Diseases (CVDs), Cancer, Diabetes, Chronic Obstructive Pulmonary Disease (COPD) (WHO, 2011). One of the early studies that gave insight of NCDs in Tanzania, The Adult Morbidity and Mortality Project (AMMP) was

carried out between 1994 and 2002 and found that 15% - 28% deaths were a result of NCDs (CVDs, cancers, diabetes, CNS diseases and chronic respiratory diseases) including injuries (AMMP, 1997). More recent studies conducted in Tanzania have shown that these major NCDs contribute 31%, of all-cause mortalities and the probability of dying from these four is 16% (WHO, 2014b). Hypertension has been described as the most common CVD in Tanzania (Mayige, Kagaruki, Ramaiya, & Swai, 2011) contributing to 68% of heart failure cases (Mayosi, 2007). Most heart conditions in Sub Saharan countries present during the productive age with the exception of endomyocardial fibrosis which manifests in children and young adults (Mayosi, 2007).

In 2010 there were 12.1 million people living with type 2 diabetes in Sub Saharan Africa, and it is indicated that if unattended it may rise to 23.9 million in 2030 (Hall, Thomsen, Henriksen, & Lohse, 2011). The rapid rise in diabetes burden and mostly among the work force age (36-64 years) had already started raising concern more than a decade ago (Boutayeb & Boutayeb, 2005). Diabetes has previously been reported to be more common in the urban than rural (Aspray et al., 2000), however such profile is changing with effects of globalization, urbanization and industrialization reaching the rural practices (Hall et al., 2011) It has also been noted that almost 80% diabetes cases go undiagnosed (Ramaiya, Swai, McLarty, Bhopal, & Alberti, 1991), due to multiple reasons originating from both the health system as well as community.

Another important NCD is cancer which in developing countries rests mainly on lung, breast, stomach, colorectal and liver cancer (WHO, 2011). According to Ocean Road the only cancer referral hospital in Tanzania, the registry for 2006 to 2009 indicates most common cancers to be cervical cancer (35%), Kaposi sarcoma (12%), and breast cancer (8%). Prevalence of HIV has been linked with elevation of cervical cancer and Kaposi sarcoma observed (Kahesa et al., 2008). Early detection of cancer and prevention of risk factors including tobacco and alcohol use as well as specific infections are desired strategies.

NCDs are both a health as well as an economic burden (Habib & Saha, 2010; WHO, 2011). The impact of disability can be felt as pain and suffering due direct effects of the disease (McIntyre, Thiede, Dahlgren, & Whitehead, 2006). The cost involved in getting medical care for NCDs is very high (Abegunde et al., 2007; Alouki et al., 2015; Ngalesoni, Ruhago, Norheim, & Robberstad, 2015). Most health facilities that offer NCD care are higher level facilities found in towns and big cities, so patients residing in remote areas have to pay a high price in money, time and physical energy to access such care (Jan et al., 2018; Q. Wang et al., 2015; Wirtz, Kaplan, Kwan, & Laing, 2016). Many families end up compromising quality of life in order to sustain NCD treatment, but still poverty drives them into catastrophic health expenditures (Alam & Mahal, 2014; Brinda, Andres, & Enemark, 2014; Jaspers et al., 2015). Considering that the world's poorest countries are also the ones that still bear a substantial burden of communicable diseases supported by a debilitated health care system, makes the need to address the NCD burden even more urgent.

Evidence has demonstrated that NCDs initiate from unhealthy lifestyle including insufficient FV (Boeing et al., 2012; Liu, 2013; Slavin & Lloyd, 2012; X. Wang et al., 2014), insufficient physical activity (Briazgounov, 1988; Lee et al., 2012; Powell, Paluch, & Blair, 2011; WHO, 2010), harmful alcohol use (Parry, Patra, & Rehm, 2011) and smoking (Forey, Thornton, & Lee, 2011; Sasco, Secretan, & Straif, 2004; Willis, 2006). Dissemination of these unhealthy practices ensures that the NCD burden grows and sustains in the community. Urbanization, industrialization and globalization are important contexts in the initiation and propagation of lifestyle practices and consequently the ongoing epidemiological transition (Omran, 1971). Tanzania has recorded among the highest urbanization rates in the world at 13.8% in 1978 and 21% in 2002 (TNBS, 2018). Urbanization allows influx of new culture and norms which brings communities closer and thereby facilitates exchange of lifestyle practices. These new behavior practices subsequently put people at risk of NCD.

Clinical data and one off cross sectional data have shown that NCDs are a growing problem in Tanzania (Aspray et al., 2000; Mayige & Kagaruki, 2013; Mayige et al., 2011; Marina A Njelekela et al., 2009). Increase in the burden of NCDs is an indication that NCD lifestyle risk factors are also increasing and hence more people are affected (Mayige & Kagaruki, 2013; Mayige et al., 2011) including multiple NCD lifestyle risks as evidenced by neighboring Kenya (Haregu, Oti, Egondi, & Kyobutungi, 2015).

At national level Tanzania has been able to establish a NCD unit under the Ministry of Health and Social Welfare (MOHSW), with the aim of coordinating and formulating NCD policies in partnership with all relevant stakeholders (Mfinanga et al., 2011). Since the inception of the unit, several strategies have been drafted. However, lack of epidemiological evidence may have largely limited implementation of public health strategies. Failure to roll out the Framework for Tobacco Control (FTCT), while it was already signed, stratified and passed in parliament since 2007 suggests that poor political commitment may play a significant role too. While lack of epidemiological evidence hampers public health responses, that exact shortfall may also be a reason why policy makers have not been convinced enough that the NCD burden is a significant problem and needs urgent attention. Through early primary prevention of these key risky lifestyles, 80% of CVDs and diabetes cases and 40% of cancer cases can be prevented (WHO, 2011). This study explored the burden of NCD risky lifestyles and hence responds to the global call by WHO coordinated leadership of “The Lancet NCD Action Group and NCD Alliance” to reduce risky lifestyle by 25% by 2525.

1.1 Literature review on lifestyle transition and predisposing contexts

Lifestyle practices are behavioral entities, which according to Bandura are initiated through observation and thereafter shaped by the context in the physical, social and personal environments (Bandura, 1991). These environments have a direct interplay with each other thereby shaping the resulting behavior response. Considering this context, health issues are no longer evaluated as an independent entity, but with all possible determinants in the

biological, physical and social environment that may influence the outcome (Blas & Kurup, 2010; Braveman, Egerter, & Williams, 2011; Irwin et al., 2006; Wilkinson & Marmot, 2003). For instance, the gender specific prevalence patterns observed in smoking or alcohol consumption (Koula, 2010; Mayige et al., 2011; Msyamboza et al., 2011; WHO, 2008) , may have largely been influenced by cultural norms and taboos existing within ethnic groups (Priscilla Martinez, 2013; P. Martinez, Roislien, Naidoo, & Clausen, 2011; Schaffer, 2012; Unger et al., 2003). Moreover, many years of exposure to NCD risks may be an important reason why prevalence of NCDs is higher in older people (Mayige et al., 2011; Msyamboza et al., 2011; Negin, Cumming, de Ramirez, Abimbola, & Sachs, 2011). Tanzania boasts a diverse cultural make up with more than 100 distinct tribes spreading across an approximately 40 million population count (TNBS, 2018). Lifestyles patterns may hence differ between places even if within small geographical distances.

Advances in agricultural technology and trade liberalization are accompanied with better earnings for farmers**.** Affluence in most African settings goes along with among others obesity (McLaren, 2007) as a result of poor diet and less PA and excessive alcohol consumption (Grittner, Kuntsche, Gmel, & Bloomfield, 2012). Although, being educated is expected to facilitate awareness about healthy choices and has sometimes demonstrated so, it has not been the case always (Villamor et al., 2006; Ziraba, Fotso, & Ochako, 2009). Higher paying wages may allow people access to unhealthy choices. The social environment through influence of peers and social networks may also independently influence lifestyles (Ali & Dwyer, 2010; Davey-Rothwell, Chander, Hester, & Latkin, 2011; Rosenquist, Murabito, Fowler, & Christakis, 2010), this could also be presented at occupational environment. We therefore realize that people's lifestyle practices are in constant dynamics depending on environmental context. In addition, unhealthy choices may also be a result of poor understanding of the public health importance of NCDs, lack of awareness of health recommendations (Nyaruhucha, Achen, Msuya, Shayo, & Kulwa, 2003) or poor

comprehension of health experts' recommendation (Erinosho, Moser, Oh, Nebeling, & Yaroch, 2012; Glasson, Chapman, & James, 2011).

Just like the rest of LMIC, Tanzania is faced with rapid urbanization where by people are flocking the cities in search of better quality of life (TNBS, 2018). There is therefore and up rise of semi-urban areas in form of small town settings (Satterthwaitem, 2006). These areas are important links between large urban cities and rural remote areas and hence a suitable platform for transfer of risky lifestyle into remote rural. More than 70% of the whole population reside in these rural remote areas (TNBS, 2018). It is therefore critical that these uprising peri-urban small town settings are examined in order to establish the level of threat to rural settings.

1.1.1 Fruit and vegetable intake in the context of nutrition transition

Many studies have confirmed that African countries are in nutrition transition, including rural areas (Steyn & McHiza, 2014; Vorster, Kruger, & Margetts, 2011). Most traditional diet patterns include predominantly fruit, vegetables, nuts (Keding, Msuya, Maass, & Krawinkel, 2011). Some studies have shown that people do not have trust in health benefits of fruits, thereby regarding fruits as snack to children (A. Keller, 2012; Amélie Keller, de Courten, & Dræbel, 2012). In Tanzania most people eat food that mainly contains carbohydrates with one type of legume and very little protein, vegetable and fruits if at all (Mazengo, Simell, Lukmanji, Shirima, & Karvetti, 1997). This is convincing indication that there is lack of knowledge about the public health importance of fruits and vegetables.

Globalization and urbanization are introducing people to new tastes in form of purchased food options (Monteiro, Moubarac, Cannon, Ng, & Popkin, 2013; Barry M. Popkin, Adair, & Ng, 2012). Most of these foods are unhealthy, loaded with energy from fat, sugars and starches (Hawkes, 2005; Labonté, Mohindra, & Lencucha, 2011; Monteiro et al., 2013; Rayner, Hawkes, Lang, & Bello, 2006). So, people are moving away from traditional high

carbohydrate and high fiber to manufactured foods (Barry M Popkin, 2004, 2006; Barry M. Popkin et al., 2012). Free trade continues to bring in processed foods, soft drinks and other unhealthy foods (Labonté et al., 2011).

Studies done in Tanzania have shown that many households shift from home prepared food into buying food from vendors also known as “street food” in order to reduce costs of ingredients and preparation (Kinabo, 2003). Street food vendors do serve vegetables but in very little portions, whereas fruits are not served at all. Groups with high social economic status rarely consume street foods, they are instead a victim of western fast food chains (Kinabo, 2003). These fast food chains consists of food that is mainly fried (Kinabo, 2003). Despite all new influences on diet, seasonal variation may have an impact on diet too, since availability of fruit and vegetable varies with seasonality too.

Fruits and vegetables have scientifically been proven to be a protection against NCDs (Boeing et al., 2012; Slavin & Lloyd, 2012) . In most low and middle income countries (LMIC) people consume very small portions of vegetables (Weinberger & Swai, 2006). As for the case of fruits high prices limit many from access to fruits (Miller et al., 2016; Ruel, Minot, & Smith, 2005). The WHO recommends that people consume 5 portions (400mgs) of FV daily (Nishida, Uauy, Kumanyika, & Shetty, 2004). It is essential that the two key aspects of the recommendation are fulfilled to get maximum benefit. That is daily frequency of FV intake and a daily FV intake of at least 5 portions. The last national representative WHO STEPS survey in Tanzania revealed that more than 90% did not fulfill the FV intake recommendation (Mayige & Kagaruki, 2013). The amount of fruits consumed and vegetables consumed may be distinct from one place to another depending on the socio-cultural and economic make up (Guillaumie, Godin, & Vézina-Im, 2010; Ruel et al., 2005). Some have shown to consume more fruits, and some have shown to consume more vegetables (A. Keller, 2012; Amélie Keller et al., 2012; Padrao, Laszczynska, Silva-Matos, Damasceno, & Lunet, 2012; Peltzer & Pengpid, 2012; Peltzer & Promtussananon, 2004). This is why exploration of FV intake

recommends consideration of fruits and vegetables as separate constructs (Glasson et al., 2011).

1.1.2 Shift from a more active to a less active population

The WHO recommends that people spend at least 75 min or 150 min on vigorous and moderate intensity physical activity respectively per week (WHO, 2010). Livelihood through farming and long-distance walks and cycling has for many years granted populations in Africa the much needed physical activity (Micklesfield et al., 2017; Ng & Popkin, 2012). Leisure activities like football, netball and other traditional games have been around more for children than for adults, and not for keeping fit but mainly for entertainment. Most of these games do not demand complicated infrastructure. Open spaces, make-shift playing tools like balls made from junk paper and/or fabrics will get the children rolling with their game. Leisure exercise for adults is not common (John et al., 2017), possibly because physically intense work and travel related activities keep grown-ups too exhausted to engage in leisure exercises. Now with signs of decline in work and travel related physical activities even in LMIC (Micklesfield et al., 2017; Ng & Popkin, 2012), leisure activities including purposeful walking and cycling need to be promoted to replace all manual work that is disappearing (Bauman, Allman-Farinelli, Huxley, & James, 2008).

Today, people do less by themselves but rather depend more on machinery, vehicles and other equipment. Advances in science and technology encourages less household work with all new appliances that come into the market every day. Children are also changing the nature of their leisure activities from more physically active to sedentary (Kafyulilo & Mafumiko, 2010). Overweight, obese and hypertensive children are also becoming common in Tanzania as a result (Muhihi et al., 2018; Pangani, Kiplamai, Kamau, & Onywera, 2016). Students in school have also been reported to lead lives with a lot of time lost being sedentary excluding the hours sitting in class lectures (Guthold, Cowan, Autenrieth, Kann, & Riley, 2010).

People in urban areas are said to be less active because they are more affluent and can better afford an inactive life than those residing in rural areas (Mbalilaki et al., 2007; M. A. Njelekela et al., 2011). Rural and semi urban areas may temporarily be protected from insufficient PA due to the nature of their occupation and transportation being still not as modern as in urban cities. This may however change soon with ongoing advances in urbanization, industrialization and globalization (Omran, 1971) and thus has to be closely monitored. Interventions to sustain PA will have to consider existing social cultural challenges for instance the perception that weight is an indicator of wealth and beauty (McLaren, 2007). The most recent national representative WHO STEPS survey revealed that 7.5% of the population were not sufficiently active (Mayige & Kagaruki, 2013). Although this evidence gives a clear picture of the size of the burden of insufficient PA, a step further is to identify populations most vulnerable in order to start containing the problem while it is still in its infancy. The level of population PA intensity being vigorous or moderate needs to be closely monitored too, since subtle persistent decline in PA may easily go unnoticed until it has reached advanced stages. Insufficient PA increases the risk of CVDs, diabetes type II, cancer, obesity and death, and hence if allowed to grow in the population may lead into a much bigger public health burden (Kruk, 2014).

1.1.3 Populations drinking to intoxication

Besides NCDs, alcohol abuse also increases cases of road traffic accidents as well as crimes and interpersonal violence due to harmful alcohol use (Boden, Fergusson, & Horwood, 2012; Boniface, Museru, Kiloloma, & Munthali, 2016; Sarasa-Renedo et al., 2014; Staton et al., 2018). Moreover, alcohol is implicated with FAS in women (Popova et al., 2016; Rangmar et al., 2015) and increased HIV/AIDS as well as Tb in both gender (Woolf-King & Maisto, 2011). Premature mortality leaves behind orphans and spouses as well as a number of social challenges especially to orphans. Orphans affected by FAS will also have an

increased risk of going through the same circle of abusive behavior , and with one or two lost parent the risk may be higher (Coriale et al., 2013).

Traditionally alcohol has never been a casual beverage; it was consumed during social events like weddings, funerals, circumcision ceremonies and other rituals (Myadze & Rwomire, 2014). Alcohol was never traded; in fact people would bring alcohol as a gift to ceremonial gatherings (Myadze & Rwomire, 2014). Amount of alcohol consumed was self-controlled, and getting drunk was a risk that could lose someone's' dignity, respect and credibility to the community (Myadze & Rwomire, 2014). Alcohol use was also almost exclusive for adult male, and limited to women and youth (Myadze & Rwomire, 2014). We can speculate that may be community elders traced increased harm to children born to drinking mothers, like what is known today as Fetal Alcohol Syndrome (FAS). Moreover, elders might also have noticed that early initiation of alcohol use was more likely to lead to heavy alcohol use in adulthood which was a taboo. Probably, that is why many women and youth in Africa are abstainers (Collaborators, 2016; P. Martinez et al., 2011).

During colonial period alcohol traders saw the opportunity to introduce alcohol as a business, and hence introduced and promoted more reasons to drink so that drinking becomes more regular (Myadze & Rwomire, 2014). Commercial brews entered the market, and the elite and more affluent consumed it with prestige till today. Despite its many health hazards, local brew has been the most popular alcoholic beverage, particularly among the low SES population due to lower prices as well as its traditional values (Luginaah & Dakubo, 2003; Myadze & Rwomire, 2014; Saria, Kyobe, & Donnat, 2012). With manifestation of leisure drinking, taboos for getting drunk were then also easily broken, and intoxication became common particularly among males (Clausen, Rossow, Naidoo, & Kowal, 2009).

The most recent alcohol industry agenda is to do aggressive marketing in order to capture unexplored markets of women and youth in Africa. The aim is to recruit as many new

drinkers as possible and getting them to consume as much alcohol as possible (De Bruijn, 2011; D. H. Jernigan & Babor, 2015; David H Jernigan, Obot, & Jos, 2006; McCall, 2017; Obot, 2013). The alcohol per capita consumption in Tanzania matches that of those observed in countries with high prevalence of current drinkers (WHO, 2014a). This means the few who drink in Tanzania do so to levels of intoxication, a common practice known as heavy episodic drinking (HED) or locally referred as binge drinking. Heavy episodic drinking is the most common form of alcohol abuse in Tanzania and the continent at large (Jenkins et al., 2015; Mbatia, Jenkins, Singleton, & White, 2009; Padrao et al., 2011; Peltzer, Davids, & Njuho, 2011; Willis, 2006). The WHO defines binge drinking as consumption of 4/5 standard drinks or more for women/men during one drinking session (NIAAA, 2017).

The alcohol industry operating under the umbrella of the International Centre for Alcohol Policy (ICAP), has managed to establish relations with governments that favored them with self-regulation and freedom to trade anywhere, trade with anyone, trade at any time and advertise without limitation (T. F. Babor, Robaina, & Jernigan, 2015; Bakke & Endal, 2010; D. Jernigan, Noel, Landon, Thornton, & Lobstein, 2017; McCall, 2017; Obot, 2006, 2013; Peer, 2017). Cooperate social responsibility activities like drinking competitions for lucrative prices and creative advertisements draw youth into more drinking (T. Babor, Miller, & Edwards, 2010; Bakke & Endal, 2010; D. Jernigan, 2013). New alcoholic beverages designed in fruity designs to appeal to the women market and in small sizes to fit small budgets are part of the efforts by the alcohol industry to attract more women drinkers (D. H. Jernigan & Babor, 2015; David H Jernigan et al., 2006). Besides these efforts, women feminism and increase in women economic independence, may also favor more women breaking traditional taboos and becoming drinkers in response to the alcohol industry promotions. In order to reach majority of the population, the alcohol industry must compromise on prices for small profit margins which therefore have to be recovered by huge number of sales and this means a pandemic of heavy episodic drinking is almost inevitable.

According to the most recent WHO STEPS survey, prevalence of current drinking was 38.3% and 20.9% for men and women respectively (Mayige & Kagaruki, 2013). The same study also revealed that HED was 27.4% and 13.4% for men and women respectively. Women are restricted from alcohol use due to cultural norms and taboos (P. Martinez et al., 2011; Myadze & Rwomire, 2014) though there are signs of increase in alcohol abuse (Acuda, Othieno, Obondo, & Crome, 2011). Alcohol abuse in Africa comes in two main forms; binge drinking and use of unrecorded alcohol. Several studies have reported on cases of harmful alcohol consumption in Tanzania (Kimoi, 2008; Mongi et al., 2013). Locally made brew remains to be the most popular alcoholic beverage both in urban and rural, accounting for more than 80% of total alcohol consumption. (Rehm et al, 2014). This locally made brew is very cheap and hence widely accessible. It has uncontrolled levels of alcohol as well toxic substances like methanol, detergents (Razvodovsky, 2010; Saria et al., 2012). Alcohol consumption is largely socially oriented, and many times is a reflection of a person's economic status (Almeida-Filho et al., 2004; Grittner et al., 2012)). Alcohol consumption is deeply rooted in cultural norms and taboos, and hence alcohol use and abuse displays diverse patterns between communities (Clausen et al., 2009). The continuous increase in new drinking places, ensures that harmful alcohol consumption habits cannot be close to improving for healthier options (Kinabo, 2003). Understanding the burden of this risky behaviour should hence be among the initial stages towards developing public health control measures .

1.1.4 A growing tobacco smoking burden

Tobacco use is an important risk factor for cancers, cardiovascular diseases and chronic obstructive pulmonary disease (COPD) (Doll, 1998; Forey et al., 2011). Records of 2005 indicate that 5.4 million deaths globally are a result of smoking related illnesses (Mathers & Loncar, 2006). It is expected that if the situation is not attended, 2030 will witness smoking as the single biggest underlying cause of fatal cases worldwide, more than HIV, malaria, Tb, maternal mortality, accidents, homicides, and suicides all combined (The World Bank, 1999).

Efforts by the tobacco industry to shift its trajectory towards youth and women of LMIC started more than a decade ago and there are no signs of slowing down (King et al., 2003), which means evidence to enforce protective strategies is a critical public health demand. After having saturated the developed countries' market and being faced by tobacco control policies in those areas, the tobacco industry is now actively shifting trajectory to LMIC countries specifically the youth and women (King et al., 2003).

Tobacco use is a very rare event in Tanzania, and like alcohol it is almost exclusively a male practice (Brathwaite, Addo, Smeeth, & Lock, 2015). National representative prevalence studies emphasized the existing gender difference, with 26% and 2.9% being men and women current smokers respectively (Mayige & Kagaruki, 2013). However, smoking has been reported to be a rising problem among adolescents, and 3.0% males and 1.4% females were found to be current smokers in Tanzania (Siziya et al., 2007). In Dar Es Salaam the largest commercial city in Tanzania, 12.6% adolescents were reported to be smokers, which was much higher than other countries in the region such as Harare (8.5%) and Cape Town (5.9%) (Siziya et al., 2007). Evidence has also shown that most smoking adults initiate the habit as adolescents or young adults (Patton, Coffey, Carlin, Sawyer, & Wakefield, 2006). Soon tobacco will no longer be a rare event, and indications are increasingly becoming evident with more women and youth becoming smokers especially in urban settings. Poor settings like Tanzania should grab the opportunity to thoroughly measure the tobacco smoking burden and guide interventions to control it before it has reached unmanageable proportions.

1.1.5 Social determinants of health

The WHO defines health as "a state of complete physical, social and mental wellbeing and not merely absence of disease or infirmity" (WHO, 2006). Scientific evidence has come to realize that health enhancement goes beyond fully functioning and equipped health facilities. The Lalonde model was the first to describe key context factors within the health system and

outside which influence the dynamics of health outcome (Glouberman & Millar, 2003). These factors which are also referred as social determinants of health fall under different categories including biological (e.g. gender, age), social (e.g. Ethnicity, marital status) social economic status (e.g. education, occupation), political environment (Fig 2).

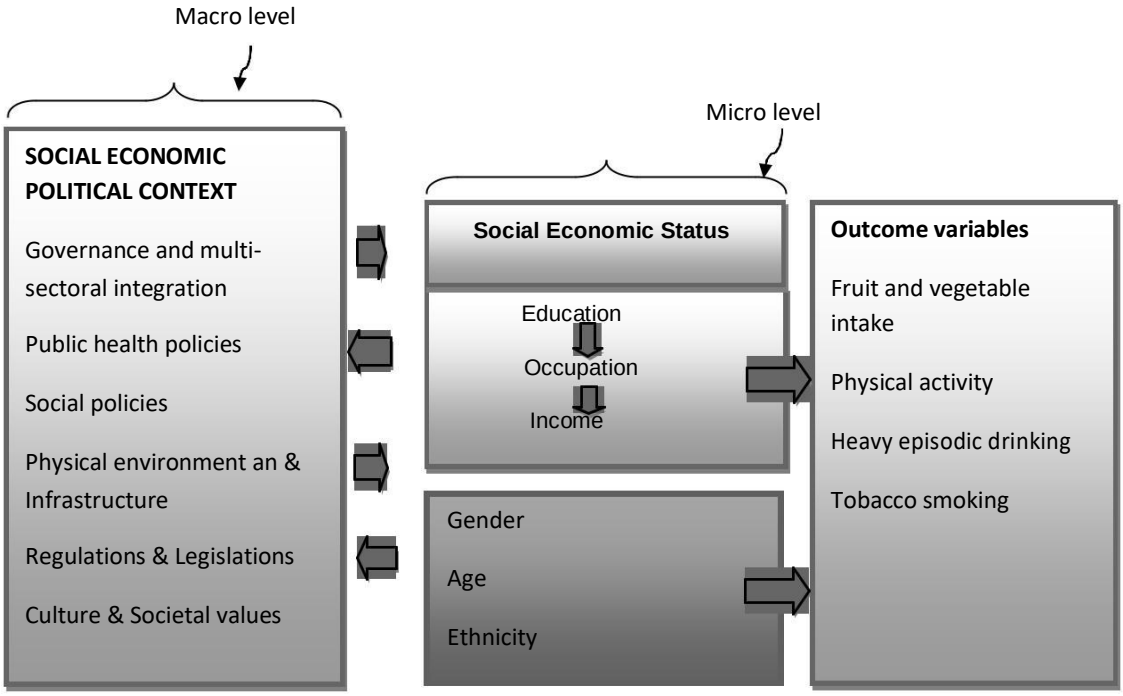

Fig 2: Conceptual framework showing relationship between NCD risky lifestyles as outcome and its determinants

Some of these factors which are also termed determinants of health may act directly on individuals and others indirectly and hence have different value in terms of impact. This study will look at how education, occupation, gender, age and ethnicity; relate to key NCD lifestyle risk factors (insufficient FV, insufficient PA, smoking and alcohol abuse) in different populations in Ifakara -Tanzania. The conceptual framework has been adopted from two models describing health outcomes; (WHO 2010a; Koelen MA 2004).

1.1.5.1 Gender and age

These are biological social determinants. Biological determinants are those factors occurring within a person's body including hereditary situations and gender (Koelen & van den Ban, 2004). Like for instance how cervical cancer is biased to females (Louie, De Sanjose, & Mayaud, 2009; Pitts & Clarke, 2002). and on the other hand prostate is linked to males (Mwakyoma & Magandi, 2010). The other groups of biological determinants are termed "acquired" because they evolve from the interactions with the structural/physical and social environment and lifestyle practices (Koelen & van den Ban, 2004). Such include raised blood pressure, raised heart rate, raised blood sugar due to poor diet and sedentary life practices or acquired oncogenic bacterial or viral infection leading into potential cardiovascular and cancerous conditions respectively (Koelen & van den Ban, 2004). Cultural norms and taboos may influence distribution of behavior and thereby vulnerability to NCDs. This is for instance limitation of tobacco and alcohol use in women and youth. Likewise in the case of age we see old people being more vulnerable to NCDs due to more life years of exposure to NCD risk factors (Fitzmaurice et al., 2017; Habib & Saha, 2010) or nature of their life being less physical than younger people (Owen et al., 2011) or accessing of more vegetables by older people (Salehi et al., 2010) and peak alcohol use from middle age upwards (Clausen et al., 2009).

1.1.5.2 Education and occupation

Education and occupation are part of a collection of parameters that define the social economic status (Glouberman & Millar, 2003). Knowledge and skills related to a specific behavior builds "behavioral capacity", an important pre-requisite for successful performance the behavior (Bandura, 1991). Education is supposed to expose people to health information and in the processes learn how to access more health information (Koelen & van den Ban, 2004). Some studies have reported an increase in healthy behavior with more education and some have reported a decrease in healthy behavior with more education. Education may create awareness and capacity to comprehend health experts' recommendation, but it may

also create the financial capacity to access more unhealthy products like alcohol, tobacco and fat, sugar and energy rich foods (Glasson et al., 2011; Kanungsukkasem et al., 2009; Wolf et al., 2008). This therefore also means that the type of occupation may influence people's behavior by the amount of wages one receives. It is also predicted that some people travel long distances after long hours at work, and by the time they reach home they are too tired to prepare a health meal with vegetables, and probably would order a fast food meal. Moreover, people spend many ours of their lives with peers at work, and hence there is potential for forming social networks with potential to influence on each other's behavior towards either healthy or unhealthy options.

1.1.5.3 Ethnicity

Societal values and norms influence behaviour patterns of a population and Tanzania has in excess of 120 tribes distributed across all its 25 regions (TNBS, 2018). We have observed fruits being consumed mostly by children and less by adults because fruits are not regarded as a nutritional necessity (A. Keller, 2012; Amélie Keller, de Courten, & Dræbel, 2012). We have also observed some ethnic groups prioritizing vegetables over fruits and vice versa (A. Keller, 2012; Amélie Keller et al., 2012; Padrao, Laszczynska, Silva-Matos, Damasceno, & Lunet, 2012; Peltzer & Pengpid, 2012; Peltzer & Promtussananon, 2004). Cultural norms that do not put priority on education for females may have an effect on access of health education among females and consequent disadvantage on adoption of healthy options. Most parts of Tanzania report lower literacy among women as compared to men (TNBS, 2018). The difference is higher in ethnic groups that originate from areas that are furthest from large cities (TNBS, 2018). Moreover, ethnic groups originating from areas with least access to health care may also be least exposed to health education and promotion activities on healthy lifestyle options. Since different ethnic groups may have different norms and values which either protect or expose to risky lifestyles, this may reflect on risky lifestyle pattern profiles too.

1.2 Rationale

The World Health Organization (WHO) advocates for prevention of lifestyle risk factors as fundamental for control of the NCD burden (WHO, 2011). Much of the NCD deaths so far, could have been prevented if people adhered to health experts' recommendation on how to avoid risky lifestyle practices. Most governments in Africa fail to implement responses against the NCD burden and its risk factors because of lack of epidemiological evidence. Recent National NCD STEPS surveillance presented an overview of the size of risky lifestyle burden (Mayige & Kagaruki, 2013). However, it does not give detailed epidemiological evidence that is comprehensive enough to guide priority setting and development of targeted interventions.

In order to address the FV burden, we need first to establish the prevalence of the burden and the source of the problem. Whether it is an outcome of infrequent fruit or vegetable intake, small fruit or vegetable portions or a combination of more than one attributes. We need also to deduce most vulnerable population groups for targeted interventions and priority setting. Most people in Tanzania get sufficient PA from work and travel related activities (Mayige & Kagaruki, 2013). However, this will potentially change soon as people get more affluent and shift from predominantly manual work to less manual and less purposeful walking and cycling to motorized travel (Micklesfield et al., 2017; Ng & Popkin, 2012). Moreover, misconceptions indicating overweight to be a sign of beauty and affluence , may further facilitate insufficient PA. We need to seek an understanding of work, travel and leisure activity related patterns. This will not only identify areas of problem and populations most vulnerable but will later also present an opportunity to deduce activities that have potential of being promoted for sustainable PA in the community. Moreover, it is also a means of noting changes in physical activity frequency and intensity in order to prevent threats of insufficient PA and sedentary lifestyle at its earliest stages. Insight into frequency patterns of heavy episodic drinking (HED) and use of unrecorded alcohol will be able to describe main contributors to the rising alcohol per capita (APC) consumption and its corresponding

context. The existing high country APC (7.7), despite high level of abstinence is indicative of a small group of the population that is drinking to intoxication (WHO, 2014a). We need to assess the situation by exploring how HED is practiced and identify most vulnerable populations in order to know how best to intervene and eventually reduce alcohol attributable events. Tobacco smoking is a rare event in Tanzania, but there are no age restriction measures, and this puts the future generation at risk . Moreover, particularly damaging is dual practice of alcohol and tobacco use, since it significantly predisposes to the risk of several cancers (Canova *et al.*, 2010; Jin *et al.*, 2014; Lee and Hashibe, 2014; Singh *et al.*, 2015; Menvielle *et al.*, 2016). Majority of cancer cases in developed countries were reported to be attributed to combined effect of alcohol and tobacco (Pelucchi *et al.*, 2008).Knowing that both the alcohol (De Bruijn, 2011; D. H. Jernigan & Babor, 2015; David H Jernigan, Obot, & Jos, 2006; McCall, 2017; Obot, 2013) and tobacco (King et al., 2003) has launched sophisticated market strategy to hook unexplored markets of women and youth , public health counter measures need to start by understanding the current burden and practices.

Majority of Tanzanians (≈ 70%) reside in rural settings (TNBS, 2018), and hence manifestation of NCDs in these areas will be the same as manifestation of almost the whole population. It is hence important that rural areas are closely monitored and where possible protected from influx of lifestyle practices that predispose to the NCD burden. Exploration of lifestyle risk patterns in semi-rural areas is an indirect way of measuring the threat to surrounding rural areas. Semi urban areas are stop overs for people coming from rural as well as those coming from the urban, and hence these places present an important link for introducing new lifestyle practices from the urban to the rural. Semi–urban areas have been reported to be rising across the whole African region (Satterthwaite 2006). Ifakara town which is the site of this study is one such semi urban setting. It is a multi-ethnic setting and active economic zone with continuous in and out migration (MPEE 2007; TNBS 2018). The focus of this study is thus to examine the burden of NCD lifestyle risk factors and associated social determinants in different populations in Ifakara town. Ultimately this PhD study aims to

contribute evidence towards the National NCD efforts for advancing primary prevention of NCD including the NCD research agenda.

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Chapter Two

This chapter describes the objectives of the study

2.0 Objectives

2.1 General objectives

This PhD responds to the WHO call to generate evidence on NCD risk factors through surveillance as an effort to contain the growing NCD burden. Most recent public health milestone set at global level is the “25 x 25” risks which seeks to reduce 25% unhealthy lifestyle by the year 2025. The study aims to reveal the prevalence of the different unhealthy lifestyles, and to identify most vulnerable populations, as well as identify important socio-cultural and economic contexts.

2.1.1 Specific objectives

2.1.1.1 To explore FV patterns (including FV insufficiency, frequency of fruit intake, frequency of vegetable intake, portions of fruits consumed, portions of vegetables consumed) and association to socio-determinants (including gender, age, education, type of occupation, health seeking behavior) among different population groups of Southeastern Tanzania. Results are presented in chapter 4.

2.1.1.2 To explore the distribution of socio-demographic and lifestyle determinants of physical activity, with focus on gender differences in total and vigorous physical activity in an adult population of Tanzanian. Results are presented in chapter 5.

2.1.1.3 To examine patterns of HED and use of local brew and how it associates with gender, age, education and occupation in different population groups of Southeastern Tanzania. Results are presented in chapter 6.

Chapter Three

This chapter describes methods used to study NCD risky lifestyle practices

3.0 Methodology

Cross-sectional analyses using the MZIMA Adult Community cohort was used to answer research questions of this study. Each manuscript in the respective chapters (Chapter 4, 5 and 6) describes methods employed, with minimum information in line with journal requirements. Here, more information regarding study design, study population and participants' recruitment, participant interviewing, and data analysis is described.

3.1 Study design

The MZIMA Open Adult community cohort is lodged in to the Ifakara Urban Health and Demographic Surveillance System (IU-HDSS) since 2012 (Geubbels et al., 2015) The IU-HDSS is a longitudinal prospective database platform which collects information on demographic and vital events including birth outcome, death, changes in marital status changes as well as in and out migration details. The MZIMA research platform therefore adds to the information collected by IU-HDSS, by adding information on NCD burden, NCD lifestyle risk factors, social determinants and related health seeking behaviors (Abdul, Ramaiya, Mtenga, Mtowa, & Geubbels, 2014). Survey round 1 data collected in 2012 was used to generate responses for objectives 1 and 3, while data collected during round 2 in 2014 was used to generate responses for objective 2.

3.2 Study site, population and sample size

The MZIMA Open Adult Health Community Cohort is situated in Ifakara town. Ifakara is a small rural town situated in Kilombero district part of Morogoro region. It harbors the headquarters for the Kilombero district Administrative Office. Ifakara is home to four big academic and public health institutions as well as one non-governmental organization. These include: Ifakara Health Institute which is a leading public health research institute (IHI, 2016). The second is St Francis University College of Health and Allied Sciences, which offers doctor of medicine degree program (SFUCHAS, 2017). St Francis the designated district hospital is in the center of the area and main point of health care for the members of the

community (STFrancis, 2007). Ifakara also harbors the Tanzania Training Center for International Health (TTCIH, 2018). Maji Safi kwa Afya Bora (MSABI) is an NGO which works implementing cost effective water sanitation and hygiene mechanisms (MSABI, 2018).

The study site covers three areas; Ifakara Town, Mlabani and Viwanja Sitini located within a radius of 5 km of the town center. Community members in this study area are mainly farmers, traders and few professionals. Main religions in these communities is Catholic, Lutheran and Muslim, Indigenous tribes to Kilombero valley include the pogoro, ndamba, bena as well as immigrant tribes from all over the country. According the demographic surveillance round in 2010, the area is populated by a total of 20,429 aged 15 years and above.

Participants enrolled for the MZIMA cohort round 1 and round 2 constituted the study sample size for the respective sub studies (presented in Chapters 4, 5 and 6) within this whole study. Recruitment of round 1 and round 2 surveys were 8734 and 4274 participants respectively. This accounts for an approximate response rate of 43.7% for round 1 and 21.4% for round 2 from the whole Ifakara community.

The focus of this secondary analysis was on FV intake, physical activity, HED, use of local brew and tobacco smoking as well as associated social determinants. Since no data were available on which a reliable estimate of FV intake, insufficient PA, alcohol intake and tobacco smoking could be made at the time of the study design, we employed the rule of having at least 10 outcome events per covariate included in the multivariable model to prevent problems with bias, precision and significance (Peduzzi, Concato, Kemper, Holford, & Feinstein, 1996). A sample size of 7834 participants from round 1 was used to interview FV intake and alcohol habits. Moreover, a sample size of 4274 participants from round 2 was used to interview physical activity habits.

3.3 Participant recruitment and interviews

Participant recruitment was initiated by meetings with community leaders on the aims and process of the study including participants' rights and responsibility. Pamphlets, radio spots and sensitization drama, football matches, national celebration events and door-to-door visits were used to get the message the study across the community and need for volunteers as participants. Eligible participants were those ≥15yrs, who are willing and able to give informed consent. Participant who qualified also had to be resident in the study areas during the latest IU-HDSS round. A total of 8734 and 4274 participants were recruited from June 2012 to April 2013 and 2013 to 2014 for round 1 and 2 respectively. Round 1 MZIMA included 8734 participants aged ≥15 years and round 2 MZIMA included 4274 participants aged ≥15 years. All participants provided informed consent and were recruited from Mlabani and Viwanja Sitini areas of Ifakara town.

Interviews were conducted at participants' homes by trained interviewees using a structured questionnaire. The interview tool was translated from English into Swahili and back translated to English and was pilot tested. Interviewers used tablet personal computers programmed with the open source Open Data Kit [(Boriello, Schilit, Lerer, & Chin, 2008)]. Validation checks and skip patterns helped reduce faulty entries.

3.4 Tools and variables

Tools

Questions exploring FV intake, physical activity, alcohol use and tobacco smoking measures were adapted from the WHO STEPS tool for NCD surveillance (WHO, 2005a, 2005b)

FV intake - outcome variables

Outcome variables for assessing FV intake included: insufficient FV, frequency of fruit intake, frequency of vegetable intake, portions of fruits consumed, portions of vegetables consumed.

These outcome variables have been defined in Chapter 4. Questions explored patterns of fruit intake and vegetable intake in respect to frequency of consumption in the past 7 days and total number of standard portions consumed in any of these days (Tab 1).

Table 1: List of interview question assessing FV intake

Main question	**Follow on questions**
On how many days in a typical week do you eat fruits?	How many servings of fruits do you eat in one of those days?
On how many days in a typical week do you eat fruits?	How many servings of vegetables do you eat in one of those days?

Physical activity – outcome variables

Outcome variables for assessing physical activity were based on WHO cut offs and included: insufficient PA, low moderate physical activity (MPA) and low vigorous physical activity (VPA). These outcome variables have been defined in Chapter 5. Question explored time spent on vigorous work related activities, time spent on moderate work related activities, time spent on travel related activities, time spent on travel related activities, time spent on leisure activities and time spent on leisure activities (Tab 2).

Table 2: List of interview question assessing physical activity

Main question	**Follow on questions**
Does your work involve moderate – intensity activities like fishing, herding animals, driving?	In a typical week how many days do you do moderate-intensity work?
	How many hours do you spend doing moderate-intensity work in one of those days
	How many minutes do you spend doing moderate-intensity work in one of those days?
Does your work involve vigorous – intensity	In a typical week how many days do you do

activities like land tilling, harvesting, rice planting, carpentry?	vigorous-intensity work?
	How many hours do you spend doing vigorous-intensity work in one of those days
	How many minutes do you spend doing vigorous-intensity work in one of those days
Do you walk or use bicycle at least 10 minutes continuously?	In a typical week how many days do you walk or use bicycle at least 10 minutes continuously?
	How many hours do you spend walking or using bicycle at least 10 minutes continuously in one of those days
	How many minutes do you spend walking or using bicycle at least 10 minutes continuously in one of those days
Does you do moderate – intensity exercise like brisk walking, netball, volleyball?	In a typical week how many days do you do moderate-intensity exercise?
	How many hours do you spend doing moderate-intensity exercise in one of those days
	How many minutes do you spend doing moderate-intensity exercise in one of those days
Does you do vigorous – intensity exercise like football. Swimming, basketball, running?	In a typical week how many days do you do vigorous-intensity exercise?
	How many hours do you spend doing vigorous-intensity exercise in one of those days
	How many minutes do you spend doing vigorous-intensity exercise in one of those days

Harmful alcohol use – outcome variables

Outcome variables to explore harmful alcohol use included: HED, use of local brew, HED on local brew, frequency of alcohol use among binge drinkers. These outcome variables have been defined in Chapter 6. Adapted questions were used to examine the total number of

current drinkers, frequency of alcohol use, HED and use of local brew as well as frequency proportion for HED on local brew among drinkers (Tab 3).

Table 3: List of interview question assessing alcohol use

Main question
Have you ever consumed an alcoholic drink such as beer, wine, spirit and fermented cidar or (other local examples)
Have you consumed and alcoholic drink in the past 12 months?
Have you consumed and alcoholic drink in the past 30 days?
During the past 30 days on how many occasions did you have at least one alcoholic drink?
During the past 30 days when you drank alcohol on average how many standard alcoholic drinks did you have during one drinking occasion?
During the past 30 days what was the largest number of standard alcoholic drinks you had on a single occasion, counting all types of alcoholic drinks together. During the past 30 days did
you have: (For men)- 5 or more standard alcoholic drinks in a single drinking occasion (For women- 4 or more standard alcoholic drinks in a single drinking occasion

Questions adapted to assess smoking explored ever smoker which is not having used tobacco in a lifetime; never smoker which is not having used tobacco for 12 months or more; current smoker which is having used tobacco in the past 30 days and daily smoker; which is using tobacco every day (Tab 4).

Table 4: List of interview question assessing tobacco smoking

Questions
Do you currently smoke any tobacco products?
Do you currently smoke tobacco products daily?

Exposure variables

Participants responded to questions which assessed the socio-demographic profile to represent exposure variables. These include age, gender, education, marital status, religion, ethnic affiliation, migration status, occupation. These variables were adapted from “Analyzing Longitudinal Population-based HIV/AIDS data for Africa” (ALPHA) studies (LSHTM, 2005).

Age was categorized as “below 25 years”, “25 – below 50 years”, “50-below 60 years” and “60 years and above”. Sex was categorized into “male” and “female”. Education categorize included “no formal education”, “primary education”, “secondary education” and “tertiary education”. Occupation status was deduced by “yes/no” to status of having or not having an income generation activity. Specific categories for those with occupations were as follows: farming, fishing and livestock keeping; owning a small business; owning a large business; professionals (white collar jobs); skilled manual labors (including drivers, carpenters, etc.); and unskilled manual labors (including menial jobs). Religion was categorized into “Muslim”, “Catholic”, “Lutheran” and “Others”. Ethnicity of participants was categorized as follows: “Morogoro”, “Iringa”, “Shinyanga/Mwanza/Tabora”, “Kilimanjaro/Arusha", “Ruvuma”, “Coast”, “Mbeya” and “Others”.

3.5 Data analysis

In order to minimize bias error, fruit and vegetable cards were used first to help participants remember whether they consumed any of the fruits and vegetables displayed to them of similar ones. Second the cards aided estimation of number of standard portions consumed in any of the past 7 days. Similarly, different food serving utensils were used to help establish how many standard portions of vegetables were consumed. The average number of standard portions of fruit or vegetable consumed was computed from the formula below.

X = (D * P)/7 days

Key

X = Average # of standard portions fruit/vegetables consumed in past 7 days
D = # of days fruits/vegetables consumed in past 7 days
P = # of standard portions fruits/vegetables consumed in past 7 days

Total FV intake was the sum between average standard portions of fruit consumed and portions of vegetables consumed.

Physical activity was deduced by calculating the daily total number of minutes spent on moderate intense physical activity and vigorous intense physical activity, and this was referred as total MVPA. Moderate intense activities included work related activities that did not make one sweat or/and breath fast after 10 minutes of continuous activity. So, this included all professional occupations, driving, large business owners. It also included purposeful and leisure walking and cycling. Vigorous intense activities included work related activities that did make one sweat or/and breath fast after 10 minutes of continuous activity. Such included farming, harvesting, manual labor both skilled and unskilled. Insufficient physical activity was the proportion of the population that did not meet the minimum recommended total weekly MVPA of 75 min vigorous intense activity or 150 min moderate intense activity or a combination of both, and is represented by the formula below:

MVPA = (MW + 2VW + T + ML + 2VL)/7days

Key
Total weekly MVPA
MW= Total moderate intense work related activity (days * minutes)
VW= Total vigorous intense work related activity (days * minutes)
T= Total travel (purposeful walking/cycling) related activity (days * minutes)
ML= Total moderate intense leisure related activity (days * minutes)
VL= Total vigorous intense leisure related activity (days * minutes)

HED was defined by 4 or more standard drinks in one drinking session in women current drinkers and 5 or more standard drinks in one drinking session in men current drinkers

STATA version 12 was used for the analysis. Outcome variables were binge drinking and type of alcoholic drinks consumed. Outcome variables were described by socio-demographic variables including age, education level, marital status, type of occupation, religion, ethnicity, and migration status using frequency percentages. Exposure variables of interest in multivariable analysis were the social determinants: education, work, type of occupation, migration status and ethnicity. Lifestyle factors (smoking, care use) were also analyzed for association with HED and local brew use. Separate logistic regression models assessed the associations with outcome variables “local brew use” and “binge drinking on local brew”. For the association analysis of local brew use the complement was commercial brew. For the association analysis of binge drinking on local brew, the complement was binge drinking on commercial alcohol. Since men and women consume alcohol differently, hence descriptive and multivariable analyses were separated by gender. A significance level of 0.05 was assumed.

3.7 Ethics Consideration

Both the Ifakara Health Institute Institutional Review Board and National Institute for Medical Research reviewed and approved this study. All interviewers were trained in basic health research ethics. Confidentiality of participant identity was ensured by use of encrypted ID codes and proper storage of data and personal information.

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Chapter Four

4.0 Article: Insufficient Fruit and Vegetable Intake in a Low - and Middle -Income Setting: A Population-Based Survey in Semi-Urban Tanzania

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Article

Insufficient Fruit and Vegetable Intake in a Low- and Middle-Income Setting: A Population-Based Survey in Semi-Urban Tanzania

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Abstract: A daily intake of 5 portions of fruit and vegetables (FV) is recommended for protection against non-communicable diseases (NCDs). Inadequate FV intake is a global problem but resource-poor countries like Tanzania are most deprived and constitute settings where little is known for informing public health interventions. This study aimed to describe the prevalence of inadequate FV intake, frequency of FV intake, portions of FV intake and their associations with socio-demographic/lifestyle factors in South-Eastern Tanzania. Data on FV dietary indicators, socio-demographic factors, smoking, alcohol and healthcare use were collected from 7953 participants (≥15 years) of the population-based MZIMA open community cohort (2012–2013). Multivariable logistic regression was used to examine associations between FV intake outcomes and their socio-demographic/lifestyle determinants. Most (82%) of the participants did not meet the recommended daily FV intake While only a fraction consumed fruits daily (15.5%), almost half consumed vegetables daily (44.2%). However, the median (IQR) number of vegetable portions consumed was lower (2(1)/person/day) than that for fruits (2(2)/person/day) People with higher education were more likely to consume fruits daily. Independent correlates of inadequate FV intake included young age, being male, low education, low-income occupations, low alcohol, high tobacco and low healthcare use. Public health interventions should target the socio-economically deprived and culturally-rooted preferences while prioritizing promotion of vegetable for most immediate gain in overall FV intake.

Keywords: fruit and vegetables; education; occupation; healthcare use; Ifakara; Tanzania

1. Introduction

A daily intake of fruits and vegetables (FV) is recommended for protection against almost all major non-communicable diseases (NCDs) [1–4]. FV have vitamins, minerals and fiber which either singly or synergistically protects against NCDs as well as communicable diseases [4,5]. Antioxidants found in

FV can prevent the action of carcinogens by inhibiting oxidative DNA damage [6]. Furthermore, vitamins B12, B6 as well as B9 help reduce levels of homocysteine and risk of cardiovascular diseases (CVDs) [7,8]. Many FV are also rich in potassium which helps modulate blood pressure [9,10]. Maximum benefits from FV could be attained by daily consumption of five portions (400 g) [11,12].

Despite promising benefits from FV consumption, more than 75% of the global population do not consume sufficient FV [13] and according to the most recent estimate, this accounted for 2.9% of all lives lost in 2009 [14]. A STEPwise approach to surveillance (STEPS) survey conducted in 2012 showed that almost all Tanzanians (>95%) consumed insufficient FV [15]. Similar findings were found in neighboring Malawi [16], Zambia [17], Mozambique [18] and Botswana [19]. The STEPS survey findings provide useful information on the scale of the problem but do not allow better characterization of FV intake and susceptibility factors to inadequate FV consumption. Depending on the context, inadequate FV intake may be attributed more to lower fruit intake [20,21], or lower vegetable intake [22]. Hence, it was recently suggested that studies on FV consumption should consider fruits separately from vegetables given that separate interventions may be needed [18,23,24]. According to the literature, most African countries do not have food-based dietary guidelines and the few countries with food based dietary guidelines are not explicit on how much FV should be consumed [25–29]. This is noteworthy because people can only act in favor of good health if they are aware, are convinced and know how to act [30,31]. In Tanzania, the Ministry of Health and Social Welfare promotes two important elements of FV intake, first is daily consumption and second is consumption in high quantities. Shortage of detailed evidence on FV consumption practices hampers targeted responses at policy and health system levels to promote FV consumption [32].

Socio-demographic determinants are important in shaping FV intake patterns [33,34]. Education and wealth, as indicators of socio-economic status (SES) are related to FV intake [13,35]. Education exposes people to necessary health information [36] and builds capacity for comprehension of existing recommendations [31,37–39], both of which could be limiting factors when absent [23]. People with more education can secure higher paying jobs which may help address issues of "affordability," a critical barrier in most developing countries [18,21,40]. Variations in the social, cultural and structural environment of different occupations may also pose different constraints to FV consumption. Lifestyle factors like alcohol consumption and smoking may also in principle affect FV intake where an increased intake may be a compensatory behavior to heavy drinking or smoking [41]. Although this has been explored by Western studies with other lifestyle factors [42,43], evidence from an African population is limited. Although the use of health services may also influence lifestyle choices and vice versa partly through preventive counseling [44], there is limited evidence on how healthcare use influences FV intake.

Evidence on the importance of socio-demographic determinants in FV consumption may help guide public health responses that are population-specific. In this study, we aimed to describe the patterns of FV consumption and explored how these patterns associate with socio-demographic and lifestyle factors in southeastern Tanzania, using data from the MZIMA open community cohort.

2. Materials and Methods

2.1. Study Design and Participants

The MZIMA open community cohort is lodged within the Ifakara Urban Health and Demographic Surveillance System (IU-HDSS) [45]. The IU-HDSS is a longitudinal database that collects information on demographic and vital events including births, deaths and migration. The MZIMA cohort was created in 2012 to study among others, changes in NCD burden and their determinants over time [46]. Information collected in the cohort includes socio-demographic characteristics, NCD risk factors such as FV consumption, smoking, alcohol habits as well as health care use.

Community sensitization activities were conducted and these included meetings with community leaders, pamphlets, radio spots, sensitization at community events. Door-to-door visits,

following prior notification by the ten-cell leader, the lowest level of local administration, were conducted. Eligible participants were ≥ 15 years, willing and able to give informed consent and resident in the study areas during the latest IU-HDSS round. In the first study round, a total of 8734 participants were recruited from June 2012 to April 2013 from two areas of the IU-HDSS (Mlabani and Viwanja Sitini). Community members in the study area are a mix of indigenous inhabitants and migrants. Both Mlabani and Viwanja Sitini are parts of Ifakara ward, situated in Morogoro Region, southeast Tanzania.

2.2. Data Collection

Interviews were conducted at participants' homes between June 2012 and August 2013 by trained interviewees using a structured questionnaire. The interview tool was translated from English into Swahili and back translated to English and was piloted. Interviewers used tablet personal computers programmed with the open-source Open Data Kit [47]. Automated validation and skip patterns were programmed to minimize faulty data entries. Interviewers also kept field diaries for problems that occurred during data collection. These sheets were reviewed by the supervisor, who made suggestions for improvement, at the end of each day.

Classification of FV consumption.

Participants were asked questions on their intake of fruits and intake of vegetables using questions from the WHO STEPS survey tool for NCD risk factors [48]. Questions covered frequency of consumption in a typical week and number of standard portions on days of consumption. A standard portion equals 80 g. Medium size fruits like an orange, an apple, a banana, a pear counted for one portion. Other fruits like half an avocado, half a large mango also formed one standard portion. A typically very large watermelon accounted for 16 portions. One small glass (150 mls) of 100% fruit juice was equal to one portion of fruit. Three heaped tablespoons (~30 g per heaped spoon) of cooked vegetables were equal to one portion. Sometimes people used small bowls for relish, which was equivalent to two standard portions if it were cooked vegetables, or one standard portion if it were fresh salad. Interviewers used picture cards with common fruits and vegetables found in the study setting. The picture cards were used to help participants recall on FV intake in the past week but also to help them minimize errors in estimation of standard portions consumed. In order to get the average daily portions of fruits and portions of vegetables, we multiplied the number of days of consumption and the number of portions consumed in a typical day and divided by seven. Participants who reportedly consumed fruits or vegetables every day in a typical week were classified as having "daily fruit intake" or "daily vegetables intake," respectively. People who consumed fruits or vegetables on a less than daily basis were categorized as "no daily fruit intake" or "no daily vegetable intake," respectively. Those without fruit or vegetable intake in a usual week were classified as "no fruit intake" or "no vegetable intake," respectively. Participants who ate less than 5 portions of fruits and/or vegetables per day were categorized as having inadequate FV intake.

2.3. Covariate Information

Participants were interviewed for their age (years), sex (male/female), marital status (single/monogamous/polygamous/widowed/separated), migration status (migrant/non-migrant), regions of ethnic affiliation (Morogoro/Iringa/Shinyanga/Kilimanjaro/Ruvuma/Coast/Mbeya/Others) and religion (Muslim/Catholic/Lutheran/Others) as previously described [46]. Participants were also asked about their educational attainment and occupation. Educational level was categorized as: no formal education; primary education (up to 7 years of formal education); secondary education (7–13 years of formal education); and tertiary education (>13 years of formal education) [46]. Phrasing for social determinants listed above was adapted from standard questions used in Analyzing Longitudinal Population-based HIV/AIDS data for Africa (ALPHA) network [49].

Occupational status was categorized as follows: "unemployed "being those who have no income generating activity; farming, fishing and livestock keeping; owning a small business (employing < 5 persons); owning a large business (employing ≥ 5 persons); professionals (white collar jobs); skilled manual labors (including drivers, carpenters, etc.); and unskilled manual labors (including menial jobs). Participants were also asked if they smoked or consumed alcohol in the past 12 months [48]. Smoking status was categorized into never, former and current smokers while alcohol use was categorized into daily and not daily, for exploratory purposes, based on the available data. Information on frequency of healthcare visits (hospital, dispensary or home-based care worker) in the past 12 months was also collected and categorized into none, one, two, three, four, five and six or more visits, which allowed for investigating dose-response relationship with FV intake. Participants were also asked if they have been diagnosed with diabetes or hypertension, or any cardiovascular disease in order to derive NCD variable, assigning yes to the presence of any of the three diseases and no to the absence of all three.

2.4. Statistical Analyses

We described the study population stratified by sex. We tabulated the FV intake according to socio demographic characteristics and healthcare use. Using three outcome variables- "less than daily fruit intake versus daily fruit intake," "less than daily vegetable intake versus daily vegetable intake" and "inadequate FV intake versus adequate FV intake," we applied logistic regression to explore the independent association of these outcome variables with sex, age group, marital status, educational level, occupation, ethnicity, religion and migration status, using mutually-adjusted models. In a further step using the adjusted socio-demographic model, we explored associations of FV intake with lifestyle characteristics and healthcare use habits. Data analyses excluded participants with missing data as well as those with doctor-diagnosed hypertension, diabetes or cardiovascular diseases (Figure 1). The intention for NCD exclusion was to capture trends of FV intake in apparently healthy individuals, towards prevention. All statistical analyses were done using STATA Version 14 (STATA Corporation, Texas). Associations between these outcome variables and socio-demographic and lifestyle determinants are presented as odds ratios (OR) and their 95% confidence intervals. Associations were considered significant at p value < 0.05.

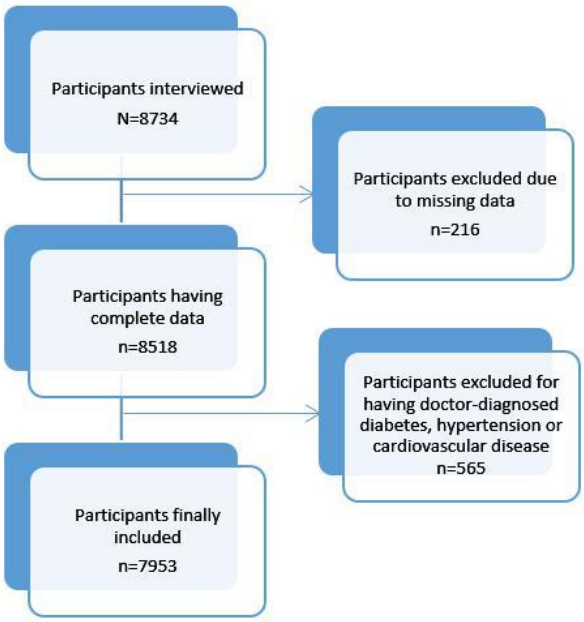

Figure 1. Participant selection flow chart.

2.5. Ethics Consideration

The MZIMA open community cohort was approved by the Ifakara Health Institute Institutional Review Board and the National Institute for Medical Research with reference numbers IHI/IRB/AM/01-2014 and NIMR/HQ/R.8a1Vol. IX/I320 respectively. All participants provided informed written consent to participate in the study. Confidentiality of participants' identity was ensured by use of encrypted identification codes and proper storage of personal information.

3. Results

3.1. Population Description

Out of 8734 (≥15 years) enrolled, 8518 had complete information and 565 participants with confirmed NCDs were excluded bringing the total number of participants for the present analyses to 7953 (Figure 1). Women comprised 64.3% of the study population. Participants below 18 years comprised 27% of those below 25 years and 10% of the entire study population. More than half (55.2%) of the participants were educated at primary level and more women than men had not received any formal education. More than half of all participants were engaged in an income-generating activity (59.8%) and were mainly farmers (25.4%). Major ethnic groups included Morogoro, Iringa and Ruvuma. Alcohol consumption and smoking rates were generally low. (Table 1).

Table 1. Description of the study population.

Variables	Groups	All % (*N*)	Males % (*N*)	Females % (*N*)	Chi- Squared Test
All participants		100 (7953)	35.7(2839)	64.3(5114)	N/A
Age	Below 25 years	39.1 (3111)	36.2(1027)	40.8(2084)	<0.001
	25–50 years	45.1 (3588)	45.1(1292)	44.9(2296)	
	50–60 years	6.7 (535)	7.3(206)	6.4(329)	
	60 and above	9.0 (719)	11.1 (314)	7.9(405)	
Education	No Formal Education	14.1 (1118)	9.1(258)	16.8 (860)	<0.001

	Primary Education	55.2 (4387)	53.0 (1505)	56.4 (2882)	
	Secondary Education	27.5 (2186)	32.9 (935)	24.5 (1251)	
	Tertiary Education	3.3 (262)	5.0 (141)	2.4 (121)	
Marriage	Never married	38.8 (3088)	46.6 (1324)	34.5 (1764)	<0.001
	Monogamous	47.4 (3770)	44.7 (1268)	48.9 (2502)	
	Polygamous	1.2 (94)	1.1 (30)	1.3 (64)	
	Widowed	5.8 (461)	2.4 (68)	7.7 (393)	
	Separated	6.8 (540)	5.3 (149)	7.7 (391)	
Work status	Working	59.8 (4754)	72.1 (2047)	52.9 (2707)	<0.001
	Not working	40.2 (3199)	27.9 (792)	47.1 (2407)	
Occupation	Farming, Fishing, Livestock keeping	25.4 (2017)	26.9 (763)	24.5 (1254)	<0.001
	Small business	15.4 (1221)	14.8 (421)	15.6 (800)	
	Large business	1.2 (95)	2.3 (66)	0.6 (29)	
	Professionals	4.7 (367)	6.5 (183)	3.6 (184)	
	Skilled manual labor	7.9 (625)	12.4 (352)	5.3 (273)	
	Unskilled manual labor	5.4 (429)	9.2 (262)	3.3 (167)	

	Not working	40.2 (3199)	27.9 (792)	47.1 (2407)	
Religion	Muslim	37.1 (2952)	38.2 (1085)	36.5 (1867)	0.258
	Catholic	54.3 (4317)	53.6 (1521)	54.7 (2796)	
	Lutheran	1.9 (147)	1.6 (44)	2.0 (103)	
	Other beliefs	6.8 (537)	6.7 (189)	6.8 (348)	
Migration	Non-migrant	41.5 (3301)	40.4 (1146)	42.1 (2155)	0.124
	Migrant	58.5 (4652)	59.6 (1693)	57.9 (2959)	
Ethnicity	Mbeya region	1.6 (127)	1.4 (41)	1.7 (86)	<0.001
	Kilimanjaro and Arusha region	3.3 (265)	4.1 (115)	2.9 (150)	
	Coast region	6.2 (491)	6.2 (177)	6.1 (314)	
	Shinyanga/Mwanza/Tabora regions	6.9 (545)	8.2 (234)	6.1 (311)	
	Iringa region	11.4 (904)	10.6 (302)	11.8 (602)	
	Ruvuma region	14.8 (1179)	14.2 (403)	15.2 (776)	
	Other regions	12.8 (1020)	14.7 (418)	11.8 (602)	
	Morogoro region	43.0 (3422)	40.5 (1147)	44.5 (2273)	
Alcohol	Not daily	97.6 (7764)	96.7 (2746)	98.1 (5018)	<0.001

	Daily	2.4 (189)	3.3 (93)	1.9 (96)	
Smoking	Never smoker	89.7 (7131)	76.4 (2169)	97.0(4962)	<0.001
	Former smoker	3.1 (245)	6.5 (183)	1.2 (62)	
	Current smoker	7.3 (577)	17.2 (487)	1.8 (90)	
Healthcare use	No visit	40.0 (3180)	45.5 (1291)	36.9(1889)	<0.001
	One visit	20.7 (1643)	21.3 (604)	20.3(1039)	
	Two visits	12.6 (1004)	11.6 (328)	13.2 (676)	
	Three visits	11.8 (935)	10.7 (305)	12.3 (630)	
	Four visits	7.4 (590)	5.5 (157)	8.5(433)	
	Five visits	2.7 (214)	2.3 (64)	2.9(150)	
	Six visits and more	4.9 (387)	3.2 (90)	5.8(297)	

N/A: not applicable. The chi-squared test compares proportions between males and females.

3.2. Patterns of FV Consumption

Inadequate FV consumption was observed in 82% of the study population (Table 2), i.e. the prevalence of not meeting the recommendation for daily eating of fruits or vegetables. Fruits tended to be consumed less frequently than vegetables. However, median vegetable portions were smaller than median portions of fruits (Table 2). Inadequate FV consumption appeared less prevalent as people became more educated, as well as in people who have higher-earning occupations. Inadequate FV consumption also tended to decrease with increasing use of healthcare services (Table 2).

Almost the entire study population consumed at least some vegetables (98.5%) in the seven days preceding the interview. Vegetable consumption revealed two main patterns; “Daily vegetable intake” (44.2%) and “No daily vegetable intake” (54.3%). Median (IQR) vegetable portions consumed per day per person was 2 (1) portions. Older participants tended to have higher number of standard vegetable portions than younger people. The frequency of daily vegetable intake

appeared to be lowest among least educated, unskilled and skilled laborers. Participants with more frequent use of healthcare also tended to have higher proportion of daily vegetable consumption when compared to those with less frequent health care use (Table 2).

The median (IQR) fruit portions consumed per day per person was 2 (2) portions. For fruits, three patterns emerged "Daily fruit intake" (15.5%), "No daily fruit intake" (71.7%) and "No fruit intake" (12.7%). Younger participants appeared to consume more fruits daily (16.1%) compared to older participants (8.1%). The oldest age group had the lowest median (IQR) fruit portions (1 (1) portions). Figure 2 shows that participants tended to consume more FV with higher educational level, irrespective of gender.

Table 2. Frequency and Patterns of Fruit and Vegetable Intake in the MZIMA Cohort, *N* = 7953.

Variable	Groups	Daily Fruit Intake [a] % (*N*)	No Daily Fruit Intake [b] % (*N*)	No Fruit Intake [c] % (*N*)	Daily Fruit Portions (Median (IQR))	Daily Vegetable Intake [a] % (*N*)	No Daily Vegetable Intake [b] % (*N*)	No Vegetable Intake [c] % (*N*)	Daily Vegetable Portions (Median (IQR))	Inadequate FV Intake [d] (%)	Chi Squared Test
All	N/A	15.4 (1227)	72.1 (5734)	12.5 (992)	2 (2)	44.2 (3516)	54.3 (4318)	1.5 (119)	2 (1)	82	N/A
Sex	Male	15.6 (440)	72.7 (2064)	11.8 (335)	2 (2)	34.7 (985)	62.8 (1782)	2.5 (72)	1 (1)	83	0.269
	Female	15.4 (787)	71.8 (3670)	12.9 (657)	2 (2)	49.5 (2531)	49.6 (2536)	0.9 (47)	2 (1)	82	
Age	Below 25	16.1 (502)	72.5 (2254)	11.4 (355)	2 (2)	36.1 (1124)	62.1 (1932)	1.8 (55)	1 (1)	84	<0.001
	25–50	15.9 (572)	72.6 (2603)	11.5 (413)	2 (2)	46.4 (1665)	52.1 (1872)	1.4 (51)	2 (1)	82	
	50–60	17.8 (95)	65.6 (351)	16.6 (89)	2 (2)	55.2 (397)	43.7 (314)	0.9 (5)	2 (1)	76	
	Above 60	8.1 (58)	73.2 (526)	18.8 (135)	1 (1)	55.2 (397)	43.7 (314)	1.1 (8)	2 (1)	84	
Education	No Education	7.3 (81)	71.1 (795)	21.7 (242)	1 (1)	51.3 (573)	47.1 (527)	1.6 (18)	2 (1)	86	0.002
	Primary	14.4 (631)	73.7 (3231)	12.0 (525)	2 (2)	45.5 (1996)	53.3 (2336)	1.3 (55)	2 (1)	82	
	Secondary	20.2 (441)	70.3 (1537)	9.5 (208)	2 (2)	38.1 (883)	60.0 (1312)	1.9 (41)	1 (1)	82	
	Tertiary	28.2 (74)	65.3 (171)	6.5 (17)	2 (2)	43.5 (114)	54.6 (143)	1.9 (5)	1 (1)	77	
Marital status	Never married	15.7 (485)	72.6 (2243)	11.7 (360)	2 (2)	36.2 (1117)	61.7 (1904)	2.2 (67)	1 (1)	84	0.001
	Monogamous	16.3 (627)	72.1 (2718)	11.3 (425)	2 (2)	47.6 (1796)	51.4 (1937)	1.0 (37)	2 (1)	81	
	Polygamous	14.9 (14)	69.2 (65)	16.0 (15)	2 (2)	55.3 (52)	43.6 (41)	1.1 (1)	2 (1)	79	
	Widowed	8.0 (37)	69.2 (319)	22.8 (105)	1 (1)	59.4 (274)	39.3 (181)	1.3 (6)	2 (1)	84	

	Divorced	11.9 (64)	72.0 (389)	16.1 (87)	1 (2)	51.3 (277)	47.2 (255)	1.5 (8)	2 (1)	85	
Work status	Working	16.4 (780)	71.8 (3415)	11.8 (559)	2 (2)	47.4 (2252)	51.3 (2437)	1.4 (65)	2 (1)	80	<0.001
	Not working	14.0 (447)	72.5 (2319)	13.5 (433)	2 (2)	39.5 (1264)	58.8 (1881)	1.7 (54)	2 (1)	85	
Occupation	Farming, Fishing, Livestock	12.0 (241)	75.8 (1528)	12.3 (248)	2 (2)	53.1 (1070)	46.0 (928)	0.9 (19)	2 (1)	82	<0.001
	Small business	18.0 (221)	71.7 (876)	10.2 (124)	2 (2)	45.5 (556)	53.2 (649)	1.3 (16)	2 (1)	79	
	Large business	30.5 (29)	62.1 (59)	7.4 (7)	2 (3)	47.4 (45)	49.5 (47)	3.2 (3)	1 (1)	71	
	Professionals	28.6 (105)	64.0 (235)	7.4 (27)	2 (3)	47.7 (175)	52.0 (191)	0.3 (1)	1 (1)	73	
	Skilled manual labor	20.4 (129)	66.9 (418)	12.5 (78)	2 (2)	40.0 (250)	58.7 (367)	1.3 (8)	2 (1)	80	
	Unskilled manual labor	12.8 (55)	66.7 (299)	17.5 (7)	2 (2)	36.4 (156)	59.4 (255)	4.2 (18)	2 (1)	87	
	Not working	14.0 (447)	72.5 (2319)	13.5 (433)	2 (2)	39.5 (1264)	58.8 (1881)	1.7 (54)	2 (1)	85	
Religion	Muslim	15.6 (459)	71.8 (2119)	12.7 (374)	2 (2)	44.7 (1319)	53.6 (1582)	1.7 (51)	2 (1)	82	0.934
	Catholic	14.9 (641)	72.8 (3141)	12.4 (535)	2 (2)	44.5 (1922)	54.3 (2345)	1.2 (50)	1 (1)	83	
	Lutheran	24.5 (36)	60.5 (89)	15.0 (22)	2 (2)	49.0 (72)	50.3 (74)	0.7 (1)	1 (1)	84	
	Others	17.0 (91)	71.7 (385)	11.4 (61)	2 (2)	37.8 (203)	59.0 (317)	3.2 (17)	1 (1)	83	
Migration	Non-migrants	16.0 (527)	71.4 (2357)	12.6 (417)	2 (2)	44.8 (1478)	54.2 (1788)	1.1 (35)	2 (1)	82	0.151
	Migrants	15.0 (700)	72.6 (3377)	12.4 (575)	2 (2)	43.8 (2038)	54.4 (2530)	1.8 (84)	2 (1)	83	
Ethnicity	Morogoro region	14.2 (485)	72.2 (2471)	13.6 (466)	2 (2)	48.6 (1664)	50.4 (1723)	1 (35)	2 (1)	82	0.140
	Iringa region	14.6 (132)	73.8 (667)	11.6 (105)	2 (2)	41.0 (371)	58.2 (526)	0.7 (7)	1 (1)	83	
	Shinyanga/Mwanza/Tabora	13.9 (76)	76.2 (415)	9.9 (54)	2 (2)	30.8 (168)	65.5 (357)	3.7 (20)	2 (1)	85	
	Kilimanjaro/Arusha region	24.2 (64)	67.6 (179)	8.3 (22)	2 (3)	37.4 (99)	60.4 (160)	2.3 (6)	2 (1)	78	

	Ruvuma region	15.4 (181)	72.2 (851)	12.5 (147)	2 (2)	45.3 (534)	53.7 (633)	1 (12)	1 (1)	81	
	Coast region	14.0 (71)	70.9 (348)	14.7 (72)	2 (2)	45.4 (223)	52.6 (258)	2.0 (10)	2 (1)	84	
	Mbeya region	17.3 (22)	74.8 (95)	7.9 (10)	2 (2)	32.3 (41)	66.1 (84)	1.6 (2)	2 (1)	87	
	Other regions	19.2 (196)	69.4 (708)	11.4 (116)	2 (2)	40.8 (416)	56.8 (577)	2.7 (27)	1 (1)	83	
Alcohol use	Not Daily	15.3 (1187)	72.3 (5615)	12.4 (962)	2 (2)	43.9 (3409)	54.6 (4239)	1.5 (116)	2 (1)	83	<0.001
	Daily	21.2 (40)	63.0 (119)	15.9 (30)	2 (3)	56.6 (107)	41.8 (79)	1.6 (3)	2 (1)	72	
Smoking	Never	15.7 (1119)	72.5 (5167)	11.9 (845)	2 (2)	44.4 (3164)	54.3 (3870)	1.4 (97)	1 (1)	82	
	Former	12.2 (30)	71.8 (176)	15.9 (39)	2 (2)	46.9 (115)	49.0 (120)	4.1 (10)	2 (1)	81	0.630
	Current	13.5 (78)	67.8 (391)	18.7 (108)	2 (2)	41.1 (237)	56.9 (328)	2.1 (12)	2 (1)	84	
Healthcare use	No visits	12.8 (407)	73.0 (2322)	14.2 (451)	2 (2)	38.0 (1208)	60.4 (1919)	1.7 (53)	2 (1)	85	
	One visit	16 (259)	72.4 (1190)	11.8 (194)	2 (2)	44.2 (726)	54.2 (890)	1.6 (27)	2 (1)	84	
	Two visits	16.4 (165)	71.1 (714)	12.5 (125)	2 (2)	47.7 (479)	51.1 (513)	1.2 (12)	1 (1)	82	
	Three visits	16.7 (156)	73.2 (684)	10.2 (95)	2 (2)	48.3 (452)	50.7 (474)	1.0 (9)	2 (1)	83	<0.001
	Four visits	18.0 (106)	73.2 (432)	8.8 (52)	2 (2)	50.7 (299)	48.0 (283)	1.4 (8)	1 (1)	79	
	Five visits	19.2 (41)	65.4 (140)	15.4 (33)	2 (3)	53.7 (115)	44.9 (96)	1.4 (3)	1 (1)	72	
	Six visits and more	24.0 (93)	65.1 (252)	10.6 (42)	2 (3)	61.2 (237)	37.0 (143)	1.8 (7)	1 (1)	69	

IQR: interquartile range. N/A: not applicable. The chi-squared test refers to the comparison of inadequate FV intake across categories of socio-demographic and lifestyle variables; [a] Participants who reported daily consumption; [b] Participants who reported consumption on a less than daily basis; [c] Participants who reported no consumption; [d] Participants who reported consumption of less than 5 portions of fruits and/or vegetables per day.

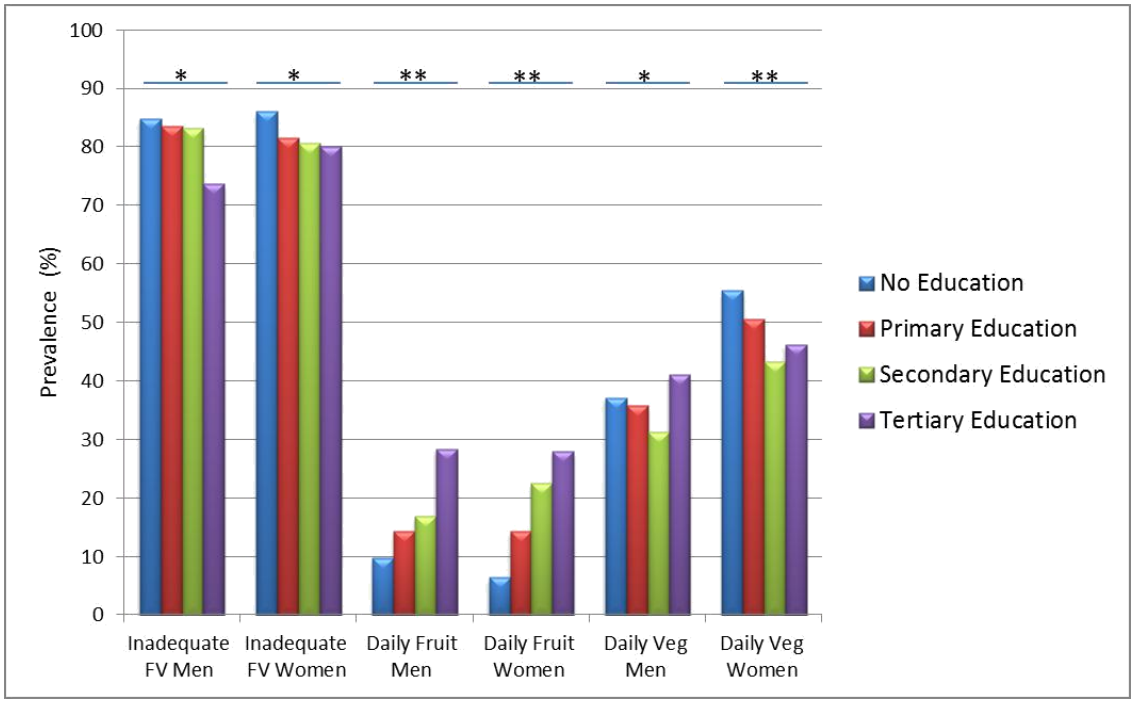

Figure 2. Prevalence of daily fruit, daily vegetable and inadequate fruits and vegetables (FV) intake among men and women in different education categories (N = 7953). * Significant differences in fruit or vegetable intake across different educational levels ($p < 0.05$); ** Significant differences in fruit or vegetable intake across different educational levels ($p < 0.0001$).

3.3. Independent Association of FV Intake with Socio-demographic Characteristics

. Women were at a lesser risk for less than daily fruit (OR = 0.84, 95% CI: 0.73, 0.96) and vegetable intake (OR = 0.51, 95% CI: 0.46, 0.56) as well as inadequate FV (OR = 0.82, 95% CI: 0.72, 0.93) compared to men (Table 3). There was a strong association between the risk of less than daily vegetable intake and age. Older participants were less likely to have less than daily vegetable intake with OR of 0.54 (95% CI: 0.43, 0.67) for the oldest age group compared to the youngest age group. Lower education was significantly associated with less than daily fruit intake but not vegetable intake. Odds of less than daily fruit intake decreased in those with primary education (OR = 0.55, 95% CI: 0.43, 0.70) and those with secondary education (OR = 0.27, 95% CI: 0.18, 0.40) compared to those without any formal education. Employment and occupation were important in the overall risk of inadequate FV intake. Those with higher earning occupations like small (OR = 0.83, 95% CI: 0.69, 1.00), large business owners (OR = 0.50, 95% CI: 0.32, 0.83) and professionals (OR = 0.66, 95% CI: 0.50, 0.86) were less likely to have inadequate FV intake compared to farmers. Migrants were at higher risk of less than daily fruit consumption as well as overall inadequate FV intake compared to non-migrants. Also, ethnic groups from Iringa (OR = 1.31, 95% CI: 1.12, 1.52), Shinyanga/Mwanza/Tabora (OR = 1.78, 95% CI: 1.45, 2.21), Kilimanjaro (OR = 1.39, 95% CI: 1.06, 1.82) and Mbeya (OR = 1.79, 95% CI: 1.20, 2.64) were more likely not to consume vegetables daily compared to those from Morogoro but there were no significant differences in their overall FV intake (Table 3).

Table 3. Association of fruit and vegetable intake with socio-demographic characteristics ($N = 7953$).

		Risk for Less than Daily Fruit Intake		Risk for Less than Daily Vegetable Intake		Risk for Inadequate Fruit and Vegetable Intake	
		OR *	**95% CI**	**OR ****	**95% CI**	**OR *****	**95% CI**
Sex	Men	Ref	-	Ref	-	Ref	-
	Women	**0.84**	**0.73–0.96**	**0.51**	**0.46–0.56**	**0.82**	**0.72–0.93**
Age	<25 years	Ref	-	Ref	-	Ref	-
	25–50	1.00	0.85–1.20	**0.80**	**0.70–0.91**	**0.94**	**0.79–1.11**
	50–60	**0.70**	**0.51–0.93**	**0.46**	**0.37–0.57**	**0.60**	**0.46–0.79**
	>60	1.28	0.88–1.76	**0.54**	**0.43–0.67**	0.79	0.59–1.05
Marital Status	Never married/cohabiting	Ref	-	Ref	-	Ref	-
	Monogamously married/cohabiting	**0.84**	**0.71–0.99**	**0.88**	**0.77–0.99**	0.89	0.76–1.05
	Polygamous married/cohabiting	0.90	0.49–1.65	0.75	0.48–1.15	0.84	0.50–1.43
	Widowed	1.33	0.88–2.01	0.86	0.67–1.11	1.19	0.85–1.66
	Separated/divorced	1.13	0.83–1.54	0.88	0.72–1.09	1.21	0.91–1.59
Education Level	No education	Ref	-	Ref	-	Ref	-
	Primary	**0.55**	**0.43–0.70**	1.01	0.87–1.17	**0.78**	**0.64–0.95**
	Secondary	**0.35**	**0.27–0.46**	1.00	0.85–1.19	**0.67**	**0.53–0.84**
	Tertiary	**0.27**	**0.19–0.40**	0.94	0.70–1.27	0.61	0.43–0.88
Occupation	Farming/Livestock/Fishing	Ref	-	Ref	-	Ref	-
	Small business	**0.69**	**0.56–0.84**	1.16	1.00–1.34	**0.84**	**0.69–1.00**
	Large business	**0.39**	**0.25–0.63**	0.75	0.49–1.15	**0.50**	**0.32–0.83**
	Professionals	**0.51**	**0.39–0.68**	1.00	0.79–1.28	**0.66**	**0.50–0.86**
	Skilled manual workers & drivers	**0.61**	**0.48–0.78**	**1.25**	**1.03–1.51**	0.87	0.68–1.09
	Unskilled laborers & bar workers	0.90	0.65–1.25	**1.28**	**1.02-1.60**	1.26	0.92–1.72
	Not working	0.99	0.81–1.20	**1.46**	**1.27–1.66**	**1.28**	**1.07-1.52**
Ethnicity	Morogoro	Ref	-	Ref	-	Ref	-
	Iringa	1.03	0.83–1.28	**1.31**	**1.12–1.52**	1.08	0.88–1.32
	Shinyanga/Mwanza/Tabora	1.06	0.80–1.41	**1.78**	**1.45–2.21**	1.14	0.87–1.49
	Kilimanjaro	**0.66**	**0.48–0.91**	**1.39**	**1.06–1.82**	0.83	0.60–1.14
	Ruvuma	1.98	0.81–1.18	1.09	0.95–1.25	0.94	0.79–.12

	Coast	0.96	0.72–1.27	1.06	0.87–1.30	1.13	0.86–1.47
	Mbeya	0.91	0.56–1.48	**1.79**	**1.20–2.64**	1.43	0.83–2.46
	Other	**0.79**	**0.65–0.96**	**1.18**	**1.01–1.37**	1.07	0.88–1.31
Religion	Muslim	Ref	-	Ref	-	Ref	-
	Catholic	1.12	0.97–1.28	0.97	0.88–1.08	1.06	0.93–1.21
	Lutheran	0.69	0.46–1.03	0.68	0.48–0.97	1.12	0.70–1.77
	Other & No Religion	0.99	0.75–1.29	1.02	0.83–1.26	0.98	0.75–1.27
Migration Status	Non-Migrant	Ref	-	Ref	-	Ref	-
	Migrant	**1.15**	**1.00–1.31**	1.08	0.97–1.19	**1.14**	**1.00–1.30**

All estimates were from a multivariable model adjusting for gender, age, marital status, educational level, occupation, ethnicity, religion and migration status. * OR > 1 and OR < 1, describes the increased and decreased likelihood to consume fruits less than daily respectively; ** OR > 1 and OR < 1, describes the increased and decreased likelihood to consume vegetables less than daily respectively; *** OR > 1 and OR < 1, describes the increased and decreased likelihood to consume less than 5 portions fruits and vegetables daily respectively.

Participants who reported drinking alcohol on a daily basis were less at risk for less than daily fruit (OR = 0.68, CI: 0.47, 0.98), vegetable (OR = 0.68, CI: 0.50, 0.92) and inadequate FV consumption (OR = 0.62, CI: 0.44, 0.86) even after adjustment for all socio-demographic indicators and this was similar for men and women (Table 4). In contrast, no statistically-significant associations were observed between FV consumption and smoking.

Table 4. Association of inadequate fruit and vegetable intake with smoking and alcohol consumption (*N* = 7953).

			Risk for Less than Daily Fruit Intake		**Risk for Less than Daily Vegetable Intake**		**Risk for Inadequate Fruit and Vegetable Intake**	
			OR *	**95% CI**	**OR ****	**95% CI**	**OR *****	**95% CI**
All subjects	Smoking status	Never	Ref	-	Ref	-	Ref	-
		Former	1.1	0.70–1.61	0.98	0.74–1.29	0.91	0.64–1.28
		Current	1.00	0.76–1.31	0.68	0.50–0.92	1.05	0.82–1.35
	Alcohol consumption	Not daily	Ref	-	Ref	-	Ref	-
		Daily	**0.68**	**0.47–0.98**	**0.68**	**0.50–0.92**	**0.62**	**0.44–0.86**
Men	Smoking status	Never	Ref	-	Ref	-	Ref	-
		Former	0.96	0.62–1.51	0.85	0.61–1.18	0.84	0.57–1.26
		Current	1.01	0.75–1.36	0.94	0.75–1.17	0.97	0.74–1.20
	Alcohol consumption	Not daily	Ref	-	Ref	-	Ref	-
		Daily	0.85	0.45–1.47	**0.59**	**0.38–0.90**	0.83	0.50–1.39
Women	Smoking status	Never	Ref	-	Ref	-	Ref	-

	Former	3.36	0.79–14.32	1.39	0.82–2.35	1.19	0.57–2.49
	Current	1.52	0.64–3.59	1.17	0.75–1.82	1.83	0.90–3.73
Alcohol consumption	Not ~~daily~~	~~Ref~~		~~Ref~~		~~Ref~~	
	Daily	**0.57**	**0.35–0.95**	0.79	0.52–1.20	**0.48**	**0.31–0.74**

All estimates were from a mutually-adjusted model, additionally adjusted for socio-demographic characteristics (gender, age, marriage, education, occupation, ethnicity, religion and migration). * OR > 1 and OR < 1, describes the increased and decreased likelihood to consume fruits less than daily respectively; ** OR > 1 and OR < 1, describes the increased and decreased likelihood to consume vegetables less than daily respectively; *** OR > 1 and OR < 1, describes the increased and decreased likelihood to consume less than 5 portions fruits and vegetables daily respectively.

We observed a strong association between inadequate FV intake and healthcare use in this cross-sectional study even after adjusting for various socio-demographic factors as well as smoking and alcohol consumption. Higher healthcare service use seemed to be protective for inadequate FV intake. The results showed maximum protection for participants who reported ≥ 6 visits where the odds of inadequate FV intake reduced by 59% compared to those without any healthcare visits (Figure 3). We did not observe any sex differences in the association between inadequate FV intake and healthcare use (result not shown).

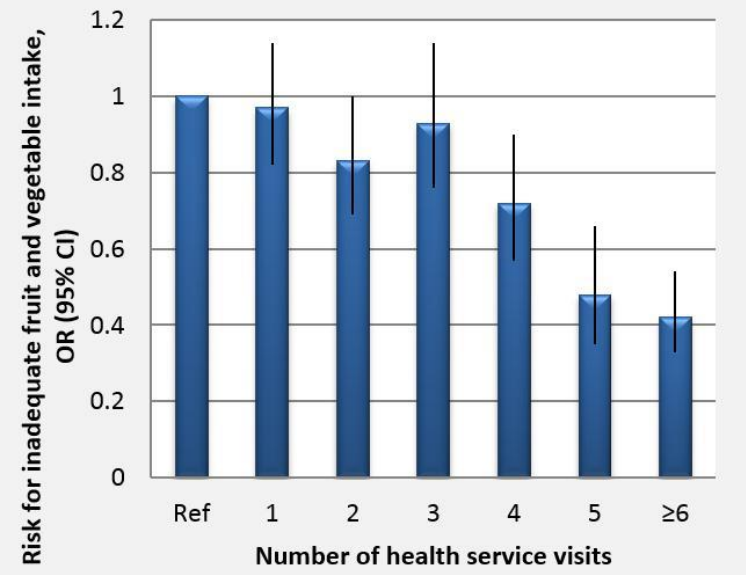

Figure 3. Odds ratios and confidence intervals for the association of inadequate fruit and vegetable intake with frequency of healthcare use in the previous 12 months (cumulate number of outpatient, health dispensary and home visits) *N* = 7953.

4. Discussion

In line with findings from other STEPs surveys done in the sub-Saharan African region [15–19], most of these rural and semi-urban Tanzanian study participants did not meet the five portions daily FV consumption recommendation. More effort is needed to increase the frequency of fruit intake than is needed to increase the frequency of vegetable intake. This is because almost half of the participants consumed vegetables daily while a lesser fraction consumed fruits daily. An important target group for nutritional recommendation is persons of lower SES.

We generally observed that vegetables are widely consumed but in very small portions while fruits are mainly consumed in larger portions, especially among those with higher SES. Daily vegetable consumption was three-fold more prevalent when compared to daily fruit intake. Furthermore, those who had not eaten a fruit at all in the past 7 days of the interview were almost ten times more (12.7%) than those who had not eaten vegetables (1.5%) at all. Our finding of a higher consumption of vegetables than fruits is supported by evidence from studies in South Africa and Mozambique [18,20]. Vegetables are a cheap relish that accompanies daily staples like stiff polenta ("Ugali"), rice, flat bread and others [21,50] and this may explain to a large extent, the high daily vegetable consumption.

Although inadequate FV intake was not different between men and women, it was evident in our findings that men were 49% less likely to consume vegetables daily. This could be due to gender differences in health consciousness or gender roles which may give women more access to food supplies [51–53] as well as the fact that men tend to consume more out of home prepared meals especially for lunch while at work [54], most of which is low on vegetables.

Epidemiologic transition in the semi-urban settings where particularly younger people are exposed to more western-style diets may explain the observed decline of daily vegetable intake as well as portions sizes with decreasing age. Although participants under 18 years are more likely to be financially dependent, thus depending on parental food choices, the observed protective age effect was also made among subjects older than 25 years. This age group (<18 years) comprised only 10% of our study sample, thus, we expect minimal bias of our results due to their inclusion. In rural settings, older people have shown more attachment to vegetables as their source of nutrition, being that they are mostly farmers with a wealth of knowledge on vegetable varieties and use [50,55]. Interestingly, in this study we did not observe farmers to have high vegetable intake.

For fruit intake, cost is a clear barrier in many poor settings similar to Tanzania [56,57]. Our findings demonstrate the importance of SES to fruit intake. Higher level of education and high-income occupations were facilitators of more frequent and larger portions of fruit consumption. It has been previously reported that affordability of fruits is an important bottleneck for their consumption [18,20,54]. Unlike vegetables, the relationship between income and affordability of fruits has received global attention [13,56]. The relative cost of fruits in low income countries has been reported to be 50 times higher than the relative costs in high income countries [58]. Fruits are easy-to-perish commodities and often lack controlled environments for quality storage, transportation as well as packing. This leads to large post-harvest losses and results in high market prices of fruits [59].

Cultural perceptions on FV intake differ. Contrary to our findings on vegetable intake, the oldest participants consumed least fruits. This may be explained by attitudes towards fruits as demonstrated by another study in neighboring Zanzibar where fruits are regarded as snacks for children [22,60]. Another study conducted in rural Tanzania, also reported that children consumed fruits the most [61]. The difference in association between fruit intake and age groups across countries in different continents [62–64] suggests culture to be an important context that needs to be considered in developing prevention programs.

This study also found that frequent health care use was associated with more FV consumption. Even though we do not have information on reasons for health care use, it is more likely that those with more health care use are more health conscious and may therefore benefit from preventive health advice including FV consumption. Exploratory analyses suggested that participants with higher SES were more likely to have higher healthcare use thus, health education or promotions aimed at people most vulnerable to inadequate FV intake, should rely more on community-based approaches rather than health facilities as the delivery channel. This, in addition, provides an opportunity for public health interventions to address both inadequate FV intake and poor health service use through integrated approaches. Our observation of higher consumption of FV among those who drank more alcohol is supported by previous studies which showed that individuals tend to compensate an unhealthy lifestyle with another healthy one [41]. Interestingly, this was not true for smoking in our study.

Strengths and Limitations

The strengths of this study derive from being the first study to the best of our knowledge from Tanzania providing detailed description about patterns of FV intake and socio-demographic and lifestyle determinants. This study also contributes in detail, to the growing literature on the burden of NCD risk factors in Africa. Our sample size is large and representative of the IU-HDSS area. The MZIMA cohort includes 70% of eligible adults from the HDSS area [46] whereas our sample includes 92% of the MZIMA cohort. All ethnic groups, religious affiliations and other socio-demographic attributes of the area were well-captured in our sample. We explored FV intake both separately and in combination according to WHO recommendations. The diverse cultural make-up makes these findings generalizable to other small towns with similar settings. Being nested within the IU-HDSS, a part of the INDEPTH network and as the NCD research agenda is building up in the African continent, our findings will make a useful source of comparison to similar studies in the future in Tanzania and beyond. Our study also has limitations. First, it was a cross-sectional study and precludes drawing conclusions about causal associations. Second, there may have been recall bias in the responses for FV intake. However, the recall period was short (seven days) hence, we expect minimal recall bias. The short recall period in this setting is also likely representative of longer-term dietary habits. Second, there was lack of information on some of the possible confounders or modifiers, including awareness about importance of FV intake, actual purchasing power and availability. These findings represent data collected over one year and no specific seasonal analysis was done.

5. Conclusions

FV consumption in the study setting was associated with SES and cultural patterns. Most immediate gain in improving overall FV consumption in resource-poor settings may be attained by promoting daily consumption of vegetables and increase in number of standard portions of vegetables consumed. Improving access to fruits by making them more affordable may contribute to improving intake rates. More qualitative and quantitative research are needed to better understand the prevalent knowledge, attitude and perception of fruits and vegetable consumption in local cultural contexts in order to improve their intake rates in these settings. Given the importance of awareness in health behavior change, more effort is also needed in the dissemination of the message regarding the number of FV portions necessary to maintain good health.

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Chapter Five

5.0 A Cross-Sectional Examination of Physical Activity Levels and Their Socio-Demographic Determinants in Southern Tanzania

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Article

A Cross-Sectional Examination of Physical Activity Levels and Their Socio-Demographic Determinants in Southern Tanzania

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Abstract: Physical activity is essential for healthy aging. Evidence suggests that vigorous-intensity physical activity (VPA) may be more beneficial than moderate-intensity physical activity (MPA). We examined physical activity levels (MPA, VPA and total physical activity), and their socio-demographic determinants in 2311 participants (15–93 years; 68% women) of the MZIMA Open Community Cohort, who had complete relevant data. Physical activity levels were estimated in minutes per week across three domains—work, leisure and transport. We created three outcome variables: low MPA (<150 min per week of MPA), low VPA (<75 min per week of VPA) and insufficient physical activity (IPA: <150 min per week of total physical activity) and applied sample-weighted multivariable logistic regression to assess associations with potential socio-demographic determinants. Prevalence of IPA, low MPA and low VPA were 25%, 26% and 65% respectively. IPA and low MPA were correlated (Spearman R = 0.98; $p < 0.001$). Work, leisure and transport contributed 54%, 25% and 21% to total physical activity respectively. IPA and low VPA were significantly associated with female sex, lower education, non-manual occupation and frequent fruit consumption. We observed significant differences by sex ($P_{heterogeneity} < 0.001$), on the associations between education and IPA, and between age, occupation and low VPA. In conclusion, low levels of VPA, which were more pronounced in women, support the monitoring and promotion of VPA alongside overall physical activity. Leisure-related activities should also be promoted towards gains in vigorous-intensity and total physical activity in this setting.

Keywords: physical activity; vigorous physical activity; determinants; leisure; Tanzania; cross-sectional study; adults

1. Introduction

Physical activity is a key factor in the prevention of non-communicable diseases (NCD) [1]. In order to maximize its health benefits, more physical activity should be desired, while avoiding injury or harm [2]. A 75 min per week of vigorous-intensity physical activity (VPA) or 150 min per week of moderate-intensity physical activity (MPA) or their combination (150 min per week of total physical activity calculated as MPA+(VPA*2)) is currently recommended to reduce the risk of major NCDs [3,4]. Yet, levels of physical activity around the world fall below these recommendations, contributing to 3.2 million mortalities and 13.4 disability-adjusted life years due to cardiovascular diseases, diabetes, and cancers [5,6]. Several studies showed that VPA was associated with better physical function and cardiovascular health compared to moderate activity [2,7–10]. Hence, VPA should be encouraged and described alongside total physical activity to better capture the state of physical activity towards targeted interventions, in any population.

Many low- and middle-income countries (LMICs) like Tanzania display sufficient physical activity mainly via their occupations and transport [11–13]. Manual occupations such as farming and transport via foot or bicycle therefore help to meet the World Health Organization (WHO) recommendation for physical activity. The development of machines has made occupations less strenuous, leading to less VPA [5,14]. According to survey results from Uganda, 94.3% met the WHO recommendation for physical activity, but had low VPA and high sedentary behaviour [13]. A study in Mozambique also showed predominance of MPA than VPA [15]. Therefore, a concurrent study of VPA and total physical activity levels is warranted. This will help in the identification of areas for intervention, and with longitudinal evidence, an early identification of transition into inactivity could be achieved and addressed, towards attainment and maintenance of optimal overall physical activity levels.

Various socio-demographic factors may influence physical activity levels. For instance, occupations are a major contributor to physical activity, especially those which are strenuous in nature [16,17]. Gender disparity in physical activity is commonly reported, with higher levels in men than women [12,18]. Differences in responsibilities at the household level and in choice of occupation may influence this disparity [17,19–21], which is also evident in younger populations [22,23]. The mutual influence between NCD risk factors, where for instance smokers may tend to engage in more physical activity to compensate for the adverse effect of smoking, has been of interest [24–27], but has not been widely studied in African populations.

Given the on-going epidemiologic transition, evidence on determinants of NCD risk factors including physical activity in LMICs, is essential for the development of population-specific public health interventions. This paper therefore explores the distribution of physical activity levels and their socio-demographic and lifestyle determinants, with focus on gender differences, in a Tanzanian population.

2. Materials and Methods

2.1. Study Design and Population

This was a cross sectional study using data from the second survey of the MZIMA Open Community Cohort which has been described elsewhere [28]. The cohort is lodged in the Ifakara Urban Health and Demographic Surveillance System [29]. This MZIMA survey occurred between May 2014 and September 2015 and included 4274 participants aged at least 15 years who were recruited from Mlabani and Viwanja Sitini areas of Ifakara town. Among other health indicators, the survey collected information on NCDs, socio-demographic and lifestyle characteristics including physical activity. The present study included only participants of the MZIMA cohort who responded to all physical activity questions and had all relevant socio-demographic and lifestyle variables for analyses.

Ethics approvals for the MZIMA Open Community Cohort were obtained from the Ifakara Health Institute Institutional Review Board (IHI/IRB/AM/01-2014) and the National Institute for Medical Research (NIMR/HQ/R.8a1Vol.IX/I320). All participants provided informed written consent to participate in the study.

2.2. Measurement of Physical Activity

Questions exploring domains of physical activity were based on the WHO Stepwise approach for surveillance tool for NCDs and their risk factors (STEPS) in member countries [30]. The physical activity questions, which have been validated in different settings [31–33], assessed MPA and VPA from work, transport (by foot or bicycle) as well as leisure-related activities. The merits of this questionnaire include the assessment of different physical activity domains, provision of activity examples to improve the understanding of interviewees, and the limited need to define leisure time for retirees and older adults [34]. The study questions used to assess physical activity are shown in Table 1. Data collection was done electronically using tablets in Open Data Kit format [35] and automatic skip patterns (the skipping of questions when they are not relevant based on a preceding response) were applied to minimize faulty entries.

Table 1. Questions used to assess physical activity in the present study, based on the WHO STEPS survey questions.

Main Question	Follow on Questions
Does your work involve moderate- intensity activities that cause small increases in breathing or heart rate such as brisk walking, carrying light loads, fishing, herding animals for at least 10 min continuously?	In a typical week how many days do you do moderate-intensity work?
	How many minutes do you spend doing moderate-intensity work in one of those days
Does your work involve vigorous-intensity activities that causes large increases in breathing or heart rate like carrying or lifting heavy loads, digging or construction work, land tilling, harvesting, carpentry for at least 10 min continuously?	In a typical week how many days do you do vigorous-intensity work?
	How many minutes do you spend doing vigorous-intensity work in one of those days
Do you walk or use bicycle at least 10 min continuously to get to and from places?	In a typical week how many days do you do you walk or use bicycle at least 10 min continuously?
	How many minutes do you spend walking or using bicycle at least 10 min continuously in one of those days
Do you do moderate-intensity exercise, fitness or recreational activities that cause a small increase in breathing or heart rate such as brisk walking, cycling, swimming, netball, volleyball for at least 10 min continuously?	In a typical week how many days do you do moderate-intensity exercise?
	How many minutes do you spend doing moderate-intensity exercise in one of those days
Do you do vigorous-intensity exercise that causes large increases in breathing or heart rate like football. swimming, basketball, running for at least 10 min continuously?	In a typical week how many days do you do vigorous-intensity exercise?
	How many minutes do you spend doing vigorous-intensity exercise in one of those days

Based on the participants' responses, we calculated the following: (i) VPA as the sum of the product of time spent on vigorous-intensity activity and number of days in a week, across domains of physical activity (work, transport or leisure-related); (ii) MPA was evaluated as the sum of the product of time spent on moderate-intensity activity and number of days in a week, across domains of physical activity (work, transport or leisure-related) and (iii) total physical activity as the sum of (VPA*2) and MPA in min per week [4]. Based on the WHO cut-offs, we defined three physical activity outcomes: (i) insufficient physical activity (IPA) as having less than 150 min per week of total physical activity (ii) low MPA as having less than 150 min per week of MPA and (iii) low VPA as having less than 75 min per week of VPA [4].

2.3. Measurement of Socio-Demographic and Lifestyle Indicators

Participants also responded to socio-demographic and other lifestyle questions. Age was categorized into "below 25 years", "25–below 50 years", "50–below 60 years", and "60 years and above". Sex was categorized into "male" and "female". Education categorize included "no formal education", "primary education", "secondary education" and "tertiary education". Occupational status was dichotomized into "yes/no" representing having or not having an income-generating activity. Specific categories for those with occupations were as follows: "farming, fishing and livestock keeping"; "business owners"; "professionals (white collar jobs)"; "skilled manual workers (including drivers, carpenters, etc.)"; and "unskilled manual workers (including menial jobs)". Religion was categorized into "Muslim", "Catholic", "Lutheran" and "others". Ethnicity of participants was categorized into "Morogoro", "Iringa", "Shinyanga/Mwanza/Tabora", "Kilimanjaro/Arusha", "Ruvuma", and "others". Participants also responded to questions on their alcohol consumption (e.g., beers, wines, spirits or local brews) in the past 12 months, tobacco smoking (e.g., cigarettes, cigars or pipes) and frequency of consumption of fruits and vegetables in any form, in a usual week. Alcohol consumption was classified into "yes" or "no", whereas smoking status was classified into "current smoker" or "never smoker/former smoker". Frequency of fruit consumption and vegetable consumption in a usual week were classified as ≤3/>3 days per week respectively.

2.4. Data Analysis

We identified participants who provided complete responses to the physical activity questions, as well as having complete socio-demographic information. We summarized the characteristics of these participants included in the final sample: categorical variables were described as proportions whereas continuous variables, due to their non-normal distributions, were described as medians and interquartile ranges (IQR). We calculated the contributions of the major physical activity domains to the total physical activity, based on their mean values in the study sample. We assessed the prevalence of IPA, low MPA and low VPA, as well as their correlations using the Spearman correlation test. We tested socio-demographic differences in these physical activity outcomes using univariable logistic regression. In a further step, we performed mutually-adjusted logistic regression to test the independence of observed associations, as well as explore the potential influence of fruit, vegetable and alcohol consumption, and smoking as correlates or modifiers of physical activity.

Due to the overrepresentation of women in the cohort (male to female ratio of 41%), we applied sex-specific sampling weights to the models that combined men and women. These weights were derived as the inverse of sex-specific ratios of our cohort and those of the general population in the study area (male to female ratio of 83%) obtained from the 2012 National Census [36]. Thus, sampling weights of 2.02 (83/41) and 1 were applied to men and women respectively. We also stratified the descriptive estimates and the regression models by sex for sex-specific estimates and differences in trends and associations. Since our study included only 54% of survey participants, we explored potential selection bias by comparing the socio-demographic characteristics between included and excluded participants. Finally, we performed sensitivity analyses by additionally applying the inverse of the probability of participation in the present analyses, derived from the overall study sample, to the sex-weighted combined univariable and multivariable models.

All association results were expressed as Odds ratios (OR) and 95% confidence intervals (CI), and statistical tests were considered significant at alpha-value of 0.05. All analyses were performed using STATA version 14 (STATA Corporation, College Station, TX, USA).

3. Results

A total of 2311 (54%) participants responded to questions in completeness and no ambiguity hence were included in the analysis. Age range of the participants was 15–93 years. Median (IQR) age of participants was 30 (19) years, with 15% being at least 50 years old. Women comprised two-thirds

of our study sample (68%). More than three-quarters (76.6%) of this sample had formal education, with only 4.3% having tertiary education. The participants included mixed ethnic groups from all parts of the country, but the largest groups were from Morogoro region (58.5%), and farming was the main economic activity (Table 2). There were significant differences between men and women in relation to education and occupation, but there were no significant differences by age, religion and ethnicity (Table 2).

Table 2. Characteristics of study population included in the present study.

Variables	All [a]	Males	Females	*P*-value [b]
	2311 (100%)	743 (100%)	1568 (100%)	
Categorical variables, N(%)				Chi-Squared Test
Age groups				0.941
<25 years	882 (38.2)	282 (37.9)	600 (38.3)	
25–50 years	1080 (46.7)	346 (46.6)	734 (46.8)	
50 and above	349 (15.1)	115 (15.5)	234 (14.9)	
Educational level				<0.001
No Education	542 (23.5)	141 (19.0)	401 (25.6)	
Primary education	1119 (48.4)	328 (44.1)	791 (50.4)	
Secondary education	551 (23.8)	222 (29.9)	329 (21.0)	
Tertiary education	99 (4.3)	52 (7.0)	47 (3.0)	
Occupation				<0.001
Unemployed	687 (29.7)	171 (23.0)	516 (32.9)	
Business owners	309 (13.4)	76 (10.2)	233 (14.9)	
Professionals	89 (3.9)	45 (6.1)	44 (2.8)	
Skilled manual labour	144 (6.2)	67 (9.0)	77 (4.9)	
Unskilled manual labour	77 (3.3)	47 (6.3)	30 (1.9)	
Farming (including crop, livestock, fishing)	1005 (43.5)	337 (45.4)	668 (42.6)	
Religion				0.180
No religion	8 (0.3)	6 (0.8)	2 (0.1)	
Muslim	804 (34.8)	250 (33.6)	554 (35.3)	
Catholic	1239 (53.6)	404 (54.4)	835 (53.3)	
Lutheran	49 (2.1)	15 (2.0)	34 (2.2)	
Others	211 (9.1)	68 (9.2)	143 (9.1)	
Ethnicity				0.386
Morogoro region	1352 (58.5)	421 (56.7)	931 (59.4)	
Iringa region	282 (12.2)	86 (11.6)	196 (12.5)	
Shinyanga/Mwanza/Tabora regions	138 (6.0)	51 (6.9)	87 (5.6)	
Ruvuma region	349 (15.1)	116 (15.6)	233 (14.9)	
Other regions	190 (8.2)	69 (9.3)	121 (7.7)	
Consumption of fruits >3 days/week	1140 (49.3)	373 (50.2)	767 (48.9)	0.684
Consumption of vegetables >3 days/week	1680 (72.7)	484 (65.1)	1196 (76.3)	<0.001
Alcohol consumption in the past 12 months	333 (14.4)	163 (21.9)	170 (10.8)	<0.001
Current smoker	111 (4.8)	95 (12.8)	16 (1.0)	<0.001
Insufficient physical activity	576 (25)	138 (19)	438 (28)	<0.001
Low moderate physical activity	592 (26)	143 (19)	449 (29)	<0.001
Low vigorous physical activity	1498 (65)	350 (47)	1148 (73)	<0.001
Continuous variables, (Median (IQR))				Median test
Age in years	30 (19)	30 (21)	29 (18)	0.426
Minutes per week of moderate physical activity	720 (1560)	960 (1740)	540 (1350)	<0.001
Minutes per week of vigorous physical activity	0 (480)	180 (1080)	0 (150)	<0.001
Minutes per week of total physical activity	840 (2700)	1680 (3780)	660 (2040)	<0.001
Minutes per week of total physical activity due to work	0 (1200)	0 (2520)	0 (0)	<0.001
Minutes per week of total physical activity due to travel	360 (480)	420 (660)	240 (420)	<0.001
Minutes per week of total physical activity due to recreational activities	120 (600)	300 (840)	0 (420)	<0.001

Insufficient physical activity was defined as having less than 150 min per week of total physical activity (i.e., moderate physical activity + (2*vigorous physical activity)). Low moderate physical

activity defined as having less than 150 min per week of moderate physical activity. Low vigorous physical activity defined as having less than 75 min per week of vigorous physical activity. [a] All proportions were adjusted for sex; [b] *p*-value of the difference between males and females for each variable.

Compared to the included participants, the 1963 excluded participants were more likely to be female, younger, more educated, unemployed and non-smokers (Table 3).

Table 3. Summary of socio-demographic characteristics of the MZIMA cohort participants, stratified by inclusion status in the present study.

Categorical Variables (%)	Included N = 2311	Excluded N = 1963	Chi-Squared Test [a]
Females	68	75	<0.001
Age groups			<0.001
<25 years	38.2	44.5	
25–50 years	46.7	40.8	
50 and above	15.1	14.7	
Educational level			<0.001
No education	23.5	11.0	
Primary education	48.4	51.5	
Secondary education	23.8	32.6	
Tertiary education	4.3	4.9	
Occupation			0.003
Unemployed	29.7	34.6	
Business owners	13.4	12.4	
Professionals	3.9	5.0	
Skilled manual labour	6.2	5.9	
Unskilled manual labour	3.3	3.2	
Farming (including crop, livestock, fishing)	43.5	38.9	
Religion			0.063
No religion	0.4	0.1	
Muslim	34.8	36.7	
Catholic	53.6	50.5	
Lutheran	2.1	2.9	
Others	9.1	9.8	
Ethnicity			0.003
Morogoro region	58.5	57.3	
Iringa region	12.2	10.3	
Shinyanga/Mwanza/Tabora regions	6.0	7.7	
Ruvuma region	15.1	14.0	
Other regions	8.2	10.7	
Consumption of fruits >3 days/week	49.3	49.1	0.859
Consumption of vegetables >3 days/week	72.3	72.1	0.682
Alcohol consumption in the past 12 months	14.4	13.5	0.393
Current smoker	4.8	3.6	0.056

[a] *p*-values of the difference between included and excluded participants, for each variable.

3.1. General Picture of Physical Activity in the Population

Majority of the population met the WHO recommendation for total physical activity, with an IPA prevalence of 25%. The respective prevalence of low MPA and low VPA was 26% and 65%. All three measures of physical activity were significantly different between men and women ($p < 0.001$), with men reporting higher physical activity at all levels than women (Table 2). Spearman correlation (R) between IPA and low MPA was 0.98 ($p < 0.001$) whereas the correlation between IPA and low VPA was 0.42 ($p < 0.001$). Hence, further regression models and results are presented for IPA and low VPA.

Mean time spent on total physical activity was 2033 min per week. Mean min per week of domain-specific physical activity was 1089 (work), 434 (transport) and 510 (leisure). Thus, the

contribution of work towards total physical activity was 54%, whereas the contributions of transport and leisure were 21% and 25% respectively. This trend was similar in men and women where the respective contributions of work, transport and leisure were 53%, 22% and 25% for men and 54%, 21% and 25% for women. Median (IQR) time spent on work, transport and leisure-related activities were 0 (1200), 360 (480) and 120 (600) min per week respectively and were all significantly higher in men than in women ($p < 0.001$).

3.2. Association of Physical Activity with Socio-Demographic Factors

In the univariable models, factors associated with IPA and low VPA included female sex, having no education, less manual work, fruit intake, vegetable intake and no alcohol intake. Older age was associated with IPA but the association between age and low VPA was less apparent. Being a never-or former smoker was associated with low VPA, but not IPA. Ethnicity was neither associated with IPA nor low VPA (Table 4).

In the multivariable models, associations of IPA and low VPA with the socio-demographic factors generally remained, but were of lesser magnitude, and the associations with age, alcohol intake and smoking became non-significant (Table 4). Adjusted OR (95% CI) of IPA and low VPA for female sex were 1.42 (1.08–1.84) and 2.78 (2.26–3.43), respectively. Adjusted OR (95% CI) of IPA and low VPA for educational level (tertiary vs. no education) were 0.12 (0.06–0.22) and 0.20 (0.11–0.37) respectively, whereas adjusted OR (95% CI) of IPA and low VPA for occupation (farming vs. unemployed) were 0.67 (0.48–0.94) and 0.27 (0.20–0.36) respectively. Participants who reported frequent intake of fruits had higher odds of IPA (OR: 1.45; 95% CI: 1.21–1.74) and low VPA (OR: 1.57; 95% CI: 1.28–1.93) independent of other variables (Table 4).

Table 4. Relationship between socio-demographic characteristics and physical activity.

Variable	Categories	Insufficient Physical Activity		Low Vigorous Physical Activity	
		Model 1	Model 2	Model 1	Model 2
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex	Men	Reference	Reference	Reference	Reference
	Women	1.70 (1.37–2.11) *	1.42 (1.09–1.84) *	3.06 (2.56–3.68) *	2.78 (2.26–3.43) *
Age group	<25	Reference	Reference	Reference	Reference
	25–50	0.79 (0.63–0.99) *	0.79 (0.58–1.08)	0.72 (0.59–0.88) *	1.01 (0.79–1.29)
	>50	1.51 (1.13–2.00) *	0.95 (0.63–1.44)	1.05 (0.79–1.39)	1.42 (0.99–2.01)
Education	No	Reference	Reference	Reference	Reference
	Primary	0.07 (0.05–0.09) *	0.06 (0.05–0.09) *	0.25 (0.19–0.33) *	0.19 (0.14–0.26) *
	Secondary	0.07 (0.05–0.10) *	0.06 (0.04–0.09) *	0.27 (0.20–0.37) *	0.17 (0.12–0.24) *
	Tertiary	0.13 (0.07–0.21) *	0.12 (0.06–0.22) *	0.30 (0.19–0.50) *	0.20 (0.11–0.37) *
Ethnicity	Morogoro	Reference	Reference	Reference	Reference
	Iringa	1.23 (0.90–1.67)	1.11 (0.79–1.58)	1.02 (0.76–1.35)	0.93 (0.68–1.27)
	Shinyanga/Mwanza/Tabora	1.47 (0.98–2.20)	1.40 (0.84–2.32)	0.97 (0.66–1.43)	0.98 (0.64–1.49)
	Ruvuma	1.07 (0.80–1.42)	0.94 (0.67–1.32)	0.85 (0.65–1.10)	0.82 (0.61–1.10)
	Others	1.01 (0.69–1.47)	0.98 (0.62–1.55)	1.05 (0.74–1.47)	0.99 (0.68–1.46)
Occupation	Unemployed	Reference	Reference	Reference	Reference
	Business owners	0.59 (0.41–0.81) *	0.90 (0.57–1.42)	0.77 (0.56–1.07)	0.85 (0.59–1.21)
	Professionals	0.40 (0.22–0.87) *	0.74 (0.35–1.56)	0.45 (0.27–0.73) *	0.62 (0.35–1.10)
	Skilled manual workers	0.33 (0.18–0.52) *	0.45 (0.23–0.90) *	0.44 (0.30–0.67) *	0.63 (0.42–0.94) *
	Unskilled manual workers	0.09 (0.03–0.34) *	0.07 (0.02–0.27) *	0.27 (0.16–0.45) *	0.34 (0.18–0.63) *
	Farming	1.10 (0.87–1.38)	0.67 (0.48–0.94) *	0.39 (0.31–0.49) *	0.27 (0.20–0.36) *
Fruit intake	≤3 days/week	Reference	Reference	Reference	Reference
	>3 days/week	1.48 (1.21–1.81) *	1.55 (1.22–1.96) *	1.45 (1.21–1.74) *	1.57 (1.28–1.93) *
Vegetable intake	≤3 days/week	Reference	Reference	Reference	Reference
	>3 days/week	1.24 (0.99–1.57)	1.06 (0.81–1.38)	1.25 (1.03–1.53) *	1.05 (0.84–1.32)
Alcohol intake	No	Reference	Reference	Reference	Reference
	Yes	0.51 (0.36, 0.70) *	0.72 (0.47, 1.10)	0.67 (0.52, 0.86) *	1.10 (0.81, 1.51)
Current smoker	No	Reference	Reference	Reference	Reference
	Yes	0.78 (0.48, 1.26)	0.95 (0.47, 1.93)	0.47 (0.32, 0.70) *	0.64 (0.40, 1.04)

Insufficient physical activity was defined as having less than 150 min per week of total physical activity (i.e., moderate physical activity + (2*vigorous physical activity)). Low vigorous physical activity defined as having less than 75 min per week of vigorous physical activity. Sampling weights were applied to all estimates to account for oversampling of females. * $p < 0.05$. Model 1: Univariable model; Model 2: Multivariable model including all variables presented in the table.

3.3. Sex-Specific Association of Socio-Demographic and Lifestyle Factors with Physical Inactivity

For men, the determinants of IPA included educational level (OR for tertiary vs. no education: 0.05; 95% CI: 0.02–0.15) and fruit intake (OR: 1.82; 95% CI: 1.10–3.02) whereas the determinants of low VPA included age (OR for >50 years vs. <25 years: 2.10; 95% CI: 1.21–3.65), educational level (OR for tertiary vs. no education: 0.14; 95% CI: 0.06–0.31), occupation (OR for farming vs. unemployed: 0.40; 95% CI: 0.24–0.70) and smoking (OR: 0.56; 95% CI: 0.32–0.97). Ethnicity and alcohol intake were not significant determinants of either IPA or low VPA in men (Table 5).

For women, the determinants of IPA included educational level (OR for tertiary vs. no education: 0.27; 95% CI: 0.13–0.57), occupation (OR for farming vs. unemployed: 0.64; 95% CI: 0.46–0.88) and fruit intake (OR: 1.35; 95% CI: 1.04–1.74) whereas the determinants of low VPA also included educational level (OR for secondary vs. no education: 0.25; 95% CI: 0.16–0.39), occupation (OR for farming vs. unemployed: 0.17; 95% CI: 0.12–0.23) and fruit intake (OR: 1.53; 95% CI: 1.20–1.97). Similar to our findings in men, ethnicity, and alcohol intake did not determine IPA or low VPA levels in the women and in contrast to our findings in men, age and smoking did not determine IPA or low VPA in women (Table 5).

Comparing the determinants of IPA between men and women showed significant differences in the association between educational level and IPA. The degree of protection conferred by formal education was stronger in men than women ($P_{heterogeneity} < 0.001$). We also observed sex differences in the associations with low VPA. There were significant differences in the association with age ($P_{heterogeneity} < 0.001$), educational level ($P_{heterogeneity} < 0.001$) and occupation ($P_{heterogeneity} < 0.001$). Although fruit intake was a significant determinant of IPA and low VPA for both men and women, the differences between men and women for both outcomes were non-significant. Association with alcohol consumption or smoking was also not significantly different between men and women, for both IPA and low VPA (Table 5).

The results of sensitivity analyses using the general models corrected for potential selection bias showed very consistent findings. The determinants of IPA and low VPA from the sensitivity models were the same as those from the models limited to those with complete data, in both univariable and multivariable regression models (Table 6).

Table 5. Gender differences in the relationship between socio-demographic and lifestyle characteristics and physical activity.

Variable	Categories	Insufficient Physical Activity			Low Vigorous Physical Activity		
		Males	Females		Males	Females	
		OR (95% CI)	OR (95% CI)	*p*-value [a]	OR (95% CI)	OR (95% CI)	*p*-value [a]
Age group	<25	Reference	Reference	0.732	Reference	Reference	<0.001
	25–50	0.66 (0.35–1.25)	0.94 (0.69–1.29)		1.19 (0.78–1.84)	0.85 (0.63–1.15)	
	>50	0.91 (0.41–2.02)	1.18 (0.79–1.78)		2.10 (1.21–3.65) *	0.84 (0.55–1.29)	
Education	No	Reference	Reference	<0.001	Reference	Reference	0.001
	Primary	0.03 (0.02–0.06) *	0.10 (0.07–0.13) *		0.14 (0.09–0.23) *	0.23 (0.16–0.32) *	
	Secondary	0.02 (0.01–0.05) *	0.12 (0.08–0.18) *		0.12 (0.07–0.21) *	0.25 (0.16–0.39) *	
	Tertiary	0.05 (0.02–0.15) *	0.27 (0.13–0.57) *		0.14 (0.06–0.31) *	0.45 (0.17–1.16)	
Ethnicity	Morogoro	Reference	Reference	0.272	Reference	Reference	0.874
	Iringa	1.04 (0.49–2.23)	1.16 (0.79–1.71)		1.00 (0.61–1.66)	0.81 (0.55–1.18)	
	Shinyanga/Mwanza/Tabora	0.83 (0.32–2.17)	1.77 (1.05–3.01)		0.79 (0.41–1.53)	1.04 (0.59–1.82)	
	Ruvuma	0.70 (0.34–1.45)	1.07 (0.74–1.54)		0.87 (0.55–1.36)	0.82 (0.58–1.16)	
	Others	0.84 (0.35–1.99)	1.04 (0.65–1.68)		0.85 (0.48–1.48)	1.36 (0.82–1.26)	
Occupation	Unemployed	Reference	Reference	0.448	Reference	Reference	<0.001
	Business owners	1.06 (0.40–2.84)	0.80 (0.52–1.22)		1.33 (0.71–2.48)	0.52 (0.34–0.80) *	
	Professionals	0.69 (0.17–2.89)	0.79 (0.34–1.84)		0.68 (0.31–1.50)	0.53 (0.22–1.25)	
	Skilled manual workers	0.52 (0.17–1.60)	0.36 (0.16–0.80) *		0.53 (0.28–1.00) *	1.34 (0.63–2.86)	
	Unskilled manual workers	0.04 (0.004–0.32) *	0.12 (0.03–0.55) *		0.42 (0.20–0.88) *	0.28 (0.12–0.64) *	
	Farming	0.73 (0.36–1.51)	0.64 (0.46–0.88) *		0.40 (0.24–0.70) *	0.17 (0.12–0.23) *	
Fruit intake	≤3 days/week	Reference	Reference	0.382	Reference	Reference	0.804
	>3 days/week	1.82 (1.10–3.02) *	1.35 (1.04–1.74) *		1.62 (1.17–2.22) *	1.53 (1.20–1.97) *	
Vegetable intake	≤3 days/week	Reference	Reference	0.656	Reference	Reference	0.845
	>3 days/week	1.12 (0.66–1.90)	1.02 (0.75–1.39)		0.99 (0.71–1.38)	1.18 (0.88–1.57)	
Alcohol intake	No	Reference	Reference	0.391	Reference	Reference	0.471
	Yes	0.63 (0.30, 1.33)	0.83 (0.54, 1.29)		1.08 (0.71, 1.66)	1.00 (0.67, 1.47)	
Current smoker	No	Reference	Reference	0.141	Reference	Reference	0.959
	Yes	1.04 (0.44, 2.43)	0.45 (0.14, 1.47)		0.56 (0.32, 0.97) *	1.13 (0.26, 4.83)	

Insufficient physical activity was defined as having less than 150 min per week of total physical activity (i.e., moderate physical activity + (2*vigorous physical activity)). Low vigorous physical activity defined as having less than 75 min per week of vigorous physical activity. All estimates were from multivariable models including all variables presented in the table. [a] *p*-values of heterogeneity derived from multivariable models including interaction terms between sex and respective variables and applying sampling weights to account for oversampling of females. * *p*-value < 0.05.

Table 6. Relationship between socio-demographic characteristics and physical activity, corrected for potential selection bias.

Variable	Categories	Insufficient Physical Activity		Low Vigorous Physical Activity	
		Model 1	Model 2	Model 1	Model 2
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex	Men	Reference	Reference	Reference	Reference
	Women	1.68 (1.36–2.09) *	1.43 (1.10–1.84) *	3.13 (2.61–3.76) *	2.87 (2.33–3.54) *
Age group	<25	Reference	Reference	Reference	Reference
	25–50	0.81 (0.65–1.01)	0.80 (0.59–1.08)	0.71 (0.58–0.86) *	1.00 (0.79–1.27)
	>50	1.55 (1.18–2.05) *	0.95 (0.63–1.42)	1.04 (0.78–1.37)	1.38 (0.97–1.95)
Education	No	Reference	Reference	Reference	Reference
	Primary	0.08 (0.06–0.11) *	0.07 (0.05–0.09) *	0.26 (0.20–0.34) *	0.19 (0.14–0.26) *
	Secondary	0.10 (0.07–0.13) *	0.06 (0.04–0.09) *	0.28 (0.21–0.38) *	0.17 (0.12–0.24) *
	Tertiary	0.17 (0.10–0.28) *	0.12 (0.07–0.23) *	0.31 (0.19–0.51) *	0.20 (0.11–0.37) *
Ethnicity	Morogoro	Reference	Reference	Reference	Reference
	Iringa	1.22 (0.91–1.65)	1.12 (0.79–1.58)	1.01 (0.76–1.33)	0.92 (0.68–1.26)
	Shinyanga/Mwanza/Tabora	1.48 (1.00–2.20) *	1.41 (0.86–2.33)	0.98 (0.67–1.44)	0.98 (0.65–1.48)
	Ruvuma	1.07 (0.81–1.42)	0.95 (0.68–1.32)	0.84 (0.65–1.08)	0.82 (0.61–1.09)
	Others	0.99 (0.69–1.44)	0.97 (0.63–1.51)	1.05 (0.75–1.47)	0.99 (0.68–1.45)
Occupation	Unemployed	Reference	Reference	Reference	Reference
	Business owners	0.61 (0.43–0.87) *	0.91 (0.58–1.43)	0.76 (0.55–1.05) *	0.84 (0.59–1.20)
	Professionals	0.43 (0.23–0.80) *	0.76 (0.37–1.59)	0.45 (0.29–0.73) *	0.62 (0.35–1.10)
	Skilled manual workers	0.32 (0.18–0.56) *	0.44 (0.23–0.85) *	0.45 (0.30–0.68) *	0.64 (0.43–0.96) *
	Unskilled manual workers	0.09 (0.03–0.30) *	0.06 (0.02–0.25) *	0.27 (0.16–0.44) *	0.34 (0.19–0.62) *
	Farming	1.13 (0.90–1.41)	0.69 (0.50–0.95) *	0.38 (0.30–0.48) *	0.26 (0.20–0.35) *
Fruit intake	≤3 days/week	Reference	Reference	Reference	Reference
	>3 days/week	1.46 (1.20–1.78) *	1.52 (1.20–1.92) *	1.44 (1.21–1.73) *	1.57 (1.28–1.91) *
Vegetable intake	≤3 days/week	Reference	Reference	Reference	Reference
	>3 days/week	1.24 (0.99–1.55)	1.05 (0.80–1.37)	1.26 (1.04–1.53) *	1.05 (0.85–1.31)
Alcohol intake	No	Reference	Reference	Reference	Reference
	Yes	0.52 (0.38–0.72) *	0.74 (0.48–1.13)	0.67 (0.52–0.85) *	1.09 (0.80–1.49)
Current smoker	No	Reference	Reference	Reference	Reference
	Yes	0.80 (0.50–1.30)	0.96 (0.47–1.96)	0.47 (0.32–0.69) *	0.67 (0.42–1.08)

Insufficient physical activity was defined as having less than 150 min per week of total physical activity (i.e., moderate physical activity + (2*vigorous physical activity)). Low vigorous physical activity defined as having less than 75 min per week of vigorous physical activity. Sampling weights were applied to all

estimates to account for oversampling of females. The inverse of the probability of participating in present analyses derived from base dataset, was also applied to all models. * *p*-value < 0.05.

Model 1: Univariable model; Model 2: Multivariable model including all variables presented in the table.

4. Discussion

We found that although majority of the participants met the WHO recommendations for physical activity, VPA was very low and indicates the importance for promotion of VPA alongside MPA towards overall physical activity. Moreover, women were more inactive compared to men, independent of age, education, ethnicity and occupation.

Approximately three-quarters (74%) of the study sample reported sufficient physical activity. This physical activity profile is comparable to the national average (83.3%) reported in the 2012 Tanzania STEPS survey. Similar to the 2012 survey, we observed higher levels of physical activity in men than women. Nevertheless, the actual proportion of active men (86.3%) and women (80.5%) were higher in the 2012 survey compared to the proportion of active men (81.4%) and women (72.1%) in our study. Furthermore, the daily average time spent on physical activity in general was also lower in our study compared to those reported in 2012 [11].

Low-income countries reportedly reduced their energy expenditure from work over a period of two decades [37]. Walking and cycling have also declined with the recent rise of informal modes of transport like motorized bike taxi. Although studies have not explicitly reported the decline of vigorous activities but have highlighted a growing prevalence of sedentary practices [23,26,38], a study from Mozambique reported that 75 min per week of VPA was uncommon [15]. Thus, there is need for a longitudinal investigation of physical activity trends especially in LMICs, for early identification of potential transitions to lower physical activity and inactivity. The finding of an inverse dose response between vigorous activity and mortality in a follow up study of more than 200,000 adults over 6.5 years supports the promotion of VPA for healthy aging [7]. In order to promote VPA through purposeful and leisure cycling and other forms of recreational activity in the LMIC context, there is need to establish a supporting environment [39–41] as well as awareness about its health benefits [42–45]. These may encourage the uptake of VPA in these settings.

Our findings showed that men were less vigorously active with increasing age, while women were more likely to be active with age. While our finding of somewhat higher activity with age agrees with some studies which reported older age to be associated with more MPA than VPA [46]. Other studies showed a general decline of physical activity with age, which was associated with major life events such as losing a spouse or retirement [47,48]. Improved understanding of the patterns of sex and age interactions as determinants of physical activity, will therefore contribute to interventions aimed at improving physical activity in old age.

In agreement with other studies [17,49,50], we found participants' education and occupation to be significant determinants of their physical activity levels. Participants with higher educational attainment had lower risk of IPA. This could be attributed to increased awareness, acceptance and engagements in physical activity for health benefits. Interestingly, we observed a stronger protective effect of educational attainment on risk of IPA compared to VPA. This might also indicate higher awareness of overall physical activity than vigorous-intensity activity. Engagement in vigorous-intensity activity should be further promoted, by leveraging the already existing awareness of its health benefits. We also observed that farmers and manual workers had low risk of IPA, which was more apparent with VPA. This is not surprising given the strenuous nature of these occupations which provides avenues for physical activity. Although professionals and business owners were more educated than the farmers and manual workers, they had higher risk of IPA in comparison. In fact, the degree of protection among the professionals from being insufficiently active was non-significant in comparison to the unemployed. As these groups are more likely to lead sedentary lifestyles due to the

nature of their occupation, reinforcements of the benefits of physical activity, as well as creating enabling environment in the work place for engagement will improve their uptake of physical activity. This is especially important given that median time spent on physical activity was zero minutes per week, despite work making the greatest contribution to overall physical activity. As demonstrated in a recent review [51], there is need for further exploration into modifiable factors that determine occupational physical activity especially in this and similar settings, towards improvement.

Of all the concurrent lifestyle factors investigated in this study, only fruit intake frequency showed a significant association with lower physical activity levels. Our finding of an inverse relationship between frequent fruit intake and physical activity may imply that participants, who are less active, tend to consume more fruits as compensation for their lower activity levels. As recently described [52] and supported by our findings with educational level, this reinforces an existing awareness of the health benefits of physical activity. However, we did not replicate this finding with other lifestyle factors and in contrast to our finding with fruit intake, another study reported higher healthy eating rates with higher levels of physical activity [53]. More studies are therefore needed to better understand these interactions between lifestyles as NCD risk factors, for effective public health interventions.

Strengths and Limitations

This study describes in detail, the prevalent physical activity levels within the MZIMA cohort, and the influence of several socio-demographic and lifestyle factors. This study is a valuable contribution to evidence on the situation of physical activity in southern Tanzania. Our findings are consistent with models corrected for potential selection bias means that our findings may be generalized to the cohort. In addition, the distribution of some sociodemographic characteristics in the Morogoro region where the cohort is located is similar to an extent, to those of the study participants. Similar to the regional characteristics, men had higher literacy rates, higher employment rates in public and private sector, our sample comprised more Christians and the participants were mostly of Morogoro origin [28,36]. Thus, our findings may also be generalizable to an extent, to the region. We applied a novel approach by modelling the determinants of vigorous physical activity alongside the usually-reported total physical activity.

Limitations of our study include its cross-sectional design, which limits our causal interpretation of the observed patterns. The physical activity questions were not specifically validated in our study setting but were already validated in similar settings to sufficiently capture physical activity. Recall bias may also have affected physical activity reports, but we expect this influence to be minimal due to the short recall period (7 days). Moreover, some important factors like awareness about importance of physical activity, access to physical activity facility including owning equipment such as a bicycle for travel could not be considered. We did not have information on sitting time or time spent doing household chores thus, we could not compute total metabolic equivalents which would better capture the overall physical activity level. The lack of information on household chores, which are predominantly undertaken by women in this study setting, could partly explain the observed sex differences in our study. Lastly, the sex-distribution of our sample might impact the generalizability of our results, but our models have accounted for oversampling, and the sex-specific findings remain valid for sex-specific inferences. Furthermore, there were no sex differences in age, religion or ethnicity distribution of our sample. Despite our correction for potential selection bias, some selection bias may still persist. More representative studies are therefore warranted to confirm these findings.

5. Conclusions

The majority of participants were within the WHO recommended levels of weekly physical activity. However, the low level of VPA calls for public health response with a priority towards women and white-collar workers. Given the rise of motorised transport in this and other LMIC settings undergoing transition, routine physical activity should be highly encouraged by

improvements in recreational facilities in the community and workplace, and education for behavioural change. Advocacy for incorporation of physical activity into global and national public health agenda has been slow [14,54], and lessons learned from our study should enhance its implementation at the local level. Finally, more qualitative and quantitative research is needed to build evidence base and further understand the socio-demographic patterns of physical activity in LMICs.

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Chapter Six

6.0 Patterns of HED and local brew use amidst epidemiologic transition: An Adult Community Cohort in Southern Tanzania

This chapter describes the burden of alcohol abuse defined as heavy episodic drinking as well as use of local brew in south eastern part of peri-urban Tanzania.

Patterns of HED and local brew use amidst epidemiologic transition: An Adult Community Cohort in Southern Tanzania

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Abstract

Background Alcohol consumption patterns are in transition to abusive levels. Evidence on frequency patterns of heavy episodic drinking (HED), use of local brew and its association with the social economic and cultural context in Africa is scarce. This cross-sectional analysis gives insight on patterns of HED, use of local brew and associated social determinants in Southern Tanzania.

Methods HED (≥4/≥5 drinks in one session for women and men respectively), use of local brew, education, occupation, ethnicity and migration were self-reported through structured interviews. Logistic regression assessed association between HED and local brew use with social determinants

Results HED was widespread (91.3%) and occurred almost on every drinking session with no gender bias. Lower prevalence of local brew consumption (47.9%) may indicate its phasing out. Women and youth; men and older people had highest prevalence of HED on commercial brew and local brew respectively. Multivariate-adjusted use of local brew had rural inclination. Education and high-income occupation protected against HED but not against local brew.

Conclusion Prompt public health response against HED and existing local brew use, should be directed towards Ifakara town. Special consideration to prioritize protection of women and youth is necessary. Other small towns linking urban cities and rural settings populations across should also be explored for their alcohol use status.

Key words: heavy episodic drinking, local brew, alcohol, migration, ethnicity, Tanzania

1. Introduction

Alcohol kills more than 3 million globally as the 3rd leading risk for poor health (World Health Organisation, 2014), and African countries bear most of this burden (Rehm and Shield, 2013). Heavy episodic drinking (HED) also known as binge drinking and use of local brew

are the most common forms of alcohol abuse in the African continent (Obot, 2006a; Willis, 2006; Gureje *et al.*, 2007; Rehm and Shield, 2013; Rehm *et al.*, 2014; World Health Organisation, 2014). Intoxication through HED impairs motor functions thereby affecting rational thinking, and potentially leading into violence, injuries (Rehm *et al.*, 2003). Habitual and long term HED poses risk of chronic conditions such as coronary heart diseases (CHD), fetal alcohol syndrome (FAS), and alcohol use disorder (AUD) alcohol dependence, infections among others (Rehm *et al.*, 2003; Gmel, Kuntsche and Rehm, 2011). Local brew has a lot of harmful toxins and carcinogens including methanol, heavy metals, disinfectants, afla- and myco-toxins (Odhav and Naicker, 2002; Luginaah and Dakubo, 2003; Nkwe, Taylor and Siame, 2005; Josephat, Kyobe and Mosha, 2012; Rehm *et al.*, 2014), as well as dangerous aldehyde substrates which lead to blindness or death (Kitundu *et al.*, 2010). Dilution of local brew with methanol for more profit is very dangerous but not an uncommon practice. The most recent three major methanol poisoning outbreaks reported that occurred in Libya and Kenya, killed 227 out of 1533 victims (Rostrup *et al.*, 2016). Despite such hazards, more than 80% of all alcohol consumed in Tanzania is local brew (Josephat, Kyobe and Mosha, 2012; World Health Organisation, 2014). While global and national public health efforts seek to reduce harmful alcohol use, marketing strategies of the alcohol industry are effectively counteractive, targeting particularly unexplored markets of women and youth in Africa (Babor *et al.*, 2013; Jernigan and Babor, 2015).

The changing alcohol consumption patterns in Africa and increasing alcohol abuse epidemic around the continent is vivid and an important public health concern (Smith and Foxcroft, 2009; Peltzer, Davids and Njuho, 2011; Ramsoomar and Morojele, 2012; Dumbili, 2013; Joel M Francis *et al.*, 2014; Francis *et al.*, 2015; McCall, 2017). The general increase in heavy drinking and evolution of women and youth drinkers calls from prompt public health responses (Odejide, 2006; Willis, 2006; Jernigan, 2009; Dumbili, 2013; Jernigan and Babor, 2015; McCall, 2017). The International Centre for Alcohol Policy (ICAP), is an important

global organization financed by multinational alcohol producers used to champion policy influence in favor of increased alcohol consumption (Babor and Xuan, 2004; Babor *et al.*, 2010). On-going depreciation of protective traditional values and existing freedom of self-regulation allows ICAP and its allies to throw in a paradox of deceptions to instill and protect an acceptable image of the industry for the purpose of more alcohol consumption under the good name of social responsibility (Bakke and Endal, 2010; Dumbili, 2013; Jernigan and Babor, 2015). In an aggressive attempt to capture poor markets the alcohol industry strategized pricing to its lowest, resulting in unrecorded fatal intoxication including young girls (McCall, 2017). There is no borderline; alcohol is accessible anytime, any day, anywhere without any age limits (McCall, 2017), to the extent that children as young 14 years speak of alcohol preference as if it were their birth right (De Bruijn, 2011). Studies have confirmed that early initiation of alcohol use is more likely to abuse practices like binging (Jernigan *et al.*, 2017). A disappointment though, is that many countries in Africa including Tanzania have not been able to adopt the WHO 2008 resolution for reduction of alcohol attributable burden (WHO, 2009), and hence continue to rely on the industry self-regulation. The need to understand the extent of alcohol abuse is therefore public health priority, in order to establish an appropriate response (Obot, 2006a, 2015).

In order to intervene the changing alcohol patterns we need to understand the context that shapes it and this may differ by ethnicity, age, gender, migration and social economic status (C Donath *et al.*, 2011; E. Amundsen, 2012; Chartier, Vaeth and Caetano, 2013; Myadze and Rasomine, 2014). Only a few studies have explored alcohol abuse and associated social determinants in Tanzania or the region (Mitsunaga and Larsen, 2008; Mbatia *et al.*, 2009; Castens *et al.*, 2012; Mongi *et al.*, 2013; Joel M Francis *et al.*, 2014; Francis *et al.*, 2015; Isaksen *et al.*, 2015). Both HED and use of local brew are the two most important forms of alcohol abuse, however its public health importance is difficult to justify because the burden has not been quantified neither characterized. It is even now more relevant to evaluate the

situation of these forms of alcohol abuse amidst complex interaction between ongoing epidemiological transition, public health efforts to contain the burden of alcohol abuse, existing counteracting activities by the alcohol industry as well as governments' interests on revenues. Such evidence will provide insight on how much people in remote settings are at risk for priority setting. Moreover, it will also be a source of guidance for establishing alcohol regulatory policies and interventions that are population specific. We examined HED frequency and use of local brew and how it associates with education, occupation, ethnicity and migration status as well as other lifestyle factors in Ifakara, Tanzania.

2. Methods

Study Design

Data came from a cross section of the MZIMA open community cohort on adult health lodged in the Ifakara Urban Health and Demographic Surveillance System (IU-HDSS) (Geubbels *et al.*, 2015). MZIMA collects information on human immunodeficiency virus (HIV), non-communicable diseases (NCDs), risk factors and social determinants on a series of zero-surveys every two years. Details on study procedures are described elsewhere (Abdul *et al.*, 2014).

Study site and population

Ifakara town is the capital of Kilombero district situated in Morogoro region in south-east Tanzania. Participants were recruited from the Mlabani and Viwanja Sitini areas, where the population of people ≥15 years is estimated to be 13,035. Main source of income is from farming and trading. It is a very multi-ethnic setting due to continuous in-migration.

Participant recruitment

Following community sensitization activities and ten cell leader notification door-to-door visits recruited eligible participants (≥15yrs), resident in the study areas during the latest IU-HDSS round), willing and able to give informed consent.

Data collection

Phrasing for social determinants was adapted from standard questions used in Analyzing Longitudinal Population-based HIV/AIDS data for Africa (ALPHA) network (LSHTM, 2005). The interview tool was translated from English into Swahili and back translated to English and was pilot tested. Interviewers used tablet personal computers programmed with the open source Open Data Kit (OPD, 2008). Validation checks and skip patterns helped reduce faulty entries. Consented participants were identified through fingerprints and/or HDSS identification numbers. Alcohol use was assessed by questions that were adapted from the WHO STEPS tool for NCD surveillance (WHO, 2005).

Measures

Binge drinking was calculated among current drinkers and further characterized to understand frequency patterns of binging. Current drinkers were all participants who responded yes to the question “Have you had alcohol within the past 30 days?” Men who had 5 or more drinks in a single drinking session were classified as binge drinkers, and so were women who had 4 or more drinks in one drinking session (NIAAA, 2017). Types of alcoholic drinks was categorized as local brew, commercial brew which included commercial beer, wine and the commercially distilled liquor made of sugar cane locally known as Konyagi.

Study sample size

The focus of this secondary analysis is on binging, use of local brew and associated factors. Since no data were available on which a reliable estimate of alcohol intake could be made at the time of the study design, we employed the rule of having at least 10 outcome events per covariate included in the multivariable model to prevent problems with bias, precision and significance (Peduzzi *et al.*, 1996). A sample size of 7834 participants was used to interview alcohol habits. A complete data set was then extracted (n=762), which suffices to perform statistical analysis with sufficient power.

Data analysis

STATA version 12 was used for the analysis. Outcome variables were binge drinking and type of alcoholic drinks consumed. Outcome variables were described by socio-demographic variables including age, education level, marital status, type of occupation, religion, ethnicity, and migration status using frequency percentages. Exposure variables of interest in multivariable analysis were the social determinants: education, work, type of occupation, migration status and ethnicity. Lifestyle factors (smoking, care use) were also analyzed for association with HED and local brew use. Separate logistic regression models assessed the associations with outcome variables “local brew use” and “binge drinking on local brew”. For the association analysis of local brew use the complement was commercial brew. For the association analysis of binge drinking on local brew, the complement was binge drinking on commercial alcohol. Since men and women consume alcohol differently, hence descriptive and multivariable analyses were separated by gender. A significance level of 0.05 was assumed.

Ethics Consideration

Both the Ifakara Health Institute Institutional Review Board and National Institute for Medical Research reviewed and approved this study. All interviewers were trained in basic health

research ethics. Confidentiality of participant identity was ensured by use of encrypted ID codes and proper storage of data and personal information.

3. Results

3.1 Description of population of binge drinkers

A total of 8,734 participants were interviewed but only 776 (9%) were current drinkers, and 762 formed complete cases hence were included in the analysis. A higher proportion of current drinkers included men (56.3%) than women (43.7%) (Table 1). Majority were educated to primary level only (61.2%), and 15.7% had not received any formal education. Most people were farmers, and almost three quarters of those unemployed were women (Table 1). Although the host population originating from Morogoro formed the largest single ethnic group, migrants from various regions of the country collectively exceeded 50% (Table 1).

Table 1: Description of the study population

Variable	Specific variable	Males %(N)	Females %(N)	Total %(N)
Total	**All participants**	**56.3(429)**	**43.7 (333)**	**100.0 (762)**
Age	Below 25 yrs.	4.9(21)	15.6 (52)	9.6 (73)
	25 – 50 yrs.	58.5 (2519	58.9 (196)	58.7 (447)
	50 – 60 yrs.	17 (73)	13.8 (46)	15.6 (119)
	60 and above	19.6 (84)	11.7 (39)	16.1 (123)
Education	No Education	11(47)	21.6 (72)	15.6 (119)
	Primary Education	63.8(274)	57.7 (192)	61.2 (466)
	Secondary Education	20.3 (87)	18.6 (62)	19.6 (149)

	Tertiary Education	4.9 (21)	2.1(7)	3.7 (28)
Marital status	Never married	20.5 (88)	23.1 (77)	21.7 (165)
	Monogamous	61.1(262)	49 (163)	55.8 (425)
	Polygamous	1.4 (6)	2.4(8)	1.8 (14)
	Widowed	4.7 (20)	11.1 (37)	7.5 (57)
	Separated	12.4 (53)	14.4 (48)	13.3 (101)
Work status	Working	91.8(394)	76 (253)	84.9 (647)
	Not working	8.2 (35)	24 (80)	15.1 (115)
Occupation	Farming	38.9(167)	32.1(107)	36.0 (274)
	Small business owners	13.8 (59)	27.6 (92)	19.8 (151)
	Large business owners	4.4 (19)	1.2(4)	3.0 (23)
	Professionals	9.1 (39)	3.6 (12)	6.7 (51)
	Skilled manual labor	14.7 (63)	4.2 (14)	10.1 (77)
	Unskilled manual labor	11.0 (47)	7.2 (24)	9.3 (71)
	Not working	8.2 (35)	24.0 (80)	15.1 (115)
Migration status	Non-migrant	37.5(161)	39.3(131)	38.3 (292)
	From other part of urban Ifakara	4.7 (20)	5.7 (19)	5.1 (39)
	From other part of Kilombero	7.5 (32)	12 (40)	9.5 (72)

	From Morogoro City	2.3(10)	0.6(2)	1.6 (12)
	From other part of Morogoro	19.4 (83)	24 (80)	21.4 (163)
	From outside Morogoro	28.7(123)	18.3(61)	24.15 (184)
Religion	Muslim	32.6(140)	29.7(99)	31.4 (239)
	Catholic	60.8(261)	64.9(216)	62.6 (477)
	Lutheran	1.4 (6)	3 (10)	2.1 (16)
	Other Beliefs	4.43 (19)	2.4(8)	3.5 (27)
	No Religion	0.7 (3)	0 (0)	0.4 (3)
Ethnicity	Morogoro	46.6(200)	46.9(156)	46.7 (356)
	Iringa	11.4 (49)	11.1(37)	11.3 (86)
	Shinyanga/Mwanza/Tabora	5.8(25)	3.9(13)	5 (38)
	Kilimanjaro and Arusha	5.8(25)	6.6(22)	6.2 (47)
	Ruvuma	13.3 (57)	14.7(49)	13.9 (106)
	Coast	5.8(25)	5.7(19)	5.8 (44)
	Mbeya	0.7 (3)	2.1(7)	1.3 (10)
	Other regions	10.5 (45)	9 (30)	9.8 (75)
Smoking status	Never	43.8(188)	89.2(297)	63.7 (485)
	Former	9.8(42)	2.4(8)	6.6 (50)

	Current	46.4(199)	8.4(28)	29.8(227)
Care use in the past 12 months	No visits	42.9(184)	32.7(109)	38.5 (293)
	One visit	20.1 (86)	21.3 (71)	20.6(157)
	Two visits	8.6(37)	14.7 (49)	11.3 (86)
	Three visits	12.1 (52)	11.4 (38)	11.8 (90)
	Four visits	7.9(34)	9.6(32)	8.7(66)
	Five visits	3.5(15)	3.3(11)	3.4(26)
	Six visits and more	4.9(21)	6.9(23)	5.8(44)

3.2 Binge drinking, local brew use and socio-demographic profile

Among all current drinkers 91.3% (769) had at least one session of HED (binge drinking) in the past 30 days as defined by WHO (5/4 or more standard drinks in a single drinking session among men/women). There was no difference in prevalence of HED between men (91.1%) 391 and women (91.6%) 305) (Table 2). More cases of men HED on local brew (47.1%) were observed than women (41.4%). There was also a marked difference in prevalence of binge drinking on local brew among the youngest groups (Men: 16.7%; Women: 6.4%) and the oldest group (Men: 76.9%; Women: 79.5%) (Table 2). The more educated and the higher paying an occupation one has like ownership of large business, professionals described bingers on commercial brew. People with ethnic background from the northern part of Tanzania including Shinyanga, Mwanza, and Tabora described bingers on commercial brew. Those people from the southern part of Tanzania including Morogoro, Iringa, and

Ruvuma described bingers on local brew. Similarly, migrants from rural settings were mostly bingers on local brew. That includes migrants from other parts of Kilombero (Men: 64.3%; Women: 68.6%) and from other parts of Morogoro region besides Kilombero (Men: 68%; Women: 63.2%)

Table 2: Socio-demographic profile of bingers, local brew users and those who are both bingers and local brew users among current drinkers (Total current drinkers, N=762)

Variable	Specific variable	**Prevalence of bingers %**(N)		**Local brew users** %(N)		**Binge on local brew %(N)**	
		Males N=391	**Females N=305**	**Males N=219**	**Females N=146**	**Males N=202**	**Females N=138**
Total	All % (n, N)	91.1 (391,429)	91.6 (305,333)	51 (219,429)	43.9 (146,333)	47.1 (202,429)	41.4 (138,333)
Age	Below 25 yrs.	18 (85.7)	47 (90.4)	3 (14.3)	3(5.7)	3 (16.7)	3 (6.4)
	25 – 50 yrs.	227 (90.4)	175 (89.3)	104 (41.4)	73(37.2)	96 (42.3)	67 (38.3)
	50 – 60 yrs.	68 (93.2)	44 (95.7)	46 (63)	39(84.7)	43 (63.2)	37 (84.1)
	60 and above	78 (92.9)	39 (100)	66 (78.6)	31(79.5)	60 (76.9)	31 (79.5)
Education	No Education	40 (85.1)	69 (95.8)	36 (76.6)	62(86.1)	31 (77.5)	60 (87)
	primary	253 (92.3)	177 (92.2)	146 (53.3)	74(38.5)	138 (54.6)	70 (39.6)
	secondary	77 (88.5)	52 (83.9)	32 (36.8)	10(16.1)	28 (36.4)	8 (15.4)
	tertiary	21 (100)	7 (100)	5 (23.8)	0 (0)	5 (23.8)	0(0)
Marital status	Never married	80 (90.9)	76 (98.7)	33 (37.5)	19(24.7)	33 (41.3)	19 (25)
	Monogamous	242 (92.4)	146 (89.6)	137 (52.3)	76(46.6)	124 (51.2)	70 (48)

	Polygamous	6 (100)	7 (87.5)	4 (66.7)	2 (25)	4 (66.7)	2 (28.6)
	Widowed	19 (95)	35 (94.6)	15 (75)	30 (81.1)	14 (73.7)	29 (82.9)
	Separated	44 (83)	41 (85.4)	30 (56.6)	9 (39.6)	27 (61.4)	18 (43.9)
Work status	Working	359 (91.1)	233 (92.1)	191 (48.5)	115 (45.5)	176(49)	107 (45.9)
	Not working	32 (91.4)	72 (90)	28 (80)	31 (38.8)	26 (81.3)	31 (43.1)
Occupation	Farming	94.6 (158)	95.3 (102)	66.5 (111)	61.7 (66)	67.7 (107)	62.8 (64)
	Small business owners	78.0 (46)	88.0 (81)	27.1 (16)	38.0 (35)	21.7 (10)	37.0 (30)
	Large business owners	94.7 (18)	100 (4)	10.5 (2)	0.0 (0)	11.1 (2)	0.0 (0)
	Professionals	97.4 (38)	75.0 (9)	25.6 (10)	16.7 (2)	26.3 (10)	11.1 (1)
	Skilled manual labor	92.1 (58)	92.9 (13)	39.7 (25)	28.6 (4)	39.7 (23)	30.8 (4)
	Unskilled manual labor	87.2 (41)	100.0 (24)	57.5 (27)	33.3 (8)	58.5 (24)	33.3 (8)
	Not working	91.4 (32)	90.0 (72)	12.8 (28)	38.8 (31)	81.3 (26)	43.1 (31)
Migration status	Non-migrant	149 (92.6)	123 (93.9)	86 (53.4)	52 (39.7)	79 (53)	52 (42.3)
	From other urban Ifakara	18 (90)	15 (79)	9 (45)	9 (47.4)	9 (50)	6 (40)
	From other part of Kilombero	28 (87.5)	35 (87.5)	19 (59.4)	27 (67.5)	18 (64.3)	24 (68.6)
	From Morogoro City	9 (90)	1 (50)	2 (20)	1 (50)	1 (11.1)	0 (0)
	From other part of Morogoro	78 (94)	76 (95)	54 (65.1)	49 (61.3)	53 (68)	48 (63.2)
	From outside Morogoro	109 (88.6)	55 (90.2)	49 (39.8)	8 (13.1)	42 (38.5)	8 (14.6)
Religion	Muslim	122 (87.4)	91 (91.9)	79 (56.4)	40 (40.4)	69 (56.6)	37 (40.7)
	Catholic	244 (93.5)	200 (92.6)	130 (49.8)	100 (46.3)	123 (50.4)	96 (48)
	Lutheran	5 (83.3)	6 (60)	2 (33.3)	4 (40)	2 (40)	3 (50)
	Other beliefs	17 (89.5)	8 (100)	7 (36.8)	2 (25)	7 (41.2)	2 (25)

	No Religion	3 (100)	0 (100)	1 (33.3)	-	1 (33.3)	-
Ethnicity	Morogoro region	188 (94)	144 (92.3)	116 (58)	87 (55.8)	108 (57.5)	81 (56.3)
	Iringa region	46 (93.9)	35 (94.6)	27 (55.1)	15 (40.5)	26 (56.5)	15 (42.9)
	Shinyanga/Mwanza/Tabora	21 (84)	13 (100)	4 (16)	1 (7.7)	4 (19.1)	1 (7.7)
	Kilimanjaro and Arusha	22 (88)	19 (86.4)	4 (16)	3 (13.6)	3 (13.6)	2 (10.5)
	Ruvuma	51 (89.5)	47 (95.9)	32 (56.1)	26 (53.1)	31 (60.8)	25 (53.2)
	Coast	22 (88)	17 (89.5)	14 (56)	10 (52.6)	13 (59.1)	10 (58.8)
	Mbeya	3 (100)	6 (85.7)	1 (33.3)	1 (14.3)	1 (33.3)	1 (16.7)
	Other regions	38 (84.4)	24 (80)	21 (46.7)	3 (10)	16 (42.1)	3 (12.5)
Smoking status	Never	92.0 (173)	90.6 (269)	36.7 (69)	39.4 (117)	37.0 (64)	40.5 (109)
	Former	85.7 (36)	100 (8)	52.4 (22)	75.0 (6)	50.0 (18)	75.0 (6)
	Current	91.5 (182)	100 (28)	64.3 (128)	82.1 (23)	65.9 (120)	82.1 (23)
Care use in the past 12 months	No visits	87.5 (161)	90.8 (99)	53.8 (99)	45.0 (49)	53.4 (86)	45.5 (45)
	One visit	91.9 (79)	91.6 (65)	48.8 (42)	39.4 (28)	51.9 (41)	41.5 (27)
	Two visits	91.9 (34)	96.0 (47)	56.8 (21)	42.9 (21)	58.8 (20)	42.6 (20)
	Three visits	96.2 (50)	89.5 (34)	40.4 (21)	52.6 (20)	40.0 (20)	52.9 (18)
	Four visits	97.1 (33)	87.5 (28)	52.9 (18)	43.8 (14)	54.6 (18)	50.0 (14)
	Five visits	86.7 (13)	100 (11)	60.0 (9)	54.6 (6)	61.5 (8)	54.6 (6)
	Six visits and more	100 (21)	91.3 (21)	42.9 (9)	34.8 (8)	42.9 (9)	38.1 (8)

3.3 Frequency of binge drinking and use of local brew

Most current drinkers consumed alcohol 1 to 3 times monthly (52%, n=396) and 1 to 3 times weekly (13.4%, n=102) (Table 3). A large group of drinkers could not recall count of alcohol sessions they had in the past 30 days (28.9%, n=220) (Table 3).

Table 3: Frequency of alcohol use and proportion of binge drinkers among current drinkers

Proportion of current drinkers across frequency categories for alcohol consumption % (N)	**Proportion of bingers and non-bingers among male drinkers, N (%)**			**Proportion of bingers and non-bingers among female drinkers, N (%)**			**Proportion of total bingers among current drinkers N (%)**
	Not bingers	**Bingers**	**Total**	**Not bingers**	**Bingers**	**Total**	
1-3 monthly: 52 (396)	23 (11.1)	185 (88.9)	208 (100)	23 (12.2)	165 (87.8)	188 (100)	350 (88.4)
1-3 weekly: 13.4 (102)	7 (9.6)	66 (90.4)	73 (100)	3 (10.3)	26 (89.7)	29 (100)	92 (90.2)
>3 times weekly: 2.6 (20)	3 (21.4)	11 (78.6)	14 (100)	0 (0)	6 (100)	6 (100)	17 (85)
Daily: 3.2 (24)	1 (7.7)	12 (92.3)	13 (100)	0 (0)	11 (100)	11 (100)	23 (95.8)
Cannot recall count: 28.9 (220)	4 (3.3)	117 (96.7)	121 (100)	2 (2)	97 98)	99 (100)	214 (97.3)

On examining groups with highest proportion of binge drinkers (i.e. alcohol consumed 1-3 monthly or alcohol consumed 1-3 weekly or who cannot recall), we found that majority binged on every drinking session (Figure 1). The prevalence of current drinkers who binge drink on every drinking session is highest among women (Figure 1), The red column shows that women who consume commercial alcohol have the highest prevalence of binge drinking on every time they have a drink, both in women who consume alcohol 1-3 monthly and those who consume alcohol more frequently at 1-3 weekly (Figure 1).

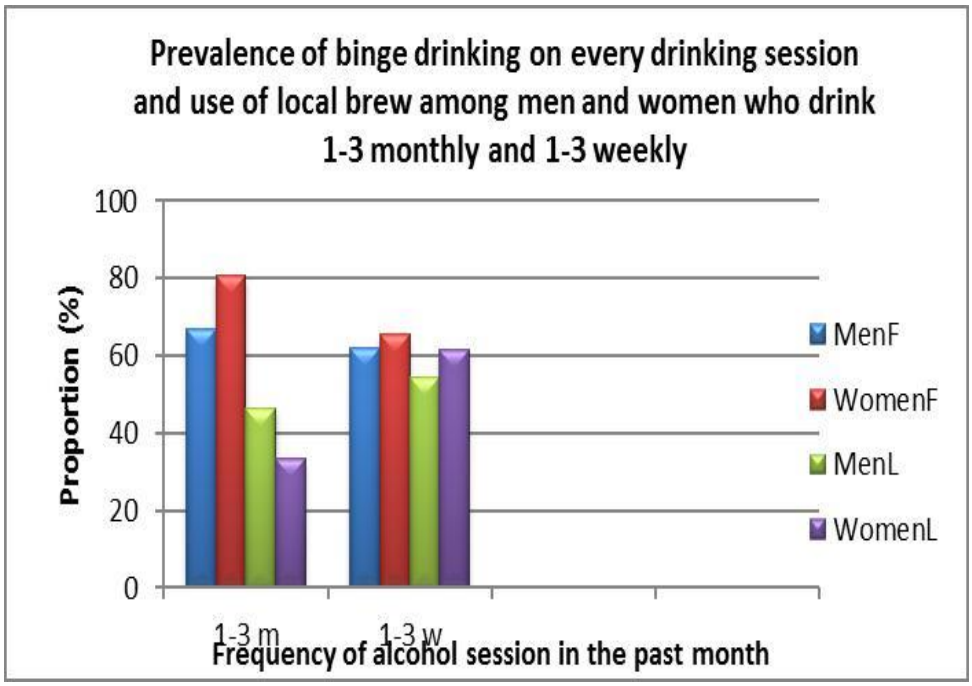

Figure 1: Binge drinking frequency of largest groups of drinkers and corresponding prevalence for local brew users by gender.

- **1-3m: current drinkers who consume alcohol 1-3 monthly.**
- **1-3wcurrent drinkers who consume alcoho1-3 weekly.**
- **MenF: men who binge drink on commercial alcohol.**
- **WomenF: women who binge drink on commercial alcohol.**
- **MenL: men who binge drink on local brew.**
- **WomenL: women who binge drink on local brew.**

3.4 Association of binge drinking and local brew use with social determinants

Regression analysis revealed that education is significantly important for protection against consuming local brew and being a binger on local brew, in both men and women (Table 4a and 4b). Higher earners like small business owners (OR: 0.3, CI95%: 0.1 – 0.6), large business owners (OR: 0.2, CI95%: 0.0 – 0.9), professionals (OR: 0.2, CI95%: 0.1 – 0.5) were all significantly less like to binge on local brew (Fig 4a). This was only true for men and not women bingers. Current drinkers originating from Shinyanga, Mwanza & Tabora regions were less likely to consume local brew (OR: 0.2, CI95%: 0.1– 0.9) (Fig 4b) , and those from Kilimanjaro & Arusha regions were less likely to binge on local brew (OR: 0.2, CI95%: 0.0 - 0,7) (Fig 4a), particularly men than women. Similarly, men bingers who migrated from outside Morogoro region were less likely to consume local brew (OR: 0.3, CI95%: 0.1 – 1.0).

Table 4 a: The odds of being both a binger and local brew user in different categories of social determinants (OR is significant at p<0.05) (OR is significant at p<0.05)

Socio determinants	Specific variable	Univariate Odds Ratio OR[1] (95%CI)		Adjusted Odds Ratio OR[1] (95%CI)		Mutually adjusted Odds Ratio OR[1] (95%CI)	
		Male	**Female**	**Male**	**Female**	**Male**	**Female**
Education	No Education	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
	Primary	0-3 (0.2-0.8)	0.1 (0.0 – 0.2)	0.4 (0.2-0.9)	0.4 (0.2 – 0.9)	0.5 (0.2 -1.3)	**0.2 (0.1 – 0.4)**
	Secondary	0.2 (0.1 – 0.4)	0.0 (0.0 -0.1)	0.1 (0.1 – 0.49	0.1 (0.1 – 0.4)	**0.2 (0.1 – 0.6)**	**0.1 (0.0 – 0.2)**
	Tertiary	0.1 (0.0 -0.3)	1 empty	0.1 (0.0 – 0.2)	0.1 (0.0 - 0.2)	**0.1 (0.0 -0.3)**	1 empty
Work status	Work	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
	Not working	4.5 (1.8 -11.2)	0.9 (0.5 – 1.5)	4.3 (1.4 -12.8)	1.1 (0.6 – 2.2)	2.6 (0.7 – 9.5)	0.8 (0.4 – 2.0)
Type of work	Farmers	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
	Livestock keeping	-	0.3 (0.0 – 3.3)	-	0.1 (0.0 – 0.8)	-	0.2 (0.0 -7.5)
	Small Business	0.1 (0.1 – 0.3)	0.3 (0.2- 0.6)	0.2 (0.1 – 0.4)	0.7 (0.3 – 1.2)	**0.3 (0.1 – 0.6)**	0.8 (0.3 -1.7)

	Large Business	0.1 (0.0 – 0.3)	-	0.1 (0.0 -0.4)	1 empty	**0.2 (0.0 – 0.9)**	1 empty
	Professionals	0.2 (0.1 – 0.4)	0.1 (0.0 – 0.6)	0.2 (0.1 – 0.5)	0.1 (0.0 -0.6)	**0.2 (0.1- 0.5)**	0.2 (0.0 -2.8)
	Driver	0.1 (0.0 – 0.3)	-	0.1 (0.0 -0.6)	-	**0.1 (0.0 – 0.4)**	-
	Skilled Manual Work	0.5 (0.3 -1.0)	0.3 (0.1 – 0.9)	0.7 (0.3 – 1.5)	0.8 (0.2 – 3.1)	0.7 (0.3 – 1.6)	0.9 (0.2 – 5.1)
	Unskilled Manual Work	0.7 (0.4 – 1.5)	0.5 (0.2 – 1.5)	1.1 (0.5 -2.3)	0.8 (0.2 – 2.6)	0.8 (0.4 – 1.9)	0.7 (0.2 – 3.1)
	Fishing	2.0 (0.4 – 9.7)	-	2.7 (0.5 – 13.6)	-	2.4 (0.4 – 13.0)	-
	Bar work	-	0.1 (0.0 – 0.6)	-	0.3 (0.0 – 3.0)	1 empty	0.8 (0.1 – 9.4)
	Not working	2.1 (0.8-5.6)	0.4 (0.2 – 0.8)	2.5 (0.8 – 7.6)	0.7 (0.3 – 1.5)	1 omitted	1 omitted
Ethnicity	Morogoro	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
	Iringa	1.0 (0.5 – 1.8)	0.6 (0.3-1.2)	0.9 (0.5 – 1.8)	0.8 (0.3-1.8)	0.8 (0.4- 1.8)	0.9 (0.4 – 2.5)
	Shinyanga/Mwanza/Tabora	0.2 (0.1 -0.5)	0.1 (0.0 – 0.5)	0.3 (0.1 – 0.9)	0.1 (0.0 – 1.0)	0.3 (0.1 – 1.2)	0.1 (0.0-1.2)
	Kilimanjaro and Arusha	0.1 (0.0 -0.4)	0.1 (0.0 – 0.4)	0.1 (0.0 -0.5)	0.1 (0.0 -0.3)	**0.2 (0.0 -0,7)**	0.3 (0.0 – 2.0)
	Ruvuma	1.1 (0.6 – 2.2)	0.9 (0.5 – 1.7)	1.4 (0.7 – 2.6)	1.1 (0.5 – 2.4)	**2.3 (1.0 – 5.1)**	1.0 (0.4 – 2.5)
	Coast	1.1 (0.4 – 2.6)	1.1 (0.4 -3.1)	1.5 (0.6 – 3.9)	1.4 (0.5-4.3)	1.9 (0.6 – 5.8)	1.1 (0.3 – 3.9)
	Mbeya	0.4 (0.0 – 4.2)	0.2 (0.1 -1.4)	0.3 (0.0 – 4.5)	0.7 (0.1 – 7.6)	0.6 (0.0 – 22)	2.2 (0.1 – 38.3)
	Other	0.5 (0.3 -1.1)	0.1 (0.0 - 0.4	0.7 (0.4 – 1.6)	0.2 (0.1 – 1.0)	0.9 (0.4 – 2.5)	0.2 (0.0 – 1.2)
Migration	Non-migrant	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
	From other part of urban Ifakara	0.9 (0.3 – 2.4)	0.9 (0.3 – 2.7)	0.6 (0.2 – 1.8)	0.5 (0.2 -1.8)	0.8 (0.3 – 2.9)	0.6 (0.2 -2.4)
	From other part of Kilombero	1.6 (0.7 – 3.7)	3.0 (1.3 – 6.6)	1.1 (0.5 – 2.6)	2.0 (0.8 – 5.0)	2.1 (0.7 -6.4)	1.3 (0.4 – 3.7)
	From Morogoro City	0.1 (0.0 – 0.9)	1 empty	0.1 (0.0 – 0.9)	1 empty	0.1 (0.0 – 1.3)	1 empty
	From other part of Morogoro	1.9 (1.1 – 3.3)	2.3 (1.3 – 4.2)	1.4 (0.8 – 2.6)	1.4 (0.7 – 2.8)	1.7 (0.9 – 3.6)	1.5 (0.7 -3.3)
	From outside Morogoro	0.6 (0.3 -0.9)	0.2 (0.1 – 0.5)	0.5 (0.3 – 0.9)	0.2 (0.1 -0.5)	1.1 (0.5 -2.2)	0.4 (0.1-1.3)

1 A positive outcome is protection against “being both a binger and local brew user”

Table 4 b: The odds of being a local brew user in different categories of social determinants (OR is significant at p<0.05)

Socio determinants	Specific variable	Univariate Odds ratio OR[1] (95%CI)		Adjusted Odds ratio OR[1] (95%CI)		Mutually adjusted Odds ratio OR[1] (95%CI)	
		Male	Female	Male	Female	Male	Female
Education	No Education	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
	Primary	0.3 (0.2-0.7)	0.1 (0.0-0.2)	0.4 (0.2-0.8)	0.2 (0.1– 0.4)	0.5 (0.2– 1.2)	**0.2 (0. – 0.4)**
	Secondary	:0.2 (0.1-0.4)	0.0 (0.0-0.1)	0.2 (0.1-0.4)	0.0 (0.0– 0.1)	**0.2 (0.1– 0.6)**	**0.1 (0.0-0.2)**
	Tertiary	0.1 (0.0-0.3)	1 (empty)	0.1 (0.0– 0.2)	1 (empty)	**0.1 (0.0– 0.3)**	1 empty
Work status	Work	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
	Not working	4.3 (1.8-10)	0.8 (0.5-1.3)	4.2 (1.4-2.3)	1.0 (0.5-1.9)	2.7 (0.8– 9.0)	0.9 (0. – 2.0)
Type of work	Farmers	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
	Livestock keeping	-	0.3 (0.0 –3.4)	-	0.1 (0.0–0.8)	-	0.2 (0.0 –4.8)
	Small Business	: 0.2 (0.1-0.4)	0.4 (0.2 –0.7)	0.3 (0.1 –0.6)	0.7 (0.3 –1.2)	**0.4 (0.2 –0.8)**	0.8 (0.4 – 1.6)
	Large Business	0.1 (0.0 – 0.3)	1	0.1 (0.0 –0.4)	1	0.2 (0.0 –1.0)	1 empty
	Professionals	0.2 (0.1 – 0.4)	0.1 (0.0 –0.6)	0.2 (0.1 –0.5)	0.1 (0.0 –0.6)	**0.2 (0.1- 0.5)**	0.5 (0.1–4.14)
	Driver	0.1 (0.0 – 0.3)	-	0.1 (0.0 –0.7)	-	**0.1 (0.0 –0.5)**	-
	Skilled Manual Work	0.5 (0.3 – 1.0)	0.2 (0.1 –0.8)	0.8 (0.4 –1.6)	0.8 (0.2-3.1)	0.8 (0.4 –1.7)	0.9 (0.2 – 4.7)
	Unskilled Manual Work	0.7 (0.4 – 1.5)	0.5 (0.2 –1.6)	1.1 (0.5 –2.3)	0.8 (0.2 –2.6)	0.9 (0.4 –2.0)	0.7 (0.2 – 2.8)
	Fishing	2.1 (0.4–10.2)	-	3.0 (0.614.9)	-	2.8(0.5-14.8)	-
	Bar work	1 empty	0.1 (0.0– 0.6)	1 empty	0.3 (0.0– 3.0)	1 empty	0.9 (0.1 11.2)
	Not working	2.1 (0.9 – 5.1)	0.4 (0.2– 0.7)	2.6 (0.9–7.8)	0.7 (0.3–1.5)	1 omitted	1 omitted
Ethnicity	Morogoro	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
	Iringa	0-9 (0.5 – 1.7)	0.5 (0.3– 1.1)	0.9 (0.4– 1.7)	0.7 (0.3–1.6)	0.8 (0.4– 1.7)	0.9 (0.3 – 2.3)
	Shinyanga/Mwanza/Tabora	0.1 (0.0 – 0.4)	0.1 (0.0– 0.5)	0.2 (0.1– 0.7)	0.1 (0.0– 1.0)	**0.2 (0.1– 0.9)**	0.1 (0.0 – 1.3)
	Kilimanjaro and Arusha	0.1 (0.0 – 0.4)	0.1 (0.0– 0.4)	0.2 (0.0– 0.5)	0.1 (0.0 -0.4)	**0.2 (0.1– 0.7)**	0.6 (0.1 – 3.1)
	Ruvuma	0.9 (0.5 – 1.7)	0.9 (0.5– 1.7)	1.1 (0.6– 2.1)	1.1 (0.5– 2.2)	1.5 (0.7– 3.2)	1.0 (0.4 – 2.4)
	Coast	0.9 (0.4 – 2.1)	0.9 (0.3 –2.3)	1.4 (0.6– 3.2)	1.0 (0.4– 3.0)	1.4 (0.5– 4.0)	0.7 (0.2 – 2.3)
	Mbeya	0.4 (0.0 – 4.1)	0.1 (0.0– 1.1)	0.3 (0.0– 4.4)	0.5 (0.0– 4.4)	0.6 (0.2–17.5)	1.4 (0.1– 19.3)

	Other	0.6 (0.3 – 1.2)	0.1 (0.0– 0.3)	0.8 (0.4– 1.7)	0.2 (0.0– 0.6)	1.0 (0.4 -2.5)	0.2 (0.0 -1.0)
Migration status	Non-migrant	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**	**Ref**
	From other part of urban Ifakara	0.7 (0.3 – 1.8)	1.4 (0.5– 3.6)	0.5 (0.2– 1.4)	0.9 (0.3– 2.6)	0.7 (0.2– 2.4)	1.1 (0.3 – 3.5)
	From other part of Kilombero	1.3 (0.6 – 2.8)	3.2 (1.5– 6.7)	0.9 (0.4– 2.0)	2.0 (0.9– 4.7)	1.6 (0.6– 4.3)	1.5 (0.5 – 4.1)
	From Morogoro City	0.2 (0.0 – 1.1)	1.5 (0.1-24.8)	0.2 (0.0– 1.0)	0.5 (0.0-12.9)	0.3 (0.0– 1.5)	0.8 (0.0– 36.3)
	From other part of Morogoro	1.6 (0.9 – 2.8)	2.4 (1.4– 4.2)	1.2 (0.6– 2.1)	1.3 (0.7– 2.6)	1.3 (0.7– 2.5)	1.4 (0.7 – 3.1)
	From outside Morogoro	0.6 (0.4 – 0.9)	0.2 (0.1– 0.5)	0.5 (0.3– 0.8)	0.2 (0.1– 0.5)	1.1 (0.5– 2.1)	0.3 (0.1 – 1.0)

1 A positive outcome is protection against “use of local brew”

Men who were current smokers were also three times more likely to be bingers on local brew when compared to non-smokers, and the association was statistically significant (Table 5). Women however, had a much likelihood of binging on local brew if she were a former smoker, and the association was significant (Table 5). Frequency of care use was not found significant in influencing local brew use as a binge drinker or current drinker.

Table 5 Association of binge drinking on local brew, local brew use and smoking, use of health care services among those without chronic disease

Sociodemographic variable		Risk of men binge drinking on local brew		Risk of women binge drinking on local brew		Risk of local brew consumption	
		OR[1]	95% CI	OR[1]	95% CI	OR[1]	95% CI
Smoking status	**Never**	**Ref**	**-**	**Ref**	**-**	**Ref**	**-**
	Former	1.5	0.5 – 4.2	**1.6**	**1.3 – 18.7**	1.6	0.7 – 3.7
	Current	**3.2**	**1.8 – 5.8**	4.4	0.9 – 21.4	**3.0**	**1.8-5.0**
Care use in the past 12 months	**No visits**	**Ref**	**-**	**Ref**	**-**	**Ref**	**-**
	One visit	1.3	0.6-2.7	0.6	0.2 -1.7	0.9	0.6-1.3
	Two visits	2.1	0.7-5.9	1.2	0.4-3.8	0.9	0.6-1.6
	Three visits	0.5	0.2-1.1	1.4	0.4-4.9	0.6	0.4-1.0
	Four visits	1.6	0.5 -4.9	1.4	0.4-5.2	0.9	0.5-1.6
	Five visits	2.9	0.7 – 11.4	1.5	0.2-10.4	2.1	0.8-5.2
	≥Six visits and	1.0	0.2-3.8	1.0	0.2-5.6	0.5	0.2-1.0

4. Discussion

Almost all drinkers in this Tanzanian semi-urban town setting have had binge drinking at least once in the past 30 days. In fact majority drink to level of intoxication defined as HED every time they have a drinking session. Moreover, we found that as drinking sessions increased, so did the prevalence of HED and local brew use. It is very possible that drinkers are not aware about harmful drinking and its benchmarks. Moreover, the understanding of what defines harmful drinking and what defines a standard alcoholic drink may be low. We also observed the that gender gap in HED, which normally exist between men and women to be almost absent. There are also signs of local brew phasing out and being replaced by commercial alcohol. All these are convincing that the alcohol industry is gaining a grip on its new targets. We observed HED on local brew to be mainly by the low SES population and commercial alcohol HED to be by the high SES. The results have also shown that almost one third of drinkers are also current smokers, and this is an important risk to head and neck malignancies.

Our results concur with previous ones in Africa (Ramsoomar and Morojele, 2012; Dumbili, 2013; Joel M. Francis *et al.*, 2014; Francis *et al.*, 2015), indicating that people are changing their drinking habits with HED becoming more widespread and the gender gap closing in. We found that almost every drinker has had HED at least once in the past 30 days (Men: 91.1%; Women: 91.6%). This HED prevalence is strikingly higher than 71.5% and 64.1% for men and women respectively reported from a national representative survey five years ago (Mayige and Kagaruki, 2012). We also deduced that HED may be the habitual way of drinking because every time people had a drinking session, most of them exceeded the HED cut offs. Several misleading concepts from marketing activities listed elsewhere may be true to this setting too. Such include among others “drinking is good for health”, drinking is essential in business affair”, “drinking heightens sexual performance” (Tang *et al.*, 2013).

Communities that are informed about what alcohol can do to health and how people can become enslaved and victimized as alcoholics, can participate in policy development dialogue including regulation of marketing strategies. The public health community calls for governments to prioritize public health over interest in alcohol business revenues, by adopting and enforcing alcohol regulation policies in line with the WHO 2009 resolution (WHO, 2009), in order to reduce harmful use of alcohol. Sadly, there has neither been any nationwide campaigns to educate people about alcohol and its potential health harms nor has there been activities to educate the population on WHO recommendations on protection against harmful alcohol use.

Obot expressed concern of a growing alcohol burden and the need to gather enough evidence for a comprehensive counter intervention (Obot, 2006b, 2015). Now more than a decade down the line, the effects of a growing alcohol market are becoming tangible in different corners of the continent, but still serious public health action and an effective political commitment is yet to be realized. A recent study in Kenya reported alcohol to be responsible for 13% of new HIV cases (Braithwaite, R. S.; Nucifora, K. A.; Kessler, J.; Toohey, C.; Mentor, S. M.; Uhler, L. M.; Roberts, M. S.; Bryant, 2014). Use of alcohol as a currency for sex shopping among men and thereafter getting involved in unprotected sex as a result of partly being under the alcohol influence is not uncommon (Watt, Aurion and Pieterse, 2012). Moreover, meta-analysis and systematic reviews revealed that many people leaving with HIV/AIDS do consume alcohol, and are more likely to engage in unprotected sex (L.A.J. *et al.*, 2013). Furthermore, there is an increased risk of inconsistent medication use in HIV patients who consume alcohol and thus subsequent risk of drug resistance and increased mortalities (Medley *et al.*, 2014). Increase in alcohol consumption is hence a clear indication that besides violence events, traffic injuries, NCDs, we should also expect more HIV cases. Since HED is the most common form of alcohol consumption in Africa, increased availability and accessibility fueled by strategic marketing of alcohol has quickly made Africa

a frontier for the alcohol industry (Obot, 2015). Consequent morbidities and mortalities are inevitable, unless governments engage in a strategic shift with increased inter-sectoral role play, increased community involvement and improved regulation of the alcohol industry (Ferreira-Borges, Dias, *et al.*, 2015; Ferreira-Borges, Esser, *et al.*, 2015; Ferreira-Borges *et al.*, 2016).

Successful marketing strategies of the alcohol industry may explain the dramatic rise in women HED prevalence surpassing that of men observed in this study. This study clearly shows women particularly those consuming commercial alcohol are on proportional terms most affected by frequent HED than men. Some argue that both increasing financial independence among women and rising feminism may have also contributed into breaking taboos that traditionally limited women from alcohol use (Dumbili, 2013). Alcohol consumption in pregnancy predisposes the unborn child to Fetal Alcohol Syndrome (FAS), which impacts the child's cognitive development with poor short-term memory, weakness in arithmetic and delay in information processing (Isaksen *et al.*, 2015; Popova *et al.*, 2016). Most women in East Africa consume alcohol in pregnancy (3.4%-20.5%) compared to others in Sub Saharan Africa (Popova *et al.*, 2016). It is also reported that many pregnant women in Northern Tanzania consume alcohol (Isaksen *et al.*, 2015). Now as the prevalence of women drinking and HED grows and with limited knowledge about alcohol use and maternal outcomes, more FAS cases should be expected. Women are also exposed to alcohol use and subsequently transactional sex and risk of HIV, as a result of engagement in the actual alcohol production and selling as part of livelihood strategy (McCoy *et al.*, 2013).The alcohol market targets women with small size affordable beverage and with appealing designs and inviting fruity tastes (Dumbili, 2013). All in all, a breakthrough into the women market is reason enough to be very worried about what calamity may be in store as a result. We must also query the health system as well as social support systems preparedness for that.

Replacement of local brew with commercial alcohol is something expected. Consumption of local brew is supported by traditional values and norms (Myadze, Hall and Hwy, 2014), and this is strengthened by our findings with older people and those from rural ethnic background and rural points of migration being more likely to consume local brew. Older people have more attachment to traditional ways and values than the younger ones (Martinez, 2012; Myadze, Hall and Hwy, 2014; Rehm *et al.*, 2014). The present study site is one among many small-town settings around the country that link urban cities with remote rural areas where majority of the population reside. As long as there are similarities on important cultural entities between drinkers at the study site and those in remote rural (Svenson, 2010; Carolin Donath *et al.*, 2011), travel exchanges may facilitate introduction of new alcoholic beverages and new ways of drinking into the rural through acculturation (E. J. Amundsen, 2012). Introduction of commercial alcohol into remote rural setting may be another success story for the alcohol industry. The influx of commercial alcohol to replace local brew which is known for its health hazard is much welcome. However, public health responses must be prepared to counteract the potentially high level HED using commercial alcohol.

Higher education and higher income occupations did not protect against HED but did protect against local brew. A study in Mozambique also observed education and income having no influence on HED (Padrão *et al.*, 2011). In other words, these findings demonstrate a facilitation role of education and higher income occupation in the transition from HED on local brew to HED on commercial brew. Local brew is the cheapest alcoholic beverage and since majority of current drinkers are in the low SES category it is an important basis of choice for many drinkers (Josephat, Kyobe and Mosha, 2012). The ability to afford the more expensive and prestigious commercial brew signifies social economic success (Smith and Foxcroft, 2009; Grittner *et al.*, 2012; Joel M. Francis *et al.*, 2014). This study showed that a person's education did not add value when it came to protection against HED. This lack of awareness

about alcohol and health implication, is an important gap and one which makes it easier for the alcohol industry to market its products with utmost freedom.

Although smoking is generally a rare event, we also found that one third of the population of drinkers were also current smokers. The dual risk factor combination of alcohol consumption and smoking is an important predisposition to cancers. Several studies done in high income as well as low and middle-income countries have reported an increased susceptibility to a number of cancers ranging from head, neck, respiratory, digestive and liver cancer (Canova *et al.*, 2010; Jin *et al.*, 2014; Lee and Hashibe, 2014; Singh *et al.*, 2015; Menvielle *et al.*, 2016). A review published in 2008 reported that three quarters of cancer cases in developed countries are attributed to the combined effect of alcohol consumption and smoking (Pelucchi *et al.*, 2008). In low income countries like Tanzania it is not easy to give an estimate of alcohol use and smoking to the cancer burden, because capacity for measuring and exploring process mechanism of the burden is still limited. Besides the risk of cancer, the synergistic effect of nicotine from cigarettes and ethanol from alcohol on specific brain centers makes it difficult on quitting attempts and increases likelihood of developing mood disorders (Abreu-Villaca *et al.*, 2017). Dual cluster presentation of alcohol use and smoking is an opportunity for reaching out to the respective target populations with health interventions.

Strength and Limitations

This study involved a large sample from the general population which gives strength to our results. However, two important limitations are worth mentioning. First, confounding factors (measure of exposure to warning on alcohol, purchasing power, individual preference) that may have modified our current findings were not available to be included in the evaluation. Second, evidence of alcohol use relied on good recall memory of participants for events in the past 30 days. Moreover, most of the time unrecorded alcohol is consumed in sharing a

one-liter container by approximately 5 people sipping it in rounds until it finishes. This may have created room for error in estimation of volume consumed. All these limitations are uniform challenges in similar studies, hence such error is also uniform, and results are comparable to others.

5. Conclusion

These findings demonstrate the importance of prompt public health response against HED and existing local brew use, to be directed towards Ifakara town. Special consideration to prioritize protection of women and youth is necessary. Increase in women HED, preference of women and youth for commercial alcohol and overall decline in popularity of local brew are three features that suggest successful progress in marketing activities of the alcohol industry. This study confirms previous and similar concerns in different parts of the African continent. If not effectively intervened, more NCDs, injuries and accidents, violence cases, HIV infections, children being born with FAS and decrease in labor output should be expected in the future. We recommend further qualitative investigations to describe the contextual process that support patterns of HED and use of local brew observed. Moreover, we recommend an assessment of the alcohol use status in other small-town settings that link urban cities and rural remote settings across.

Awareness campaigns about alcohol and health implications are critical entry points for containing the alcohol abuse burden and hence should be taken more seriously. Most governments complain of lack of funding as an important bottle neck to address the alcohol burden. In Botswana the government uses part of revenues collected from alcohol sales for economic empowerment projects for youth with aim of diverting them from early initiation of alcohol use (Pitso and Obot, 2011). Moreover, taxation is the world's most cost-effective intervention to reduce population alcohol intake. Public health responses should explore its potential in addressing the on-going changes of the alcohol burden in the study setting.

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Author Contributions

BM conceived, designed the study, analyzed the results and wrote the manuscript. NPH contributed towards data analysis, interpretation and critical review of the manuscript. ICE took part in interpretation of the results and critical review of the manuscript. RA was instrumental in data collection, data cleaning and generation of initial socio-demographic categories. EG contributed towards conceiving and designing the study and also critically reviewed the manuscript. SA, PK, MT, RK critically reviewed the manuscript. All authors read and approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest. The funding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

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Chapter Seven

This chapter provides a discussion of all findings in this study and draws a meaningful conclusion. Moreover, it provides suggestions for public health improvement

7.0 Overall discussion and Conclusion

7.1 Summary of findings

This work provides insight into epidemiologic patterns of unhealthy lifestyle in a semi-urban setting in Tanzania. It defines prevalence of unhealthy habits and characterizes them while also assessing the important context. This study confirms that the ifakara population in southern Tanzania is highly manifested by NCD risky lifestyles (Tab 1). Insufficient FV affects almost everybody (85%), especially because vegetables are consumed in low number of portions and fruits never consumed by most. As expected alcohol use presents a dichotomy of majority being abstainers and a few being drinkers who almost always consume alcohol to intoxication. However, unlike previous studies there was no gender bias in HED among drinkers. Moreover, despite tobacco smokers presenting a minute part of the population, an estimated 25% of drinkers are also daily smokers which is an important health hazard. Most people do meet the cut off point for recommended levels of PA, though there are indications that the population may be in transition to less PA and that is an important public health concern. Low SES, gender and age were found to be prominent features that defined vulnerability to the key risky lifestyles.

Table 1: **Summary of key findings on risky lifestyle profile in the study population**

			
• Low vegetable intake among youth • Small vegetable portions among all • Low SES limits fruit intake	• High SES limits PA • PA declines in old men • All population may be in transition to less PA	• Majority are abstainers • Local brew phasing out • Women and youth prefer commercial brew • Proportion of bingers not gender biased • Almost all drinkers HED	• 25% of drinkers also a daily smoker

This evidence is a new scientific contribution on NCD risky lifestyles. The evidence allows us to interpret the relevance of the populations' ways of life in regard to healthy choices and the

NCD burden. Being specific to a semi-urban setting in Tanzania, the evidence is also a contribution in a geographic context. This part of the thesis discusses the relevance of lifestyle patterns observed with current documented patterns of mortalities and morbidities attributed to major NCDs. Moreover, here we identify and discuss most vulnerable populations to unhealthy choices. Appropriate responses are proposed and critically discussed while highlighting opportunities and challenges that may influence the outcome of public health actions. The discussion also proposes areas for further research as a contribution towards the national NCD research agenda. This study is in line with the global call to address the burden of unhealthy lifestyle through the "25 x 25" risks by the WHO coordinated leadership of "The Lancet NCD Action Group and NCD Alliance" (WHO, 2013). The "25 x 25" risks seeks to reduce 25% unhealthy lifestyle by the year 2025. Specifically, these findings will be an important addition to the national NCD framework for addressing the NCD burden in Tanzania (MOHCGEC, 2016).

7.2 Public health relevance of unhealthy lifestyle patterns

Population behavior transition towards unhealthy behavior is inevitable amidst ongoing urbanization, industrialization and globalization (Omran, 1971). The WHO insists on surveying and monitoring risky lifestyles as a fundamental step in containing the NCD burden (WHO, 2011). Our findings demonstrate that people of low SES are more exposed to risk of NCD mortality. By observation unhealthy lifestyle patterns in this setting we also realise that unhealthy lifestyles are already prevalent at the gateway to rural remote populations. These rural remote areas habour more than 70% of the entire Tanzanian population. Rural populations have stayed relatively immune from NCDs compared to urban dwellers due to differences in exposure to risky lifestyle (M. Njelekela et al., 2003; M. A. Njelekela et al., 2002). However, urbanization and globalization is actively infiltrating unhealthy lifestyles to rural areas (Hendriks et al., 2012; Keding, Msuya, Maass, & Krawinkel, 2013), and already there is indication to show that rural communties have started being affected too (Agyemang, 2006; Walker et al., 2010). Findings from this study is a demonstration that a reservouir of

unhealthy lifestyle is very close to remote rural populations. Future studies may establish the level of importance of these small rural towns like Ifakara in chaneling unhealthy lifestyle to rural populations and how to establish strategies to reverse the situation.

We do not have baseline information on lifestyle patterns and major NCD mortalities and morbidities in the study area for comparison with current patterns. However, we can use past national estimates for lifestyle attributed NCD mortalities to understand the level of importance of each lifestyle to each major NCD, and hence get an insight on the public health relevance of patterns observed here. In 2016, Tanzania recorded an estimated 28,693 behaviour attributed NCD mortalities (IHME, 2018). Out of these NCD mortalities, 22,958 were CVDs (80%), 2,856 were Cancers (10%), 1,712 were Diabetes type II (6%) and 1,167 were COPD (4%). The Figure1 below shows the contribution of the four key risky lifestyles to the burden of major NCD mortality in 2016 (IHME, 2018).

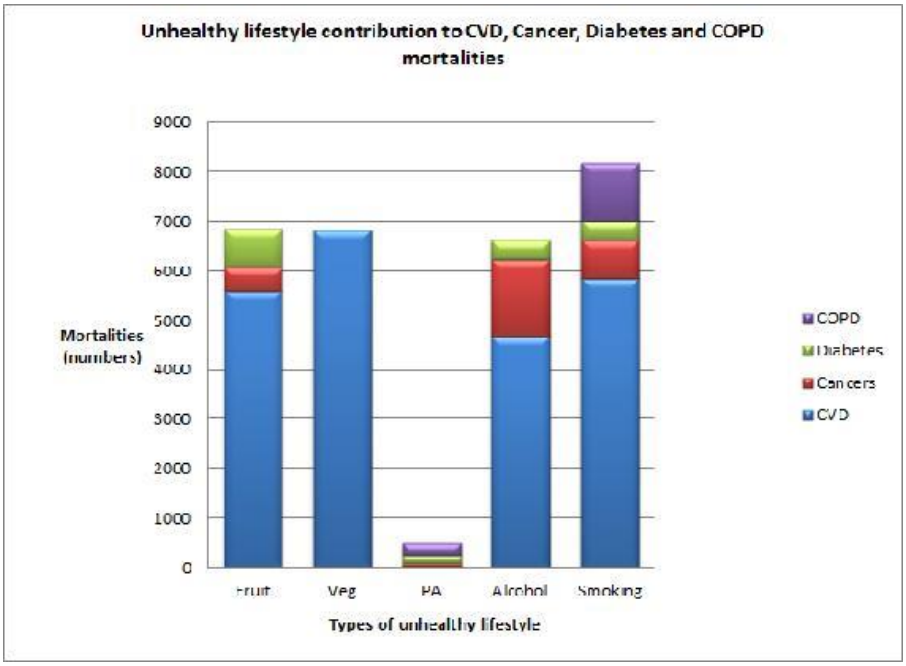

Figure 1: Distribution of NCD mortalities attributed to the four key lifestyle risks, that is low fruit intake, low vegetable intake, insufficient PA, harmful alcohol intake and tobacco smoking in 2016

Cardiovascular diseases are the most important NCDs, with Ischemic Heart Disease (IHD) and stroke being on top of the list in the region (Misganaw et al., 2017). A study in 20 countries with highest CVD burden revealed that the benefit-cost ratio of investing in prevention of CVDs was potential for 5-6 and 9-10 times in economic and social returns respectively (Bertram et al., 2018). These are very big gains and an opportunity to scale up efforts towards achieving the SDG target 3.4 and SDG target 3.8 (WHO, 2015). The SDG target 3.4 aims at one third reduction of NCD premature mortality through prevention and treatment as well as promotion of mental health and well being. The SDG target 3.8 aims at achieving universal health coverage defined as the average coverage of essential services based on tracer interventons that include reproductive maternal, newborn and child health, infectious diseases, non communicable diseases and serivce capacity and access among the general and the most disadvantaged population.

From Figure 1, we can tell that the risk of CVD mortality is distributed with fairly similar intensity across any of the major risky lifestyles, namely low fruit intake, low vegetable intake, harmful alcohol use and smoking. More than 50% of the CVD burden could be reduced with reduction of population insufficient FV intake (IHME, 2018). Findings from this study indicate that almost everybody is exposed to the risk of CVD due to overall insufficient FV intake being highly prevalent (82%) (Chapter 4). Insufficient FV intake is a universal problem, but low resource countries like Tanzania are most affected (Hall, Moore, Harper, & Lynch, 2009; V. Miller et al., 2016).

Besides insufficient FV, the other lot of behaviour attributed CVD mortalities is expected from tobacco smoking and harmful alcohol use. Only a fraction of the current study population was found to be exposed to CVD mortality attributed to tobacco smoking and harmful alcohol use. Harmful alcohol use and tobacco smoking are practiced more by people with low SES as per this study findings, as well as elsewhere (Di Cesare et al., 2013; Hosseinpoor et al., 2012). This study also observed a potential for increase in trends of population harmful

alcohol use especially among women and youth (Chapter 6). Rising harmful alcohol use in Africa, is a concern among the public health community in the continent as well as globally (E. C. Babor, 2010; T. F. Babor, Robaina, & Jernigan, 2015; Bakke & Endal, 2010; Casswell & Thamarangsi, 2009; Ferreira-Borges, Dias, Babor, Esser, & Parry, 2015; Ferreira-Borges, Parry, & Babor, 2017; D. H. Jernigan & Babor, 2015; David H Jernigan, Obot, & Jos, 2006; McCall, 2017; Isidore S Obot, 2013). With increasing harmful alcohol consumption we should expect more alcohol attributed CVD mortality as well as more economic and socio impact among the poorest. More women and youth are hence at risk of CVDs. Since alcohol consumption likes to co-exist with tobacco smoking (Dani & Harris, 2005; Harrison, Desai, & McKee, 2008; Kalman, Morissette, & George, 2005), we are hence more likely to see more women and youth becoming tobacco smokers too including its associated NCD risks in this study population .

Out of 2856 cancer mortalities in 2016 more than 80% were attributed to harmful alcohol and smoking. Estimation of the cancer burden in Tanzania and other african countries is hampered by insufficient population based cancer registries (Louie KS., Silvia, & Philippe, 2009). The single existing one was found to represent only 11% of the population (Louie KS., Silvia, & Philippe, 2009). The governement spends US$ 30mill to treat smoking attributed cancers (Kagaruki, 2015). Though we do not have national estimates of the costs to alcohol attributed cancers, this study warns of potential increasing number of harmful alcohol users and associated cancer burden especially among women and youth (Chapter 6). Therefore increase in cancers common to women should be expected and hence screening activities should be enhanced, since most cases are reported late (Burson Ref 7; Kantelhardt 2005). Cervical cancer is also an important cancer among women (Louie KS. et al., 2009), but the human papilloma virus vaccination initiation may help reduce its virulent outcomes (MOHSW, 2017). Risk of mortality due to head and neck will also start presenting more frequent among women and youth with rise in alcohol and smoking among these groups. According to the Institute for Health Metrics Evaluation (IHME) control of harmful alcohol use and tobacco

smoking can pevent almost the whole burden of behaviour attributed cancer mortality (IHME, 2018). Moreover, control of harmful alcohol use and smoking will lift up a major economic cost on population groups that are of low SES (Goodchild, Nargis, & Tursan d'Espaignet, 2018; A. Kidane, Hepelwa, Ngeh, & Hu, 2015; A. Kidane, Mduma, Naho, & Hu, 2015; Matzopoulos, Truen, Bowman, & Corrigall, 2014; Ngalesoni et al., 2017; S. Popova, Lange, Burd, Shield, & Rehm, 2014; Rehm et al., 2009; Sarasa-Renedo et al., 2014; Thomas, 2011; Wilsnack, Wilsnack, & Kantor, 2013) .

Almost half of all diabetes mortalities in 2016 were attributed to low fruit intake (IHME, 2018). Again, similar to the other key unhealthy lifestyles we found low fruit also affected those population groups with low SES (Chapter 4). High cost of fruit is an important barrier to fruit access among those with low SES (V. Miller et al., 2016). Since fruits are too expensive for many in the low SES to afford, and economic empowerment is a long term solution, it is here proposed that research explores cheap supplement alternatives to fruit. Sesame seeds, chia seeds and black seeds are some of readily available foods that have many essential nutrients also found in fruits, and have been documented to have protective effect to major NCDs (Fawzy, 2007; Llorent-Martínez, Fernández-de Córdova, Ortega-Barrales, & Ruiz-Medina, 2013; Obiajunwa, Adebiyi, & Omode, 2005; Randhawa & Al-Ghamdi, 2002). Currently these seeds are widely available and cheap and are used in drink preparations, as spices in foods in both savoury and sweet snacks. Harmful alcohol and tobacco smoking are also important attributes to diabetes (IHME, 2018). In fact, this therefore means that control of harmful alcohol consumption and tobacco smoking will be able to signifcantly help reduce the burden of almost all major NCDs among people in the low SES category.

Chronic obstructive pulmonary diseases (COPD) are more common in high income countries because they have a more advanced tobacco smoking burden (GDB, 2017a, 2017b). Therefore the burden of COPD in poor countries like Tanzania is thought to be mainly the outcome of tuberculosis burden (Zoller et al., 2018). The low prevalence of smoking

observed (Chapter 4, 6) is an opportunity to contain the burden while it is still in its infancy. Predictions are that by 2030, if not effectively controlled tobacco smokers will reach 8 million globally and by then tables will have turned completely with LMIC absorbing 80% of the burden (Eriksen, Mackay, Schluger, Gomeshtapeh, & Drope, 2015). As the second largest producer of tobacco in Africa (A. Kidane & Ngeh, 2015; URT, 2014), Tanzania contributes significantly to growth of smoking attributed harm in the country as well as globally. Local production makes cigarettes cheaper and more affordable to many, and encourages early smoking initiation. Unlike high income countries like United States, tobacco products from LMIC have most addictive and potent forms of nicotine (Gupta & Ray, 2003; Saleheen, Zhao, & Rasheed, 2014). Moreover, tobacco farming exploits families by inducing vulnerability to cancers, impotence, neuropsychiatric conditions leading to suicides (Kagaruki, 2012; WHO, 2004). Diminished quality of life and child labor and denial of chance for education is prevalent in Tanzanian tobacco farming families (Kagaruki, 2015). Deforestation and soil exposure to large amounts of potent pesticides are part and parcel of tobacco attributed environmental damages (Kagaruki, 2015; WHO, 2004). An account on all tobacco attributed costs may help expose relevance of actively integrating tobacco control in the national annual budget.

The WHO recommends 150 min of moderate to vigorous intense physical activity in 5 days or more per week (WHO, 2010). Insufficient PA predisposes to increase in CVDs, diabetes type II, and cancers including cancers of the breast, colon as well as depression (Kyu et al., 2016; Naci & Ioannidis, 2013; WHO, 2011). The vascular function and lipid profile of people who are active has been found to be in favor of protection against major NCDs (Green & Smith, 2018). Inactive people are twice more likely to get hypertension and resulting stroke than those that are active (Soares-Miranda, Siscovick, Psaty, Longstreth, & Mozaffarian, 2016). Moreover, for those who have already developed NCDs being physically active helps lessen complications (F. B. Hu et al., 2001). Besides the direct positive influence on health, physical activity when insufficient and coupled with excess food energy intake may lead to

overweight and obesity (Kopelman, 2000; Shook, 2016). Obesity is the single most important risk factor for CVDs, diabetes type II, cancers and all- cause mortality (Flegal KM, Kit BK, Orpana H, & BI., 2013; Kopelman, 2000) and interacts with physical activity on an additive scale (Qin, Knol, Corpeleijn, & Stolk, 2010).

This study identified those with high SES and old men to be most inactive population groups and hence at risk of multiple NCDs (Chapter 5). Insufficient PA is an important risk of NCDs to high SES populations (Malambo, Kengne, Lambert, De Villiers, & Puoane, 2016; Micklesfield et al., 2017; Najdi et al., 2011; A. L. Oyeyemi et al., 2016). Soon even older women may become victims due to industrialization and increased evolution of housework aids, as well as globalization that facilitates its infiltration from western countries to resource poor countries (Omran, 1971). Moreover, the study brings to our attention the fact while the high SES group was most vulnerable to insufficient PA, the whole population general was only active to moderate intensity (Chapter 5). This could be a sign of decline of physcial activity and a threat of the population being on its way to sedentary lifestyle. There is much to gain with more vigorous intensity physical activity (Gebel, Ding, & Bauman, 2014; Manson et al., 2002; Powell, Paluch, & Blair, 2011), populations of hunting and gathering are a live demonstration of that (Mbalilaki et al., 2010; Pontzer et al., 2015; Raichlen et al., 2017).

Here we have discussed patterns observed and its importance in respect to its health impact particularly mortality. However, studies to measure comprehensively the health, economic and social impact of unhealthy lifestyle are needed in order to further understand the relevance of each risky lifestyle. Moreover, insight into rates of change of impact through periods may further streamline the importance of different risky lifestyles. This is essential for priority setting in public health responses.

7.3 Unhealthy lifestyle patterns and vulnerable population groups

We identified gender, age and SES to be important predisposing demographic properties to unhealthy lifestyle (Fig 2). This section highlights the unhealthy choices that affect these groups, describes the context that sustain vulnerability and finally proceeds into a discussion of the larger picture of the potential health and economic impact.

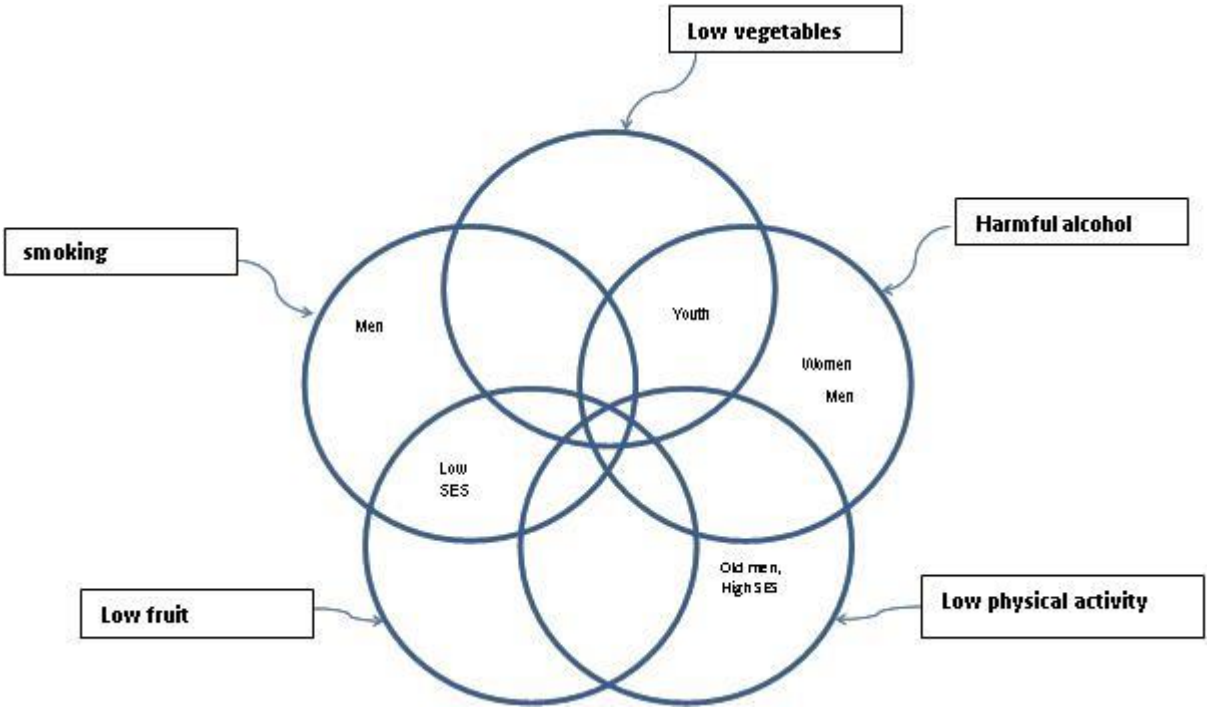

Figure 2: Venn diagram representing vulnerable groups and multiple exposures to unhealthy lifestyles

7.3.1 Men susceptibility to NCD risky lifestyles

Men are probably the most vulnerable to unhealthy lifestyle choices among all in this study setting, being affected more to harmful alcohol use, smoking and when older to insufficient PA too. Insufficient FV was found to be almost equally shared across gender. Clustering of all lifestyle risk factors is more likely to present in men than women (Noble, Paul, Turon, & Oldmeadow, 2015). Public health responses should hence be prepared to control and manage multiple NCDs in men than in women. Besides exposure to low FV intake which was

found equal between genders in this study, men were more likely to be alcohol drinkers. Other African studies have also presented alcohol use to be a predominant male habit (Mayige & Kagaruki, 2013; Mbatia, Jenkins, Singleton, & White, 2009; Msyamboza et al., 2011; Padrao et al., 2011). As a drinker in this setting one is more likely to abuse alcohol through HED every time they have a drink session. It is common in the African region to have few drinkers but who drink heavily (Jenkins et al., 2015; Mbatia et al., 2009; Padrao et al., 2011; Peltzer, Davids, & Njuho, 2011; Willis, 2006). However, the situation is reported to be worsening with efforts of the ongoing alcohol industry marketing activities to increase the number of drinkers as well as harmful alcohol consumption (D. H. Jernigan & Babor, 2015; David H Jernigan et al., 2006; Isidore S Obot, 2013)..

We found in this study that men were also more likely to be smokers than women, and this is also similar to the rest of the region (Brathwaite, Addo, Smeeth, & Lock, 2015; Winkler, Ott, Cowan, & Becher, 2013). Harmful alcohol use and smoking tobacco independently are a major contribution to cancers of the head and neck (Chaturvedi, Singhavi, Malik, & Nair, 2018; Joshi, Dutta, Chaturvedi, & Nair, 2014). When a person is both a heavy drinker and heavy smoker the risk increases 50 fold (Morita et al., 2010). Furthermore, there are reports that salted red meat increases the risk even further by another 30 fold (Lin et al., 2015). Most drinkers in this study setting may be guaranteed exposure to salted red meat because most alcohol outlets sell barbeque meat to be consumed with the drinks. In addition to the added risk of cancer to men due to harmful alcohol use and smoking (Y. C. Lee & Hashibe, 2014), those habits do also predispose to CVDs and diabetes (Akter, Goto, & Mizoue, 2017; Collart et al., 2015; Dunbar, Gotsis, & Frishman, 2013; Matsumoto, Miedema, Ofman, Gaziano, & Sesso, 2014; Pan, Wang, Talaei, Hu, & Wu, 2015).

Most men are the household bread winners, expected to pay for all essentials including food, shelter, clothing, education and healthcare. Disability due to NCDs limit many from work at full capacity and this results in frequent absenteeism from work or total loss of employment

and hence loss of income (Chaker et al., 2015; Gordois et al., 2016; Rocco). Healthcare cost for NCDs is enormous and almost endless, demanding costly travel for routine hospital visits and out of pocket payments for treatment and medication (Alouki et al., 2015; W. Janssens et al., 2016; Kankeu, Saksena, Xu, & Evans, 2013; Kengne, June-Rose McHiza, Amoah, & Mbanya, 2013; Ngalesoni, Ruhago, Norheim, & Robberstad, 2015). The national insurance cover reaches a fraction of the population who actually need it least and neither is it comprehensive (El-Sayed, Palma, Freedman, & Kruk, 2015; MOHSW, 2017). This means the poorest have to meet their bills themselves with their meager earning. All cost demand for NCD treatment and care are exerted on the patient, family and health system (Huffman et al., 2011; Manne-Goehler et al., 2016; Neuhann, Warter-Neuhann, Lyaruu, & Msuya, 2002). Quality of life has thus to be compromised with less nutritious food in the household, sometimes giving up on education for children, and struggling to meet healthcare costs of other members of the family, all that for survival of the NCD patient (Kankeu et al., 2013; McIntyre, Thiede, Dahlgren, & Whitehead, 2006).

Almost all major NCDs have been linked with sexual dysfunction, and this situation is a potential for serious social challenges (Cakar, Karaca, & Uslu, 2013; Nascimento et al., 2013; Phe & Roupret, 2012). Spouse support in illness of chronic diseases is very essential and a positive influence in for instance support for adherence to medication and dietary restriction as well as overall recovery progress (Stephens et al., 2013; Trief et al., 2003; Uchenna, Ijeoma, Pauline, & Sylvester, 2010). Since chronic diseases are long term, decline and eventual disappearance. of sexual intimacy may stress marriages (Corona et al., 2010). This may predispose spouse to extra marital affairs and risk of HIV contraction. Chronic disease clinics should hence consider packages for preparing spouses for such eventualities and how to cope with it. Accumulated damage from multiple NCDs may hasten aging and contribute in lowering life expectancy (Kirkwood, 2017) hence interventions should start early in life.

When men reach old age, they may have already had years of exposure to HED and depending on SES they may have been smokers too. With all those potential unhealthy lifestyles on their shoulders, this study revealed that men are also prone to becoming less active and risk becoming sedentary in old age. Sedentary behavior is defined as any waking behavior where one is either sitting or lying at energy expenditure of 1.5 metabolic equivalents or less (Pate, O'Neill, & Lobelo, 2008; SBRN, 2012; Tremblay et al., 2017). Majority of men spend most of their productive years earning a living by doing vigorous intense work and traveling by foot or cycling from place to place (John et al., 2017; Mbalilaki et al., 2007; Unwin et al., 2010). These activities assure them a good source of physical activity to keep them healthy. However, when they retire they lose their source of physical activity too, which puts them at serious risk of becoming sedentary. People leading a sedentary life are at an increased risk of CVDs, diabetes type II and all-cause mortality regardless of ones' level of physical activity (Biswas et al., 2015; Ford & Caspersen, 2012; Owen, Healy, Matthews, & Dunstan, 2010).

Cultural norms limit men from engaging in housework chores, because those are tasks carried out by women (Hou et al., 2014). However, it is the house chores that continue to keep women in rural settings active beyond retirement (John et al., 2017). Inactivity in old age predisposes men to risk of dementia and serious disability (Falck, Davis, & Liu-Ambrose, 2016; Hamer, Stamatakis, & Mishra, 2010; Kesse-Guyot et al., 2012). So, in addition to being at risk of disability due to major NCDs, older men have also the added risk of disability from dementia. Onset of cognitive impairment brings more significant disability in elderly than even age or gender (Dotchin et al., 2015). Furthermore, disability is the main driver of cost in dementia due to need of long term home based care (Schaller, Mauskopf, Kriza, Wahlster, & Kolominsky-Rabas, 2015). There are already several calls notifying of a growing burden of dementia among rural elderly in Tanzania (Dotchin et al., 2015; Heward et al., 2018; Kisoli et al., 2015; Paddick et al., 2015; Paddick et al., 2014). Old age on itself is a survival challenge because of the frailty and weakness it ensues, hence the aging policy for free health care to

those 60 years and above is an essential support (MLYDS, 2003). It is here suggested that the existing health policy for older people be updated to consider policies that can address preservation of physical activity beyond retirement in this population group.

7.3.2 Youth an important entry point for NCDs

Youth are also among most vulnerable groups observed in this study. They are exposed to multiple risks which make them susceptible to the full spectrum of major NCDs. Consumption of small number of vegetable portions is an important contributor to overall low vegetable intake and this was observed in almost the whole population. However, youth were found to be infrequent vegetable consumers in addition to consumption of small number of vegetable portions. Few studies that investigated barriers to FV intake in relation to the African context identified taste, appearance, cost, time for preparation as important limiting factors for both vegetables and fruit intake (V. Miller et al., 2016; Nago, Verstraeten, Lachat, Dossa, & Kolsteren, 2012). Evidence from the United States identified lack of cooking skills, poor knowledge of the importance of vegetables, family and friends influence as well as easy access in the neighborhood to be important limitations for vegetable intake in young people (Graham, Pelletier, Neumark-Sztainer, Lust, & Laska, 2013). These factors may not all be directly applicable to the current study setting, but it may be useful to explore how much of it could be relevant in this context too.

Lack of awareness of public health importance of FV intake is a problem in several places across all ages and in other cases poor comprehension of the recommendation is also prevalent (Erinosho, Moser, Oh, Nebeling, & Yaroch, 2012; Pollard, Daly, & Binns, 2009; Rooney et al., 2017; Wolf et al., 2008). Health education on fruit and vegetable intake can significantly improve peoples' attitude to fruit and vegetables and hence increase FV intake (Jones, Specio, Shrestha, Brown, & Allen, 2005). Infrequent vegetable intake and in addition to that, consumption of low number of vegetable portions put young people ahead of others in vulnerability to CVDs. Moreover observation of past trends in lifestyle attributed risk

towards CVDs, revealed low vegetable intake to contribute the most (IHME, 2018). Hence it is here suggested that an explorative study on factors that limit and promote vegetable intake in youth to be carried out in the study setting.

Moreover, these findings revealed that youth are also vulnerable to alcohol abuse through HED and this predisposes them to risk of cancer in addition to CVDs. All drinkers in general, youth being inclusive were found to be frequent alcohol abusers through HED. In addition, unlike older drinkers most of who prefer local brew, youth were found to prefer commercial alcohol which means they are on track to receiving more marketing impact from the alcohol industry. The alcohol industry is accused of fueling alcohol abuse trends in the continent in their quest to sell more (De Bruijn, 2011; D. H. Jernigan & Babor, 2015; David H Jernigan et al., 2006; McCall, 2017; Isidore S Obot, 2013). Rising alcohol abuse and alcohol adverse events which include even fatal case of young people have raised a lot of worries that these trends can bring immeasurable harm to populations in Africa if not intervened (Casswell & Thamarangsi, 2009; I. Gilmore, 2009; D. H. Jernigan & Babor, 2015; Isidore S Obot, 2006, 2013).

Since alcohol consumers tend also to be smokers, we should also expect a substantial rise in cancer of the head and neck in this population group (Chaturvedi et al., 2018; Joshi et al., 2014; Lin et al., 2015; Morita et al., 2010), as well as increased CVDs and diabetes type II cases (Akter et al., 2017; Collart et al., 2015; Dunbar et al., 2013; Matsumoto et al., 2014; Pan et al., 2015). Tobacco smoking is becoming an important problem among youth as well as minors across Africa (Chandora et al., 2016; Kwamanga, Odhiambo, & Amukoye, 2003; Odukoya, Odeyemi, Oyeyemi, & Upadhyay, 2013; Okagua, Opara, & Alex-Hart, 2016; Sreeramareddy, Pradhan, & Sin, 2014; Veeranki et al., 2017). Youth who are also in the category of low SES will have maximum exposure of risk due to low fruit intake as an addition risky lifestyle observed.

Harmful alcohol attributed mental health is an important public health concern in youth, due to its cascade of health implications and negative social outcomes (Fergusson, Boden, & Horwood, 2013; Patel, Flisher, Hetrick, & McGorry, 2007). Young people are at a critical age of brain development and alcohol abuse puts them at serious vulnerability (Hermens & Lagopoulos, 2018; Hermens et al., 2013). As a result of problems in mental health, affected youth may fail to realize their academic dreams. Some may succeed to secure employment, but frequent absenteeism and presentism significantly diminishes productivity at work (Beck et al., 2014; Evans-Lacko & Knapp, 2016; Mall et al., 2015). The risk of HIV/AIDS has also been reported to be higher in people with mental disorder than those mentally healthy (Donenberg, Emerson, Bryant, Wilson, & Weber-Shifrin, 2001; Donenberg & Pao, 2005).

In addition, substance abuse in the mentally ill is also a major risk (Bitew, 2014; Cairns, Yap, Pilkington, & Jorm, 2014) . When a person is affected by harmful alcohol, smoking as well as substance abuse then there is an increased chance of psychopathology that results in frequent violence and crimes (Patel et al., 2007; Sarasa-Renedo et al., 2014). Moreover, diabetes has been associated with increased risk of mental disorder (R. J. Anderson et al., 2002; Schmitz et al., 2014), and the reverse is also true (Rotella & Mannucci, 2013). Early initiation of alcohol is also an important reason why people maintain HED and with all its health, economic and social outcome through to adulthood (D. Jernigan, Noel, Landon, Thornton, & Lobstein, 2017). As the burden of NCD rises in this group, stress of sexual dysfunction may also become prevalent (Cakar, Karaca, & Uslu, 2013; Nascimento et al., 2013; Phe & Roupret, 2012). This may in turn rise the risk of HIV infection in young people due to increased multiple sexual partner involvement among young spouses to overcome the sexual dysfunction stress. Young people are the main workforce for economic development in resource poor settings. The economic effect of harmful alcohol consumption can be enormous (Matzopoulos et al., 2014). It is important to measure the health, economic and social impact of unhealthy lifestyle choices in order to make the unseen reality of the impact tangible to the population, policy makers, public health experts for concerted counteraction.

7.3.3 Women vulnerability to alcohol

Women are another group of vulnerable population deduced from this study. Like youth, women are also a target of the alcohol industry and this is seen in these findings with their preference for commercial alcohol and increase in proportion of HED among drinkers compared to previous reports (Casswell & Thamarangsi, 2009; I. Gilmore, 2009; D. H. Jernigan & Babor, 2015; David H Jernigan et al., 2006; McCall, 2017; Isidore S Obot, 2013). This tells a lot about the success of the industry on one of its targets. Traditionally women were protected from alcohol use by norms and taboos, and hence the high abstinence among women and youth in most parts of Africa observed (Clausen, Rossow, Naidoo, & Kowal, 2009; Martinez, Roislien, Naidoo, & Clausen, 2011; Myadze & Rwomire, 2014). Now, the fact that the proportion of HED among drinkers is not different between genders means women are raising their drinking stakes, most probably in response to the alcohol industry marketing activities. Women will therefore be vulnerable to all health and social consequences of harmful drinking just like men had always been. This includes CVDs, Cancers, Diabetes type II, Mental health disorders, intentional and unintentional injuries and more (Matzopoulos et al., 2014; Rehm et al., 2009). However, unlike men heavy drinking in women will predispose to an extra risk, which is fetal alcohol syndrome (FAS). A condition of persons whose mothers consumed alcohol while pregnant, and by so doing alcohol affected their mental function as a result of crossing the blood brain barrier (Popova et al., 2016; Rangmar et al., 2015)

A report by Culley and colleagues in 2013 showed that exposure to alcohol among pregnant women in Sub-Saharan Africa ranged between 2.2% and 8.9% (Culley et al., 2013). This is already much higher in comparison to high income countries, and with prospects of more women becoming drinkers and heavy drinkers the threat of FAS will take an exponential phase and hence needs prompt public health response (Popova, Lange, Probst, Gmel, & Rehm, 2017; Roozen et al., 2016). Isaksen and colleagues also highlighted presence of a substantial amount of alcohol consumption among pregnant women in Tanzania (Isaksen,

Ostbye, Mmbaga, & Daltveit, 2015). Even in the region and continent at large there are a number of reports alerting of ongoing alcohol consumption during pregnancy as well as presence of an important information gap (L. A. Eaton et al., 2014; Ojo et al., 2010; Ordinioha & Brisibe, 2015; S. Popova et al., 2016; Watt et al., 2014). More than 400 comorbid conditions have so far been identified in people with FAS, the most prevalent being low intelligence, poor coordination, conduct disorder, hearing and seeing problems (Svetlana Popova et al., 2016). As a result people with FAS are prone to have learning disability, to get in trouble with mischief at school, and when older with the legal system (Coriale et al., 2013).

Persons with FAS are also more likely to engage in high risk behaviors like unprotected sexual intercourse and hence risk HIV infection (Coriale et al., 2013). Other high risk behaviors include alcohol abuse, substance abuse, smoking (Coriale et al., 2013), all of which can lead into psychopathology and increased violent events and crimes (Patel et al., 2007; Sarasa-Renedo et al., 2014). In addition when people with FAS become adults they need a watch out for chronic diseases such as cancers, diabetes, hypertension, immune function impairment due to their increased susceptibility (Moore & Riley, 2015). This potentially harmful effect of alcohol on future generations in the name of FAS, is a permanent health damage and hence cannot be reversed but can only be improved through treatment (Paintner, Williams, & Burd, 2012; Rasmussen, Andrew, Zwaigenbaum, & Tough, 2008). The United States estimated the lifetime cost per child with FAS in 2002 was US$ 2million and a total of US$4 billion was spent per year (CDCP, 2015). For poor countries like Tanzania such costs will be an impossible burden to assist even a single child with FAS and with increasing heavy drinking among women it would put the nation at a risk of a FAS epidemic. This is a preventable condition, and hence it is suggested that NCD preventive interventions and NCD research groups work together to integrate FAS prevention into the national NCD control agenda more actively utilizing as many as possible entry points in additions to ante-natal clinics.

Increase in heavy drinking women is also expected to expose more women to risk of HIV infection (Chersich, Bosire, King'ola, Temmerman, & Luchters, 2014; Woolf-King & Maisto, 2011). The health and social cost of HIV/AIDS has been widely studied and is enormous (Anglaret & Salamon, 2004; Dhai, 2008). This includes among others a rise in orphans (Grassly & Timaeus, 2005; Monasch & Boerma, 2004; Watts, Lopman, Nyamukapa, & Gregson, 2005), and in this case orphans born to heavy drinking mothers then they are most likely to be affected by FAS too. Persons with FAS need physical and social support throughout life (Leenaars, Denys, Henneveld, & Rasmussen, 2012; Peadon, Rhys-Jones, Bower, & Elliott, 2009; S. Popova et al., 2014; Zwi, Jones, Thorgaard, York, & Dennis, 2011) and loss of parents from either HIV/AIDS or NCDs is just going to take them deeper into mental disorders and its social consequences. Orphans with FAS will need public health support to prevent them from risky behaviors that they are so susceptible to (Coriale et al., 2013). With an increase in women heavy drinkers, increase in women smokers should also be expected together with its health and social consequences (Dani & Harris, 2005; Falk, Yi, & Hiller-Sturmhofel, 2006; Harrison et al., 2008; Kalman et al., 2005). Heavy drinking women can potentially be a gateway to a future population with high level of learning disability, rising HIV/AIDS and Tb burden, NCDs and other chronic diseases with all social consequences of both alcohol and smoking practices.

7.3.4 Socioeconomic inequalities in unhealthy lifestyle

In the past NCDs used to be diseases of those affluent in the high SES category, but now things are changing and a shift towards low SES is observed all over the world (Hosseinpoor et al., 2012; Ziraba et al., 2009). Rapid ongoing urbanization, industrialization and globalization facilitates change in peoples' ways of eating, drinking and other behaviors like smoking and level of physical activity, which eventually leads to the ongoing epidemiological transition (Bosu, 2015; Demmler, Klasen, Nzuma, & Qaim, 2017; Hawkes, 2005; Keding, Msuya, Maass, & Krawinkel, 2011; Malina & Little, 2008; Omran, 1971; Pearson, 2003; Popkin, Adair, & Ng, 2012; Steyn & McHiza, 2014). This study also reveals people with low

SES to have a higher lifestyle risk profile than those with high SES and hence a higher NCD burden is expected in this group (Tab 2).

Table 2: Comparative risk distribution of unhealthy lifestyle among people with low and high SES

TYPE OF NCD AT RISK	HIGH SES	LOW SES	UNHEALTHY LIFESTYLE
Cardiovascular diseases	NO	YES	Low fruit intake
	YES	YES	Low vegetable intake
	YES	YES	HED
	NO	YES	Tobacco smoking
	YES	NO	Insufficient physical activity
Diabetes type II	NO	YES	Low fruit intake
	NO	NO	Low vegetable intake
	YES	YES	HED
	NO	YES	Tobacco smoking
	YES	NO	Insufficient physical activity
Cancers	NO	YES	Low fruit intake
	YES	YES	Low vegetable intake
	YES	YES	HED
	NO	YES	Tobacco smoking
	YES	NO	Insufficient physical activity
COPD	NO	NO	Low fruit intake
	NO	NO	Low vegetable intake
	NO	NO	HED
	NO	YES	Tobacco smoking
	NO	NO	Insufficient physical activity

The most economically deprived have a more difficult time facing this expected burden because of high cost of treatment and management (Alouki et al., 2015; W. Janssens et al., 2016; Kankeu et al., 2013; Kengne et al., 2013; Ngalesoni et al., 2015). The Tanzania national health insurance coverage favors the richer while the poorer need it the most (Macha et al., 2012; Mills et al., 2012; MOHSW, 2017).

The cost of getting health care, cost of not being able to work significantly cripples households in poor settings and discourages and prevents those of low SES from seeing care (Kankeu et al., 2013; Wang et al., 2015). People in poor rural settings have to go to the length of borrowing informally from friends and family, lending formal loans and mortgages, selling assets and livestock in order to meet out of pocket costs (Alam & Mahal, 2014). A study conducted in 48 LMIC countries demonstrated how health insurance can significantly address the issue of health inequalities for NCD treatment in LMIC (El-Sayed et al., 2015). In 2005, the WHO called upon all health systems around the world to move towards universal health coverage (WHO, 2005). Studies on universal health insurance coverage in Tanzania revealed key bottlenecks, and that includes cost of doubling the budget proportion of GDP for public health and overcoming physical barriers such access to health services (Borghi, Mtei, & Ally, 2012; Mills et al., 2012). Limited access to health care may prevent effective dissemination of primary prevention packages and hence may help maintain an important knowledge gap in the population. Currently the health system has too much reliance on out of pocket payment which burdens the population heavily (Alouki et al., 2015; W. Janssens et al., 2016; Kankeu et al., 2013; Kengne et al., 2013; McIntyre et al., 2008; Ngalesoni et al., 2015). More efforts should be put in place to develop financial mechanisms that will ensure that people with low SES are adequately covered.

The young and the poor are expected to carry the largest part of the NCD burden in the future, the economically productive age (Vedanthan, Seligman, & Fuster, 2014). Our findings are reflecting the same; the overlap of multiple risk factors for NCD was more evident in people with low SES (Tab1). For instance, people of low SES practiced 4 unhealthy habits out of 5 that predisposed to the risk of CVD, where as those of high SES were predisposed to 3 unhealthy habits.

Low fruit intake among those with low SES is understandable due to a known cost barrier (V. Miller et al., 2016). However, low vegetable intake may be an outcome of ignorance of WHO

recommendations for FV intake. Insufficient FV intake and harmful alcohol on itself is attributed to risk of majority CVD mortalities and morbidities (Di Cesare et al., 2013; Hosseinpoor et al., 2012). Tobacco smoking has in both rich and poor countries found to be more prevalent in people with low SES (Benziger, Roth, & Moran, 2016). We found in this setting that tobacco use was more prevalent among older men of low SES. It is hence easier to transmit the habit of tobacco smoking to younger men of the same SES. Since forces to promote more heavy alcohol consumption and tobacco smoking are ongoing (T. F. Babor et al., 2015; De Bruijn, 2011; A. B. Gilmore, Fooks, & McKee, 2011; Hastings et al., 2010; D. Jernigan et al., 2017; D. H. Jernigan & Babor, 2015; S. Lee, Ling, & Glantz, 2012; McCall, 2017; Isidore S Obot, 2013; Otanez, Mamudu, & Glantz, 2009; Siringi, 2002), and the population with low SES is most affected, we should hence expect an increase in the whole spectrum of major NCDs in in this populations. This study therefore confirms previous observations around the world that the future of NCDs is among the poorest

The biggest threat however is that these harmful practices may be transmitted from older groups to younger ones in this already economically deprived population and by such will be enforcing sustainability of unhealthy practices. Already there are a number of studies reporting access of both alcohol and cigarettes to small children, either for their own consumption or by being sent to get it from a shop for a grown up to use (Chandora et al., 2016; Kwamanga et al., 2003; Odukoya et al., 2013; Okagua et al., 2016; Veeranki et al., 2017). Such exposure is not different than advertisement done by the industries and its effect is seen with children starting smoking and drinking early (Hastings et al., 2010).

7.4 Public Health Responses to Promote Healthy Lifestyle

In this section public health responses are discussed in three major parts focusing on health education, health promotion and monitoring and surveillance of NCD risky lifestyle (Figure 6).

7.4.1 Health education for improved lifestyle

Behaviour capacity is an important pre-requisite for adopting a specific behaviour. It requires one to acquire knowledge on the importance of the behaviour as well as the know-how on practicing the behaviour (Bandura, 1991). To-date there has not been any documented evidence of population wide campaigns that aimed at educating the population on the importance of NCDs, NCD risky lifestyle and the WHO lifestyle recommendations. Below the key targets for health education, construction of public health messages and mode of public health message delivery is discussed in detail.

7.4.1.1 Literature derived health education targets to improve lifestyle

Public health education interventions aim to influence people's options towards healthy lifestyle. **Cultural norms** play an important role in limiting healthy choices in the population (P. M. Chege, Kimiywe, & Ndungu, 2015; Pilla & Dantas, 2016; Riang'a, Broerse, & Nangulu, 2017). We found from literature that one of the factors that may be contributing to low FV intake is lack of importance given to fruits and vegetables as nutritional necessities (A. Keller, 2012; Amélie Keller, de Courten, & Dræbel, 2012; Msuya, Kideghesho, & Luoga, 2004). In addition , vegetables are regarded as poor man's food which is used as relish to accompany staples while those affluent opt for animal protein base options which are also more expensive (Oniang'o, Mutuku, & Malaba, 2003). Vegetables have a traditional value attached to it (Owuor & Olaimer-Anyara, 2005; Smith & Pablo, 2007), and hence may be a reason why younger people in this study population consumed vegetables least frequent. In depth understand of peoples' attitude and perception to fruits will help develop targeted health education packages.

Furthermore, cultural norms overlap with loss of work and travel related activities thereby putting older men at increased risk of insufficient PA. Division of labor in traditional African households expects women only to engage in house-keeping, while men go out to fetch for food (Hou et al., 2014). Cultural norms that limit men from housework chores provide an

opportunity to sustain physical activity among older women but not older men (John et al., 2017). In retirement, men will have lost their respective work related activities and hence stay idle at home. Moreover, since routine leisure exercise for health keeping has not been part of the cultural norm, those most at risk of insufficient PA may not see it as a suitable replacement. Health education packages developed in line with promotion of the MoHSW that seek communities to do exercises will help break cultural barriers and thereby make people see the importance of PA.

Cost is also a limitation to healthy choices that is well established particularly with fruit intake among the poor in low and middle income countries (Allen et al., 2017; V. Miller et al., 2016). Most people in the low SES strata survive below the poverty line, and hence fruits may not be part of the food budget priority. Poverty has prioritized energy rich foods because of little financial resource and much need of physical energy to fulfill livelihood requirements through manually intense work (Oniang'o et al., 2003). Probably over time the preferential attitude towards starch over vegetables may have led to a custom of consuming small portions of vegetable relish that is observed in this study. The attitude of placing energy rich foods first is also demonstrated in food outlets where for instance people commonly refer to “chips & kuku” ; the Swahili for chips & chicken (note that “chips”, a starch is mentioned first and prioritized over chicken as the main part of the dish) instead of “chicken & chips” as it is spelled in the west where protein is prioritized over starch. Health education on how to prioritize healthy budgets is essential but not enough since changing peoples’ economic capacity is a long term and complex agenda.

Poor regulation enforcement to control activities of both the alcohol and tobacco industries is indicative of absence of a link between policy and the drive to contain the NCD burden by the public health community. To a large extent the industries have been left to trade freely under what is defined as self-regulation, which normally does not work to protect the population and evidence on huge alcohol and tobacco attributed health, social and economic

cost is evident of that (Brathwaite et al., 2015; Hastings et al., 2010; I. S. Obot, 2012; Isidore S Obot, 2013; Peer, 2017). The industries apply sophisticated marketing strategies to sell as much as possible with no regard on potential public health implications, because their focus is solely business of numbers (Casswell & Thamarangsi, 2009; David H Jernigan et al., 2006; McCall, 2017). Evidence from this study suggests that there is need for public health awareness activities to correct cultural norms, to help people priorities financial expenditure towards healthier options and even to help engage communities in the enforcing of regulations. Communities when well informed can be very effective in influencing protective policies and regulations as well as enforcing them (Minkler, 2010; Palmer et al., 2013; Grumbach et al., 2017; (Buykx, Gilligan, Ward, Kippen, & Chapman, 2015). To date there is no evidence of population wide awareness activities to inform about WHO recommendations on key risky lifestyles, namely FV intake, physical activity, heavy episodic drinking and tobacco smoking.

7.4.1.2 Health education targets specific to Ifakara setting

Education packages for responding to weaknesses of the most vulnerable populations in the study setting, need first to respond to a list of unanswered questions. The figures 3-5 below highlight evidence gaps for health education packages to influence healthy choices.

Improving FV intake

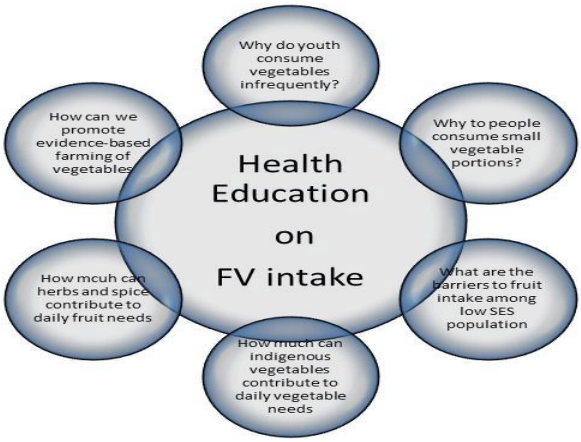

Figure 3: Diagrammatic representation of important targets for health education packages to improve FV intake

This study informed of youth not consuming vegetables as frequently as older people. Also, it informed that at population level number of vegetable portions consumed per day is very low. Moreover, the low SES populations rarely consumes fruits at all. The status of the population FV knowledge and NCDs is unknown. We can only predict that nutritional knowledge on the importance of FV as per WHO recommendations for NCD protective lifestyle is missing. There no record of population-wide campaign about WHO recommendation on FV intake, people act out of ignorance. Some people may have known the recommendation but failed to comprehend its demand (Rooney et al., 2017). In addition, taste and cost may be important limitations too (Allen et al., 2017; V. Miller et al., 2016; Nago et al., 2012). Further studies for guiding development of health education packages in this study setting should aim at ensuring people are well informed on the importance of FV intake, correct interpretation of the WHO FV intake recommendation and how to correctly estimate portions. Promotional messages should hence also include solutions to the cost barrier in addition to health importance of fruits.

Questions to contemplate on would be why do youth consume vegetables less frequently than older people? Why is consumption of small number of vegetables portions widespread in the study population? Katharine Jones in her study in Nepali said nutrition knowledge is very important for healthy eating, because she found that among those with low vitamin A rich vegetable intake their nutrition knowledge was remarkably low (Jones et al., 2005). Nutrition knowledge is essential for improved diet behavior. Unlike other interventions like cash supplementation, health education improves attitudes too which helps to empower more (J. V. Anderson et al., 2001).

How much can indigenous vegetables contribute to daily vegetable requirement in the population? By introducing indigenous vegetables in people's menus, there will be more variety to satisfy more palates. This will particularly be useful in convincing youth to consume more vegetables. There is a reservoir of non-cultivated indigenous edible plants which are highly under-utilized, despite being with full potential to help reduce insufficient FV intake (Aryal et al., 2018; Maroyi, 2014). Most indigenous vegetables can resist many harsh conditions, need very low maintenance and are loaded with nutrients (Aworh, 2018; Jimenez-Aguilar & Grusak, 2015; Neugart, Baldermann, Ngwene, Wesonga, & Schreiner, 2017; Omondi et al., 2017). Making indigenous vegetables accessible in daily use may help lower prices and allow consumers to afford increased number of vegetable portions. In Burkina Faso non-cultivated edible plants contribute 20% to all food consumed (Ogle, Hung, & Tuyet, 2001). Moreover, a wide variety of pteridophytes and edible weeds have been documented in Sub Saharan Africa (Maroyi, 2014) and in Zimbabwe respectively (Maroyi, 2013). Studies in the far eastern countries reveal that almost 85% of households are dependent on indigenous edible plants during a whole month of poverty (Aryal et al., 2018).

Agricultural experts in Tanzania can emulate what Mabhaudhi and colleagues are doing to explore potential indigenous plants for transfer into mainstream agriculture, starting with documentation of the range of plants available (Mabhaudhi, Chimonyo, Chibarabada, &

Modi, 2017). Older people have good knowledge about these plants and could be an important resource on how to grow, harvest and use them (Bethwell & Olaimer-Anyara, 2007; Smith & Pablo, 2007). The aim should be to select plants that are not time and labor intensive (Mabhaudhi et al., 2017), since that is a limitation to farmers and consumers (Aryal et al., 2018). Moreover, superior qualities should include those that are resistant to drought, heat stress, diseases and are dense in nutrients (Mabhaudhi et al., 2017).

Some of these indigenous plants are more nutritious than common foods, for instance the Dioscorea spp has five times more protein and fiber than the ordinary Irish potato and sweet potato (Bhandari & Kawabata, 2005). All unfolding evidence is convincing that there may be much public health relevance in promoting indigenous vegetables. However, the process of getting indigenous vegetables into mainstream agriculture is expected to take time, involve investigations which need funds and possible lengthy policy dialogues to justify public health benefit (Mabhaudhi et al., 2017). It is hence advised to take a stepwise approach were a small pool of vegetables is investigated at a time (Mabhaudhi et al., 2017), Supportive context for farmers to adopt indigenous vegetables may include education packages on how to grow, harvest and preserve indigenous vegetables. Moreover, consumers should be educated on the nutritional benefits of different indigenous vegetables and as well as preparation methods. It will also be motivating to growers if the government can subsidize them with high quality seeds and other agricultural necessities. If the government can support, a crop that has immeasurable harm like tobacco with fertilizers, better seeds, credit facilities, easy access to markets (T. Hu, Tingum, Hepelwa, & Kidane, 2017; Asmerom Kidane, Hepelwa, Tingum, & Hu, 2013), then it should not fail to provide vegetable seeds with a lot of potential gain on population health.

Promotion of evidence-based farming of vegetables may further help to improve FV intake in the population. Previous studies have shown that people have different taste preference, and this is crucial in their decisions to consume or not to consume vegetables (Aryal et al., 2018;

Nago et al., 2012). By growing types and amounts of vegetables as per consumer demand, it may help reduce post-harvest losses and hence lower market prices.

The Tanzania NCD Strategic and Action Plan 2016-2020 seeks to reduce insufficient FV by 30%. However, there are no documented strategies to describe how that target is going to be achieved. Herbs and spice like sesame seeds, chia seeds, black seeds have a lot of essential nutrients found in fruits (Fawzy, 2007; Llorent-Martínez et al., 2013; Obiajunwa et al., 2005; Randhawa & Al-Ghamdi, 2002), are cheap and hence easily accessible to many. Evidence from this study proposes public health education campaigns on the **importance of FV intake** to counteract the level of existing ignorance. **Promotion of IV**, **evidence based farming** and **use of herbs and spices** may help satisfy more palates as well as market prices.

Improving PA

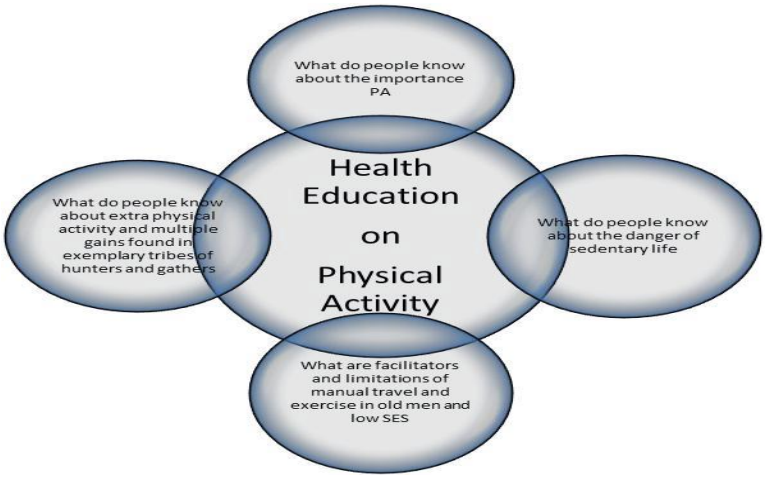

Figure 4: Diagrammatic representation of important targets for health education packages to increase level of physical activity in the population

More PA for older men and for people with highest SES is demanded from these findings. Our results show that generally the population is active to moderate intensity and that

walking and cycling are declining, which is in agreement to what is happening elsewhere in places with similar settings (Ng & Popkin, 2012). Hence health education guidelines for promoting physical activity in the population should seek ways of preserving walking/cycling and promoting leisure exercise (Bauman, Allman-Farinelli, Huxley, & James, 2008) Women are normally less active than men, but in the case of this rural setting and others (John et al., 2017), older women can bank on household chores while older men need urgent help. Countries across the world have been customizing standard guidelines to suit their gaps in physical activity (Kahlmeier et al., 2015; Oja, Bull, Fogelholm, & Martin, 2010). It will be helpful if guidelines can specifically allocate daily minimum time durations for activities for both walking/cycling and other leisure exercise for specific to vulnerable groups deduced. Overall, our findings propose **customized health education to increase PA among older men and those of high SES** as a matter of priority. Moreover, health education to **increase PA intensity and to prolong PA in the general population** is also highly recommended.

More physical activity for older men

Despite informing men of the importance of being active in their old age and the extra vulnerability to dementia, health education packages should be directed to younger men to warn them in advance. Messages should target younger men and prepare them to sustain alternative physical activity after retirement. Older men can be introduced to leisure exercises that improves their endurance, flexibility, strength and balance (Irvine, Gelatt, Seeley, Macfarlane, & Gau, 2013). They can be educated on the importance of such exercise, how to achieve it and progressively increase their activities. Research should explore ways of preparing exercise packages with messages and a mode of communication that is appealing, enjoyable and socially acceptable to older people (Baxter et al., 2016). These packages may also consider that some may feel tired and lazy and may need instructors to guide them (Justine, Azizan, Hassan, Salleh, & Manaf, 2013). The current initiative for communities to exercise on open spaces is an opportunity to strengthen the physical activity agenda in favor of the context of older men (VOT, 2017). It will bring older men in the

neighborhood together where they can build socialization bonds and encourage each other in being active. It will also be of benefit if research can explore ways of guiding old men on how to evaluate themselves, of how many times during the day they are sedentary (Baxter et al., 2016), as this will help them set goals and stay focused and perhaps increase their commitment.

More physical activity for people of high SES

There is not much documented evidence on physical activity interventions in the African context because physical activity has not been an obvious problem and hence leisure exercises are a new phenomenon. The national campaign to promote community physical activity on available open spaces is a good starting point (VOT, 2017). However, it needs to go hand in hand with information dissemination on the importance of NCDs and the link with insufficient PA and sedentary lifestyle. Second, one day per month is not enough for public health gains and hence needs to be increased to a level of at least 3 days a week (WHO, 2010). Moreover, successful promotion of walking and cycling as a means of travel for those in high SES may help fulfill physical activity requirements for this population group.

Increased intensity and prolonged PA for all

Excessive physical activity undertaken for long durations and with vigorous intensity provides additional benefits beyond what can be achieved by the WHO recommendation (Mbalilaki et al., 2010; Muhihi et al., 2012; Raichlen et al., 2017). The minimum recommendation protects against CVDs and diabetes type II but added protection against cancer can be attained with additional 60 min of moderate intensity or 30 min of vigorous intense physical activity per day (Blair, LaMonte, & Nichaman, 2004; WHO, 2010). It is theorized that during the time of hunting and gathering, physical activity was more prominent and played a bigger health role in peoples' lives (S. B. Eaton & Eaton, 2003; Lieberman, 2015; Malina & Little, 2008). Studies on modern hunters and gathers in Tanzania, demonstrated 135 min of moderate to vigorous intensity physical activity per day which is way beyond the WHO recommendation

(Raichlen et al., 2017). This explains why such communities can sustain biomarkers of CVD to be below clinical relevance and maintain low levels of hypertension with no risk of CVDs in the population (Raichlen et al., 2017).

Likewise, we learn from the Maasai how sustained highly vigorous physical activity beyond what is recommended by the WHO provides added protection against risk of chronic diseases (Mbalilaki et al., 2010). The Maasai consume high fat low carbohydrate diet, with daily calories exceeding 2500 above the basal requirement, yet the intense physical activity lifestyle maintains a healthy lipid profile and blood pressure measures (Mbalilaki et al., 2010). Deeper investigation into these very active communities can serve as a gold standard for developing customized national recommendations to promote levels of physical activity with maximum benefits and that are reasonably feasible.

In this study we observed a population that is predominantly active to moderate intensity with very little vigorous intense physical activity. Moreover, travel related activities fell short of leisure activities and this is unexpected especially in a non-urban setting. This can be explained by the shift of the population away from manual to non-manual work and with less walking and cycling (Ng, Howard, Wang, Su, & Zhang, 2014; Ng & Popkin, 2012). Unlike the hunters and gathers (Mbalilaki et al., 2010; Muhihi et al., 2012; Raichlen et al., 2017), this study population may be at risk of leaning towards sedentary behavior. Furthermore, the population is missing out on potential extra health benefits had they been highly active. Leisure exercise alone is not enough as a source of physical activity for protection against NCD as well as prevention of obesity and weight loss (Bauman et al., 2008). Dependence on leisure exercise as source of physical activity can have an unachievable price tag (Bauman et al., 2008; Ding et al., 2016; Kruk, 2014; Maresova, 2014; Ng et al., 2014; Oldridge, 2008). Therefore, reinforcing purposeful walking/cycling is what is needed in developing countries; otherwise increased mortalities and mortalities attributed to insufficient PA will be

overwhelming to an already poor and debilitated health systems. But major questions arise. How can one convince someone to walk or cycle for travel to and from places while:

- They have worked hard to own a private car which is also a prestigious achievement and a sign of success.
- The weather condition is not comfortable to walk/cycle with excessive heat reaching temperatures of 38°C most of the time during the year, and sometimes with a lot of dust due to lack of tarmac road.
- There is no guaranteed safety that no one will get attacked on the way to be robbed off personal belongings including the bike. It is easier to escape when in a car.
- There is absence of safe pathways for those walking or cycling to do so without threat of traffic accident risks. There is lack of designated parking spaces for bicycles in points of social services like shops, hospitals, banks.

Moreover, how can policy makers be convinced to prioritize building pathways for walking and cycling while there are lots of dusty roads that need tarmac in many parts of the country? The alcohol industry in the UK can afford to spend between €900million – €1.3billio a year on advertisement (Hastings et al., 2010). In 2002, a CEO of one of the world's largest multi-national tobacco company earned more than US$ 3.2 million in salary and bonus (WHO, 2004). If the alcohol and tobacco industry can make huge profits in a short time, then they should be able to support expensive social cooperate responsibility courses like building pathways for commuters. However, this needs a strong political will power and population advocacy.

Reducing harmful alcohol use and tobacco use

Figure 5: Diagrammatic representation of important targets for health education packages to control harmful alcohol use and tobacco smoking

Awareness and harmful alcohol use

The dichotomy of low alcohol use prevalence and high alcohol intoxication observed is expected in African settings (Collaborators, 2016; Ferreira-Borges et al., 2017). With absence of population campaign to educate people there is a possibility that people do not know what defines a standard drink or HED. Our findings revealed three important problems that may be contributing towards increase of the harmful alcohol use burden. First of all, we observed very high level of HED (91.3%), despite alcohol users being only a fraction of the population. The equal proportion of HED between gender, and the high prevalence of women and youth drinkers consuming commercial alcohol as well as the loss of popularity of the local brew observed are three features that suggest progress of the alcohol industry marketing outcomes. However, the affected population may not be aware of the ongoing active hunt of the alcohol industry for new drinkers and promotion for heavy drinking. The alcohol industry is penetrating populations outside urban cities, and now having reached this study site, it is now closer to the rural remote where majority of the population reside (TNBS,

2018). The health, social and economic impact of harmful alcohol intake is enormous (Matzopoulos et al., 2014; Mohapatra, Patra, Popova, Duhig, & Rehm, 2010). Making the evidence of the **health, economic and social cost public knowledge** may help solicit concerted efforts from policy makers and communities to control harmful alcohol use.

Control of tobacco smoking while still in its infancy

The low prevalence of smoking observed is an opportunity to contain the burden while it's still in its infancy. Predictions are that by 2030, if not effectively controlled tobacco smokers will reach 8 million and by then tables will have turned completely with LMIC absorbing 80% of the burden (Eriksen et al., 2015). Tanzania as the second largest producer of tobacco in Africa (A. Kidane & Ngeh, 2015; URT, 2014), may explain why the government fails to enforce tobacco control regulations (Mfinanga et al., 2011). The WHO Framework Convention for Tobacco Control is cost-effective and feasible for even the world's poorest country, besides it has been passed as policy by the parliament more than a decade ago with no substantive output yet (Mfinanga et al., 2011). Local production makes cigarettes cheaper and more affordable to many and would definitely encourage early smoking initiation. Unlike high income countries like United States, tobacco products from LMIC have most addictive and potent forms of nicotine (Gupta & Ray, 2003; Saleheen et al., 2014). Moreover, tobacco farming exploits families by inducing vulnerability to cancers, impotence, neuropsychiatric conditions leading to suicides (Kagaruki, 2012; WHO, 2004). Diminished quality of life and child labor and denial of chance for education is prevalent in Tanzanian farming families (Kagaruki, 2015). Deforestation and soil exposure to large amounts of potent pesticides are part of tobacco attributed environmental damages (Kagaruki, 2015; WHO, 2004). **exposure all tobacco attributed cost** may help expose relevance of integrating tobacco control into the national annual budget. Such evidence when effectively disseminated and comprehended by the population may help increase the advocacy on strict enforcement of legislations and effective political engagement, both of which are not there yet.

People may also need to be educated on how much expenditure goes to harmful alcohol and on tobacco, and how these compete with livelihood essentials like food, children's' education, health care, clothing (Warner, 2017). On average smokers in Tanzania consume 7.08 cigarettes per day, which means **16% of the US$456 GDP goes to tobacco smoking** (A. Kidane, Mduma, Naho, Ngeh, & Hu, 2015). As a result this denies households among others as much as 54% of the total food expenditure which goes into tobacco purchase (A. Kidane, Mduma, Naho, & Hu, 2015). In Niger, students were found to spend as much as 40% of all their earnings on cigarettes (WHO, 2004). Households in Bangladesh spend 10 times more on tobacco than education and leave millions of children to die from malnutrition (Efroymson et al., 2001).

7.4.1.3 Message construction to influence healthy choices

Messages need to be constructed and delivered through channels that will allow development of behavior capacity to the highest level (Maria and Anne, 2004).

The WHO defines health education as *"consciously constructed opportunities for learning, involving some form of communication designed to improve health literacy, including improving knowledge, and developing life skills which are conducive to individual and community health"* (WHO, 2000). This definition highlights the importance of building behavior capacity through acquiring knowledge and skills, just as described by Bandura. Bandura in his theory for behavior change he demonstrates the need for building behavior capacity as a pre-requisite for successful behavior change (Bandura, 1991). Behavior capacity is built on knowledge on the importance of the behavior change and skills knowledge on how to effect the desired change (Bandura, 1991).

As mentioned earlier in this thesis, there are no recorded population-wide campaigns that have taken place to introduce the Tanzanian population to the WHO lifestyle

recommendations for NCD prevention. One may be aware of a recommendation through their own efforts but it is not necessary that they comprehend what the recommendation demands or that they have the skills necessary to implement it successfully (Appleton et al., 2018; Kerr & Stockwell, 2012; Knox, Musson, & Adams, 2015; Marques, Martins, Sarmento, Rocha, & Carreiro da Costa, 2015; Rooney et al., 2017; Sawyer et al., 2014). A message stands a better chance of being successful when it is simple, clear, rational, persuasive and supported by an interesting context to the receiver (Gray & Harrington, 2011; Hoffman et al., 2005; Lewis, Watson, & White, 2016). People tend to be selective in what they listen to and what they accept (Koelen & van den Ban, 2004). In the case of new evidence like these on lifestyle, it is advised to construct a message with rational appeal for more chance to reach the audience (Hoffman et al., 2005). Complex and confusing messages are more likely to detach the interest of the receiver all together (Hoffman et al., 2005). This means it might be more successful to refer to number of common fruits or standard vegetable bunches as it appears on the market benches rather than portions.

Messages need to be carefully constructed ensuring clear communication that attracts attention and gives the intended persuasive outcome (Lewis et al., 2016). Tangible and dramatic news has better chance of being accepted (Durkin, Brennan, & Wakefield, 2012; Lewis et al., 2016). Fear and anxiety may have a negative persuasive effect in increasing acceptance of a health message that prohibits a specific behavior (Durkin et al., 2012; Lewis et al., 2016). For instance, describing the actual expected out of pocket cost that people with major NCDs face in order to survive and all the other indirect costs that befall a family may have a chance of getting peoples' attention especially the low SES population. Positive persuasive comments, the ones that motivate action with anticipation of great achievements are also very effective (Gray & Harrington, 2011; Lewis et al., 2016). For instance, by demonstrating how exemplary communities like the Hadza, Maasai have been able to benefit from physical activity by being super active and keeping healthy to the extent that clinical unfavorable biomarkers are not common is motivating. Studies should be done to explore

how best to use epidemiological evidence on lifestyle, mortality and morbidity to influence healthy choices. Anti-smoking and alcohol messages must be able to compete with messages that promote tobacco smoking and alcohol use from their respective industries (Agostinelli & Grube, 2002, 2003; Cohen, Caburnay, & Rodgers, 2011).

7.4.1.4 Mode of Communication and Entry Points

Public health knowledge is a tool to convince and facilitate informed decisions (Nutbeam, 2000). There are three basic methods of communicating public health messages including mass media methods, interpersonal methods and group methods (Koelen & van den Ban, 2004). Mass media methods include different types of broadcasts like TV, radio, print and now social media platforms (Durkin et al., 2012; Korda & Itani, 2013; Rice, Haynes, Royce, & Thompson, 2016). Social media platforms need to be promoted since these are the cheapest options for poor settings and can reach an almost unlimited anonymous audience (Korda & Itani, 2013). Mass media communication is good at introducing a topic for discussion but not shaping how the discussion will progress because that depends on the distinct context of the receiver (Koelen & van den Ban, 2004). Other methods like interpersonal methods and group methods can chip in to shape peoples' discussion into a favorable direction. An interpersonal method is a way of communication that involves dialogues like in a counseling encounter between health personnel and a patient (Bock, Jarczok, & Litaker, 2014). Moreover, interpersonal methods could also involve public lectures which could be very useful when addressing educated learned people at work or students at learning institutions. Demonstrations are normally used to show practical guidance on specific skills (Koelen & van den Ban, 2004). For instance, how to estimate portions of different fruits, vegetables or standard alcoholic drinks.

A group method is also an opportunity for community participatory approach. The advantage of community participation is that people get to develop ownership of the problem, and that increases their desire to contain it (Cyril, Smith, Possamai-Inesedy, & Renzaho, 2015;

O'Mara-Eves et al., 2013; O'Mara-Eves et al., 2015). Moreover, through community discussions, opportunities and challenges may unfold and that may help improve interventions (Koelen & van den Ban, 2004). Flyers and posters are not effective when just distributed to people on a door step (Koelen & van den Ban, 2004). Flyers have more impact following a one to one interpersonal dialogue, lecture or community meetings, while posters are more effective when displayed somewhere and then the audience gets an explanation afterwards (Koelen & van den Ban, 2004). Entertainment education is another effective way of using mass media, whereby the public health message is disguised by using entertainment to communicate it (Randolph, Whitaker, & Arellano, 2012). A television cooking program may demonstrate how to prepare fruits and vegetables in different ways and motivate people to consume more fruits and vegetables. It could also be a drama which demonstrates the health, social and economic impact of harmful alcohol or tobacco smoking.

Messages may be customized from the lowest learning institutions at nursery level to the highest tertiary at university (Wanyonyi, Themessl-Huber, Humphris, & Freeman, 2011). A life course approach to public health message dissemination is an effective way to ensure that interventions for healthy lifestyle have a sustainable positive impact over generations. Health system, schools, non-governmental organizations, civil society, policy makers and research institutes are existing information dissemination platform that can reach a wide range of population. The following sub-sections describe how the listed platforms or players can be used for health education to promote healthy choices across all age groups (Fig 6).

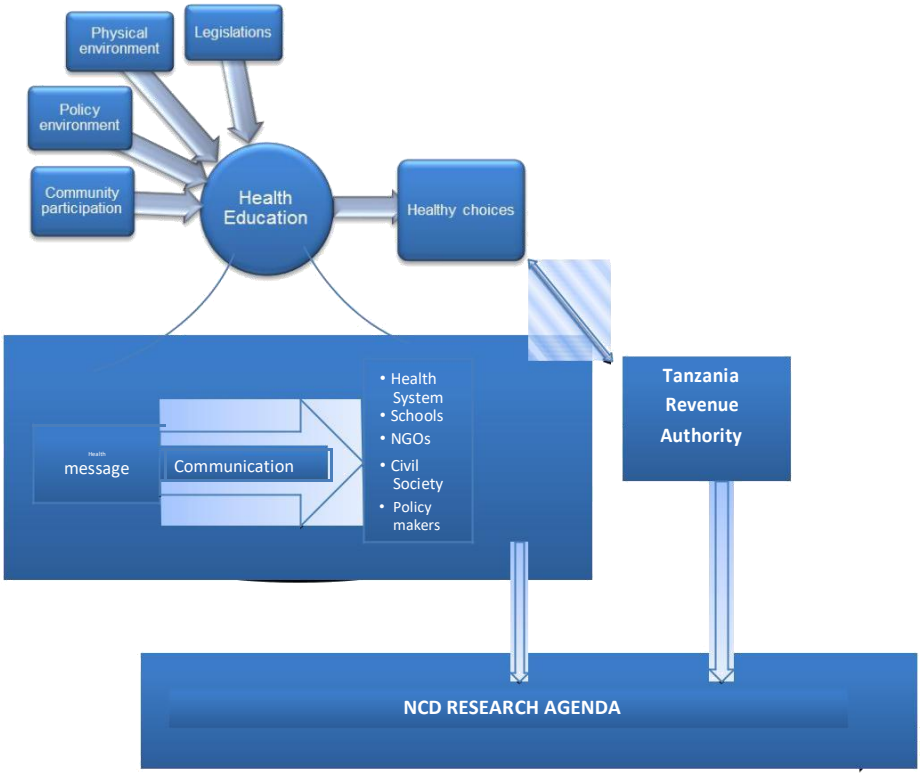

Figure 6: Health education, health promotion and its context for improved lifestyle

Use of health system platform to promote healthy choices

The lowest level of health facilities found in villages are dispensaries- These facilities are closest to the population and hence if strengthened could be used as cost effective tools for health education and health promotion. Peck and colleagues said that the NCD public health strategy can draw learning lessons from the HIV program on how roll out of anti-retroviral therapy (ART) to millions in Sub Saharan Africa (SSA) took place (Peck et al., 2014). He adds that critical entities for success included strong leadership by the Ministry of Health, clear and practical guidelines, consistent supply of medication, intensive training of staff and frequent monitoring and supervision (Peck et al., 2014). The staffs in the HIV roll out program were non-medical non-doctor and non-nurse personnel, but it was still possible and successful. The NCD public health strategy can make use of the existing HIV systems for ongoing outreach activities to follow communities where they are and deliver NCD health messages (Peck et al., 2014). It has been done in Uganda and Cambodia with success

(Chamie et al., 2012; B. Janssens et al., 2007). There are also a number of other ongoing public health outreach programs including maternal health, voluntary medical male circumcision, fistula, all from the public and private sector which can integrate NCD health education packages.

The Tanzania National Health Policy requires that low level health facility provide basic services for hypertension and diabetes including managing of uncomplicated cases (MOHSW, 2013). A recent study revealed that most health facilities (78%) are not yet equipped to offer those services (Bintabara & Mpondo, 2018). Studies on health facility preparedness conducted in neighboring countries also showed significant weakness in competent staffing, equipment, medicines (Chikowe et al., 2018; Katende et al., 2015). There has however been an improvement since a report published in 2014 which showed deficiencies in almost everything (Peck et al., 2014). A recent study has shown some improvement, in that more than half of health facilities did now have basic equipment like bp apparatus, stethoscope, weighing scale which were earlier found scarcely (Bintabara & Mpondo, 2018). However, there still remains scarcity of trained staff, NCD guidelines, and poor management as well as the recording system, and this is demonstrated in neighboring countries too (Bintabara & Mpondo, 2018; Chikowe et al., 2018; Katende et al., 2015). Since staffs in lowest level facility are non-medical non-doctors non-nurses, it is critical that complete NCD guidelines are in place.

The budget for health allocated some of its expenditure on purchase of diagnostic equipment especially for cancer, and equipment for treatment procedures like heart operations and the rest into capacity building through training of experts in NCDs (MOHSW, 2017). These good developments for NCD care were allocated to referral hospitals in urban cities. However, most of low SES population reside in rural, and these are the ones that need the NCD services the most (TNBS, 2018). The referral system from the lowest health facilities (dispensaries) need to be strengthened otherwise investments to enhance NCD services at

higher facility will end up giving fragmented services. Patients in Uganda were found to bypass the dispensary level and went straight to higher level because that is where better NCD care can be attained (Settumba et al., 2015). But in the Tanzanian rural context many decide to go seek higher level help when at the end stage of the disease, and this was particularly noted in the case of cancers (Kazaura, Kombe, Yuma, Mtiro, & Mlawa, 2007). Ngoma wrote and said cancer that is diagnosed early is that which presents on top of the skin because it is easy to note the abnormality (Ngoma, Mandeli, & Holland, 2015). Some people have other beliefs about the disease and opt to go to traditional healers instead of formal medical help (Metta et al., 2015). That is why health education on NCDs and its risks is essential.

Use of schools to promote healthy choices

Learning institutions are a platform that can effectively and efficiently reach a large part of the population through students, teachers and staff, families and the community (Pérez-Rodrigo & Aranceta, 2003). Messages may be customized from the lowest learning institutions at nursery level to the highest tertiary level at university (Wanyonyi et al., 2011). Parents are the first teachers to set what is normal to any child, and thereafter as they become older other role models including school teachers, friends, peers engage (Story, Neumark-Sztainer, & French, 2002). That is why a network that brings these different players together including parents has better chance of a desired outcome (Pérez-Rodrigo & Aranceta, 2003; Ritchie, 2001; Sherman & Muehlhoff, 2007). A health education program for kindergarten and primary school children in Netherlands describes how in a step wise fashion, young children could be guided towards the concept of taking responsibility for their health (Bob & Wiel, 1979). Most of it included interpersonal and group methods employing entertainment education tools like conflict games, stories, roll-play, discussions (Bob & Wiel, 1979)

The public education system in Tanzania is already struggling with shortage of staffing for delivery of basic subjects especially in the rural (Mulkeen, 2008). Moreover, it is unknown

how existing teachers will receive extra workload on top of existing overload and a meager salary with very little incentives (Bennell & Mukyanuzi, 2005). This means private schools have a greater chance of doing better, while students in public schools are more in need of the intervention being of low SES compared to their counterparts in private schools (Olatunya, Oseni, Oyelami, Adegbenro, & Akani, 2014). Moreover, experiences from public schools elsewhere have shown that compliance of delivery of health education periods as per curriculum may be a problem and qualification of teachers assigned to the NCD health education periods is not guaranteed (Olatunya et al., 2014). School nurses and other health professionals including students in the field of public health can play a part in supporting health education on NCD prevention (Naylor & McKay, 2009; M. Schwartz & Laughlin, 2008). Use of television to display health education periods in class may be a feasible alternative to resource deprived settings. However, the drawback would be that there will be no opportunity for students to ask questions, and if they do not understand what is communicated they may lose interest and reject the message. Organized display of video health education programs with the presence of the school nurse, health personnel from a local health facility or students from a nearby clinical college may help the audience understand the intended message.

Students at college or university level do a lot of self-learning, so health education messages need to be detailed and with new information. With the number of mobile phones increasing, public health education and promotion should take advantage of this cost-effective method which is cheap and can reach a wide population fast (Massey, Prelip, Rideau, & Glik, 2012; Mitchell, Bull, Kiwanuka, & Ybarra, 2011). Young people in Uganda preferred receiving health message through internet, email, at health center or school rather than on a mobile phone (Mitchell et al., 2011). A study conducted in two regions of Tanzania, Dar Es Salaam and Mtwara revealed that young people were interested in receiving public health message that are humorous on their phones but also added preference of communication through role models like musicians, actors (Pfeiffer, Kleeb, Mbelwa, & Ahorlu, 2014). Two class-based

interventions in South Africa and Tunisia demonstrated that interactive interventions with discussions, brainstorming, video, games had positive results because it increased both knowledge and attitude (Heeren et al., 2017; Kebaili et al., 2014). Research will have to explore the best method that has a greater chance of getting the attention of young adults, within cost-effective means.

Community participation to promote healthy choices

Communities have successfully influenced better access to healthy foods (Minkler, 2010), promote smoke free environment (Palmer et al., 2013). Moreover, they have helped regulate advertisements on sugar sweetened beverages and established tax on soda, helped prevent Starbuck and Taco Bell from attaining a license to trade alcohol, and prevented authorization of selling powdered alcohol (Grumbach et al., 2017). With community education about the potential health harms of a particular product then community support on enforcing legislations becomes stronger (Buykx, Gilligan, Ward, Kippen, & Chapman, 2015). Restriction alcohol policies have had most public support in poorest countries, and within countries more support came from the least alcohol consumers (Parry et al 2017). Even among drinkers, those who are parents support alcohol restrictions imposed on youth, like for instance increasing the legal age for drinking (C. D. H. Parry, Trangenstein, Lombard, Jernigan, & Morojele). Even as patients when invited to help plan and improve health care provision communities made a positive impact (Crawford et al., 2002). Working with communities is also an opportunity for mutual learning for both communities and researchers (Wallerstein & Duran, 2010). Thereby, research gets feedback on how to develop future interventions that are inclusive of community norms and theories because those are the ones with better chance of being successful (Wallerstein & Duran, 2010).

Constituent representatives are also key potential voices for public health. When members of the parliament join forces with the community that elected them; they may have promising results. Members of parliaments have been selected by the population to represent them

(BUNGE, 2015), and hence they are more likely to agree to terms of the community. Most politicians however, are lay on public health issues and this may be one reason why lifestyle health policies do not receive much consideration. Hence it is suggested here that policy briefs on NCD issues be prepared on a regular basis both as print in both hard and soft copy as well as audio. The audio version will have added advantage in that one can listen to it while on the way or while too tired to read. Softcopies can also be easily transmitted through social media like what's up, twitter and through email. The most important thing though is to ensure the message is persuasive enough either with fear or an exciting motivating factor (Koelen & van den Ban, 2004). Research may help to explore supportive and limiting factors that surround policy bills presented to members of parliament and use such evidence to feedback intervention development. In order to create a synergy of efforts with a common understanding and goal within and outside the parliament, it may be useful to do parallel dissemination of the same kind of information to the public as it is being discussed in parliament. The aim of this mass media sensitization is to initiate conversations on the target subject. This could then be followed by lecture sessions with members of the parliament and group discussions with communities in order to shape the discussions into a desired focus (Koelen & van den Ban, 2004). Communities will hence be aware of the public health challenge and also that a bill proposal is in parliament which they can follow up and assist in putting pressure to pass.

Non-Governmental Organizations (NGOs) and Civil Societies (CS) can be instrumental in mediating dialogue with communities. They can work closely together with existing Community Advisory Boards (CAB) which are found in clinical trial sites as links between communities and research (Crawford et al., 2002; Newman et al., 2011; Ntshanga, Ngcobo, & Mabaso, 2010; Nutbeam, 2000; Shubis, Juma, Sharifu, Burgess, & Abdulla, 2009; Vallely et al., 2007; Wallerstein & Duran, 2010). Experience has demonstrated much success in using CAB for organizing training and awareness campaigns, establishing Tb school peer educators, and much more (Newman et al., 2011; Ntshanga et al., 2010). Health education

packages should include knowledge and skills dissemination on how to use CAB for active and successful engagement of the community in policy dialogue. Though establishing a CAB can be labor intensive and time consuming, existing ones can easily be expanded to handle multiple projects (Newman et al., 2011). Moreover, if a CAB is established from scratch then it is important that its members are elected by population popular vote otherwise if selected by existing community leaders it can bring political conflicts (Shubis et al., 2009)

7.4.2 Health promotion and access to healthy choices

Health promotion operates within a context that aims at enhancing health education (Maria and Anne, 2004). This section will account on necessary legislations, physical environment and policy environment (Figure 6).

7.4.2.1 Regulatory restrictions to promote healthy choices

Part of legal restrictions is to control people's behavior in favor of health recommendations. It is not easy to legislate how people eat, or how active people decide to lead their lives. Here we describe restrictive regulations in promotion of healthy choices.

<u>Regulations for improved FV intake</u>

The WHO is calling for institutionalization of the food industry (De Vogli, Kouvonen, & Gimeno, 2014), and some countries have applied it with success (Vartiainen et al., 2010; Zatonski, McMichael, & Powles, 1998). Finland was also able to reduce CVD mortalities by banning tobacco adverts, by introducing low fat dairy products, replacing animal fat with vegetable oil and running aggressive public health education campaigns (Vartiainen et al., 2010). The United Kingdom has been able to realize a 15% population salt reduction by putting legislations on how much salt can legally be used by bakeries to make bread (Brinsden, He, Jenner, & MacGregor, 2013; He, Brinsden, & MacGregor, 2014). Some of the key components of the strategy included clear nutritional labeling, engagement of policy

players, consumer awareness and media publicity, work with industry to reformulate food with less salt and frequent surveys to measure progress (He et al., 2014).

The Tanzania National NCD Strategic and Action Plan 2016-2020 aims at reducing insufficient FV by 30% (MOHCGEC, 2016). However, there are no strategies in place that articulate how these targets will be achieved. There is also a good chance that many people do not know how to estimate portions just as others elsewhere (Appleton et al., 2018; Rooney et al., 2017). The best way to help the consumer fulfill the 5 portions a day target is to legislate labeling of fruits and vegetables with portions sizes. This will help the consumer track their fruit and vegetable intake every day. However, this may come with a few important challenges. First, portion estimating may turn out to be challenging for the trader. Second, fulfilling portion size labeling requirement may increase market prices and make fruits even more distant especially to low SES populations and vegetables will also rise in cost. Probably for resource poor countries like Tanzania it may work out better if an equivalent for portion is deduced in weight measurement. It will be much easier to legislate selling of fruits and vegetables in weight values instead of the current way where fruits and vegetables are sold singly or in bunches. Nutrition experts can explore ways of presenting weight equivalent of portions for common fruits and vegetables, which can be presented as reference charts to traders to use in their transactions.

In order to facilitate policy formulation for demanding FV labeling there is a need to consolidate political power from different relevant political players. Those may include The Minister for Industries, Trade and Investment, The Minister for Constitutional and Legal Affairs, and a member from the parliamentary committee for social development and services and another from the trade and environment committee. This team will have to work with a nutrition expert from the Tanzania Food and Nutrition Cooperation which operates under the Ministry of Health and Social Welfare, to prepare the policy draft, present and defend the bill in parliament. Campaigns to raise consumer awareness about the importance of the bill, and

regular update on policy process status may help consolidate supportive pressure from the community to demand passing of the legislation.

Regulations for increased physical activity

The Tanzania National NCD Strategic and Action Plan 2016-2020 aims at reducing insufficient PA by 10% (MOHCGEC, 2016). Again, there are no strategies in place to promote such targets. In our findings people with high SES were found to be more vulnerable to insufficient PA than low SES populations (Chapter 5). It is hence here proposed that employers take some responsibility of the inactivity because employees spend long hours in sedentary positions. The Vice President of the United Republic of Tanzania has officially launched a community exercise routine every Saturday of the second week (VOT, 2017). However, one day a week is not enough. WHO recommends 150 and 75 min of moderate vigorous intense physical activity in a week.(WHO, 2010). It here suggested that employers in the formal sector allow employees one hour early closure of offices on two days of the week to complement the community exercise day. Those two hours can be compensated by spreading them over the rest of the working days. As a policy it will ensure that all employers in the formal sector comply. The political team of players in this proposed bill should include The Minister of Information, Culture, Arts and Sports. The Minister of Constitutional and Legal Affairs, a member from parliamentary committee for social development and services. This team will have to work together with an expert in physical activity education from a higher learning institution. The involvement of the Trade Union Congress of Tanzania (TUCT) will be useful in pushing the policy agenda forward, since TUCT is the voice for those employed (TUCT, 2000).

Regulation to reduce harmful alcohol use

There are some very good policies on paper for alcohol control in Tanzania (Table 3). However, its implementation is very weak mainly due to lack of manpower and funds to enforce these legislations (Mfinanga et al., 2011).

Table 3: List of alcohol control legislations

S/N	Legislation
1.	Taxation to decrease affordability
2.	Legal restriction on advertisements
3.	Restriction of under 18 to sell or buy alcohol, or to enter alcohol outlets
4.	Restriction of opening and closing times of alcohol outlets
5.	Alcohol banned in government offices, educational buildings, healthcare facilities
6.	Control of retail sale by requirement of business license

Two measures should be put in place to enhance alcohol regulation and that includes actions to enhance implementation of existing alcohol policies and proposal of additional policies to strengthen existing ones. Taxation of alcoholic beverages can only be effective in decreasing affordability if there is regular update of the tax rates in respect to dynamic inflations. Moreover, tax rates based on volume of alcoholic beverage is more likely to increase demand than tax rate based on alcohol concentration content in the beverage (Blecher & van Walbeek, 2004). Most people report on the health cost of harmful alcohol use only, though the social and economic cost are far higher (Matzopoulos et al., 2014; Mohapatra et al., 2010). It hence is proposed here that tax rates calculation should aim at collecting revenues that will be able to cover costs of the expected total alcohol attributable harm in the society. In other words, alcohol consumers should be able to pay for their drinks as well as resulting attributed harm to individuals including themselves and the community. Studies presenting evidence on social and economic cost of harmful alcohol should therefore be promoted and used to guide tax rates updates.

The policy for alcohol advertisement legislations is not comprehensive. It needs to protect children by restricting billboard display nearby schools and public social service facilities (Saleheen et al., 2014). Alcohol sponsorship of activities that are popular among youth like

sports will encourage youth to drink more and hence need to be restricted too (Saleheen et al., 2014). Moreover, warning labels on potential health harms is an essential control tool (Miller, Ramsey, Baratiny, & Olver, 2016). A legislation that demand all alcoholic drinks to bear a label with information on amount of standard drink as well as health warning may help to control peoples' drinking.

The political team to be involved in the policy formulation to control harmful alcohol use should include The Minister of Industries, Trade and Investment, The Minister of Finance and Planning, a member for the parliamentary committee of Industries, Trade and Environment, a member from the parliamentary committee of Public Accounts Committee. This team will have to work together with an expert from the Tanzania Revenue Authority as a technical input for development of a bill draft, presenting and defending the passing of the bill in parliament. Collaboration between communities and their respective constituent's representative working towards two common goals; to strengthen law enforcement existing policies and to advocate for passing of additional alcohol bills in parliament may be useful.

Regulations for control of tobacco smoking

Increase in taxation implemented under the Framework for Tobacco Control has produced countless successful result both in high and low income countries (Saleheen et al., 2014). Increase in taxation by only 10% decreases tobacco consumption by 3% - 5% (Chaloupka, Hu, Warner, Jacobs, & Yurekli, 2000). However, in Tanzania the tobacco policy under FTCT since being ratified in April 2007 has not moved forward. The problem of poor accountability and responsibility for lifestyle policies is a major drawback in Tanzania as well as in many other countries in the continent (Husain, English, & Ramanandraibe, 2016; Mfinanga et al., 2011). That is why it is not surprising to hear that tobacco revenue collection was hardly 50% accomplished (Mackay, 2006). Moreover, while WHO advices on excise tax of 70% for tobacco, the excise tax in Tanzania is 36.67% (A. Kidane, Mduma, Naho, Ngeh, et al., 2015). The excise tax for tobacco in neighboring Kenya is 120% inclusive of all production costs

(Siringi, 2002). Moreover, there are no laws in place to restrict smoking in public places. The smoke free policy helps to remove cigarettes from the public eye and in so doing gets people to forget about it and hence reduces its preference in the population (Saleheen et al., 2014). The Ministry of Health and Social Welfare budget for 2017/18 presented last year had indicated the intention to revive the FTCT, however actions are yet to be realized (MOHSW, 2017). Moreover, on the same day a bill was passed demanding all cigarette packets to bear warning labels covering 30% of the pack, but this too is yet to be enforced (MOHSW, 2017).

7.4.2.2 Physical context to support healthy lifestyle

Walkability and cyclability studies have been done extensively in high income countries (Cerin, Nathan, van Cauwenberg, Barnett, & Barnett, 2017; Hajna et al., 2015). Studies in Brazil argue that correlates found in high income countries may not necessarily apply to low income countries (Hallal et al., 2010). For instance having a pet companion may increase leisure related walking in high income countries but not necessary in low income countries (Hallal et al., 2010). Moreover pleasant aesthetics may increase walking and cycling in high income countries, it is not necessary so in low income countries. Unpleasant neighborhood with lots of garbage have been found to have more walking and cycling in low income settings (Hoehner, Ramirez, Elliott, Handy, & Brownson, 2005). This may be explained by the fact that walking and cycling has also been reported mostly among low SES populations and most reside in poor unpleasant neighborhood (Gómez et al., 2005; Hallal et al., 2005; Hallal et al., 2010).

However, recent studies in Nigeria revealed that there are a number of overlaps in environment walkability in low and high income countries. These environmental factors that overlap include land use mix, high street connectivity, traffic safety, crime safety, pleasant scenery, presence of shade from trees (Guell, Panter, & Ogilvie, 2013; Malambo, Kengne, Lambert, De Villers, & Puoane, 2017; Adewale L Oyeyemi et al., 2013). However, aesthetics were low in walkability neighborhood which suggests it is a low SES neighborhood where

probably people walk out of poverty and not leisure or for health gains (Adewale L Oyeyemi et al., 2013). Since majority of the population are of low SES, promotions for purposeful walking and cycling may have a greater chance of success if designed to show the economic gain from walking and cycling in addition to health gains. Promotion of walking or cycling by demonstrating prospective savings on travel cost may be pleasing with positive persuasive effects (Guell et al., 2013).

People would need bikes which are expensive commodities to acquire with a meager income. Bike share programs for public health are an attractive solution to people who cannot afford big lump sum to purchase a bike of their own. Several studies have reported the bike share strategy with public health interest though it is not yet conclusive how effective it can be (Bauman, Crane, Drayton, & Titze, 2017; Choy et al., 2015; Kretman Stewart, Johnson, & Smith, 2013; Webster & Cunningham, 2013) . As long as the total rent sum does not exceed what one would have paid for public transport, then the bike share scheme may stand a chance of acceptance. Early morning community jogging clubs as well as professionals who join together and walk back home after work hours are strongly emerging. This should be encouraged by providing suitable pathways.

Pathways is an infrastructural demand, which may not be easily fulfilled immediately because of two reasons one being the high cost involved. Second, and this is a limitation to towns and cities that are already built and hence space for new modifications like these may be a design challenge. Urban development planners should work together with public health experts to in-cooperate such needs into existing set-ups where possible as well as in new developing towns and cities (Hoehner, Brennan, Brownson, Handy, & Killingsworth, 2003). For tropical places like Tanzania were temperatures go beyond 38°C for much of the year, it is important to think of pathways that will have some kind of canopy shield. Probably, that is why shades and trees on pathways featured as an important determinant of walking in a South African study (Malambo et al., 2017).

Leisure exercise has not been a popular undertaking in much part of Africa (Guthold et al., 2011), so it needs serious promotion. First of all, the government through its different sectors needs to prepare an environment that will support leisure exercises. Future urban planning should be emphasized to consider open places in development of new settlements as well as safe pathways for pedestrians and cyclists. It is also here suggested that Illegal occupation of open spaces should be controlled by imposing penalties. Allowance of a small number of business outlets in the open spaces may help raise funds for maintenance of the open space as well as for assuring continuous security for those who use these facilities. Establishing facilities for indoor exercise can be quite expensive. People with high SES are affected the most by insufficient PA, so they could be encouraged to financially support themselves for the course of physical activity. Big cooperate companies can be asked to support building exercise facilities, in door or out door for schools and for the public as part of their cooperate responsibility to the community.

7.4.2.3 Policy environment for healthy lifestyle

The United Nations (UN) high level meeting stressed the importance of utmost political support from the highest level in addressing the NCD burden (Beaglehole et al., 2011). The support is needed for the policy development process and as well as for implementation of strategies. South Africa is comparatively very advanced in efforts to address unhealthy lifestyles and has been able to pass a number of policies and regulations and the impact is vivid (C. D. Parry, 2010). But it was a big effort to align policy and stakeholders that participate in the policy development process (C. D. Parry, 2010). In Tanzania we established the NCD unit under the Ministry of Health in 2006 but still it is not fully functional and as a result even policies that are already there like the FCTC have not been able to achieve substantial outcomes. Partly, it is thought that failure to make the unit functional is because stakeholders are still operating from their original stations of work where they have

their respective sectorial responsibilities (Mfinanga et al., 2011). Obviously, it looks that there is lack of ownership of the NCD unit and hence motivation may be low.

The best way to start rectifying the situation, would be for stakeholders to assume the Ministry of Health NCD Unit as their permanent work station and move there physically. The challenge however would be the cost factor to effect such changes. What South Africa does is that stakeholders operate from their respective offices without relocation, but they assign tasks on specific policy bills to relevant ministries. Step number one is to list all regulations that are critical and give each one to a specific minister who assigns tasks to specific departments (C. D. Parry, 2010). That way tasks can be integrated into fully functioning government directorates. This is lacking in the Tanzania NCD unit, where tasks are fragmented and not integrated into any ministerial body for realizing significant output.

Another thing is about political support for funding strategies against the NCD burden. It is understandable that the government has prioritized communicable diseases, because that takes almost 70% of all cause mortalities (IHME, 2018; WHO, 2014). Although NCDs are so far causing most of the morbidity, little is visible about that to key public health stakeholders including the population. It is obvious that tangibility of the NCD burden is what is missing in the political equation. In addition to evaluation of the health costs, research needs to facilitate insight into the NCD socio-economic and cultural costs that impact our lives in order to understand the true picture of the NCD burden (Matzopoulos et al., 2014). South Africa is the only country in Sub Saharan Africa that has been able to reveal the economic cost due to one risk factor, harmful alcohol use and the results were staggering taking 10%-12% of the GDP (Matzopoulos et al., 2014). Research to produce evidence on the health, social and economic cost of NCDs may be useful in convincing policy to have a stronger role play.

7.4.3 Monitoring and Surveillance

Continuous monitoring of population lifestyle patterns as well as health and social impact is necessary in order to strengthen interventions.

Monitoring of lifestyle patterns

Both population surveys on lifestyle patterns as well as retrospective examination of peoples' choices may describe the situation of the NCD risky lifestyle burden in the population. The best place for monitoring peoples' choices is at the outlets for fruit, vegetable, cigarettes and alcohol. We therefore propose to use the TRA revenue monitoring system as a platform for collecting information on how people purchase fruits, vegetables, cigarettes and alcohol. Use of the TRA system as a platform for generating public health evidence will be one of its kind with no prior experience to lead the way but one with a promising capacity . Retrospective analysis of tax return of goods can provide information on geographic distribution of fruit, vegetable, alcohol and cigarette use across the whole country. All businesses with a turnover of Tshs 14 million (US $ 6,312) or more per year, are required by law to own an Electronic Fiscal Device (EDF) machine which monitors tax revenues of each purchase (TRA, 2018). Once a receipt is issued for a purchase, information about the purchase is sent instantly to the TRA electronic records. These records have been studied retrospectively before to inform on for instance compliance to value added tax (VAT) payment, to investigate peoples' perception and to investigate challenges of using the EFD machines (A. Chege, Kiragu, Lagat, & Muthoni, 2015; Ephraim, 2015; Kapera, 2017; Kira, 2016; SIRAJI, 2015). The EFD machine provides description of items purchased and therefore it is possible to deduce amount of fruits, vegetables, cigarettes, alcohol that are being consumed in a specific neighborhood (TRA, 2018). Places with most problems can then be identified for more detailed surveys, for more promotional needs or for more follow up of regulation compliance by traders and consumers.

Normally, codes are entered and stored in the machine, so that when the trader makes a bill, they press a specific code for that product. For now, description codes for specific goods may not be very detailed. For instance a single fruits code stands for all types of fruits, likewise for vegetables, cigarettes and probably also for alcohol drinks. However, this can change, and codes can be modified to be more specific of product purchased because there is justification for that. Detailed codes, for each type of fruit and each type of vegetable will be useful for assisting the establishment of evidence based farming of especially vegetables as well as introduction of indigenous vegetables. In the early stages of introducing indigenous vegetables to the pool of vegetables in the market, information on how people consume those new varieties can be easily studied by looking at TRA tax records retrospectively through the EFD system. The TRA system is a well-established system found particularly in urban and semi urban settings all over the country (TRA, 2018). For a nationally representative monitoring system, efforts should be put in place to ensure that the EFD system is established in rural settings too. Most traders found in rural settings do not meet an annual turnover of Tshs 14 million and above and hence are not required by law to use the EFD system. Since rural settings habour most of the population, lack of an EFD system in these areas may be limiting information on NCD risky lifestyle patterns of majority of the population.

Tax evasion has been an important challenge for many years (O.-H. Fjeldstad, 2001; O. H. Fjeldstad, 2003). However, recently aggressive control measures have been put in place with high penalty consequences for anyone who sells or buys anything that has not been deducted for tax, and that means issuing or receiving an EDF receipt (TRA, 2018). It has actually been reported that majority of traders ensure that they operate an EFD for their business to avoid problems of penalty (Kira, 2016). Although many traders feel the EFD system has simplified work of preparing reports and helps ensure records are kept securely for auditors, many still complain of high prices of purchasing an EFD machine and the technical difficulty of operating the EFD machine, especially for traders who are not learned

(A. Chege et al., 2015; Ephraim, 2015; Kapera, 2017; Kira, 2016; SIRAJI, 2015). Moreover, the same studies also complained of persistent power cuts and network to be an important problem that limit use of the EFD machine.

Monitoring health and social impact of unhealthy lifestyle

The best way to monitor health and social implications of unhealthy lifestyle would be through health facility surveillance. Mfinanga and colleagues highlighted the need for NCD status monitoring through health facility based surveillance, but has not been given attention for many years now (Mfinanga et al., 2011). Most health facilities are also not yet ready to offer even the minimum NCD services, due to lack of basic equipment and lack of qualified staff (Bintabara & Mpondo, 2018; Boateng et al., 2017; Chikowe, Mwapasa, & Kengne, 2018; Katende et al., 2015; Peck et al., 2014; J. I. Schwartz, Guwatudde, Nugent, & Kiiza, 2014; Settumba et al., 2015). Government expenditure for NCD primary prevention including surveillance activities is still very low (MOHSW, 2017). Probably it will be easier to start monitoring the social impact of unhealthy lifestyle ahead of the health impact. Social impact can be monitored through police records on crime events like robbery, interpersonal violence. Moreover, from traffic police offices reports on road injuries can also be obtained on a routine basis. Government offices should be able to provide reports on total NCD and risky lifestyle attributed absenteeism and presentism as proxy indicators for low productivity. Other places for deducing social impact of unhealthy lifestyle would be lawyer's firms and welfare and social counseling offices. Monitoring and surveillance reports will help inform policy as well as the population, as well as public health experts for strengthen implementation of interventions.

7.5 Conclusion

This study deduced that NCD risky lifestyle in Ifakara-Southern Tanzania is substantial and highly complex. Almost every population group was found to be affected by at least one type of risky lifestyle. Although majority of those most vulnerable where found to be people of low SES, gender and age bias was also present and was distinct for each risky lifestyle.

Improvement of the number of vegetable portions consumed may have a significant positive impact on the overall FV intake, because almost half of the population already consumes vegetables daily. Fruit use was minimal in general and almost completely absent among the low SES population. Studies to explore the use of herbs and spices for fulfilling the micronutrient need normally sourced from fruits may help address the cost barrier existing in low SES populations. Further in depth studies are needed to investigate means of improving vegetable intake among youth and increase in number of vegetable portions consumed by the population at large. Moreover, studies to explore ways of introducing indigenous vegetables and employ evidence base farming are recommended. Harmful alcohol use as a habit seems to be recruiting new women and youth as its new victims, and if not addressed it may have a significant impact to health and economic development in the future. Public health action against harmful alcohol use needs to be given utmost priority. Smoking is still affecting a fraction of the low SES population particularly men and should be contained before it has become uncontrollable. Moreover, it must also be noted that a rising harmful alcohol burden may also influence a rise in the tobacco smoking burden since alcohol use and tobacco smoking tend to co-exist. Furthermore, public health interventions to address insufficient PA should be directed to the high SES population as well as the older men group. Moreover, efforts should also be put in place to promote more vigorous intense activities in the population at large as this seems to be slipping away and hence poses a risk of getting the population closer to less active lifestyle.

Literature shows that the government has not yet done enough to educate the population on the importance of healthy choices and how to access them. In this way the population has been denied the right to know that they need to protect themselves and the know-how of protecting themselves. In addition, despite being denied the right to be informed on how to behave and why to behave in a specific way, it must be noted that vulnerable populations who end up being victims of NCDs have to manage much of the social and economic costs themselves. The health expenditure for NCD is still very minimal with almost negligible allocations for primary prevention. In addition, the health insurance is at the moment pro rich leaving the poorest families in catastrophic or zero health expenditures. Vulnerable population groups who succumb most to the risks are the poorest and are left to manage the health social and economic burden almost solely themselves. Besides health education and enhancing the political and legislation environments, this study also suggested actions for making healthy choices the easiest options. That includes improved access to supply of fruits and vegetables, establishment of walkability and cyclability physical environments and active community engagement in policy dialogue and law enforcement. More research is also recommended for monitoring and surveillance of lifestyle patterns across different population groups and geographic locations.

7.6 NCD research agenda

From findings of this study three main areas of research are deduced as priority for driving the NCD research agenda forward. These include

1. **Research to monitor risky lifestyle patterns as well as health and social impacts of risky lifestyle across different population groups across the country**

   This evidence will help public health experts develop targeted interventions and with the right priority setting. Moreover, it will also generate evidence on health and social impact which will help improve political commitment as well and individual and community responsibility towards healthy lifestyle.

2. **Research to improve access to healthy lifestyle options**

   This evidence will help deduce ways of introducing indigenous vegetable to mainstream markets. Moreover, it will explore the potential of replacing expensive fruits with cheaper options like herbs and spices which are accessible to many. In addition, this research domain will work to investigate ways of documenting traditional physical activity games for children which were very common just three decades ago but are now almost totally unknown to the current generation.

3. **Research to improve individual responsibility for promoting healthy lifestyle**

   This evidence will help guide development of interventions to improve population awareness about the public health importance of NCDs. Moreover, it will also include improvement of population awareness about policy formulation process and community engagement in promoting healthy lifestyle and enforcing legislations and regulations.

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Appendices

Appendix 1 List of Abbreviations

ALPHA	Analyzing Longitudinal Population-based HIV/AIDS data
AMMP	Adult Morbidity and Mortality Project
APC	Alcohol Per Capita
ART	Anti-Retroviral Therapy
AUD	Alcohol Use Disorder
CEO	Chief Execute Officer
CI	Confidence Interval
CNS	Central Nervous System
COPD	Chronic Obstructive Pulmonary Disease
CVDs	Cardiovascular Diseases
DALYs	Disability Adjusted Life Years
DNA	Deoxyribonucleic Acid
FAS	Fetal Alcohol Syndrome
FTCT	Framework for Tobacco Control
FV	Fruit and Vegetable
HED	Heavy Episodic Drinking
HIV/AIDS Syndrome	Human Immunodeficiency Virus/Acquired Immunodeficiency Disease
ICAP	International Centre for Alcohol Policy
IHD	Ischemic Heart Disease
IHI	Ifakara Health Institute
INDEPTH	Network of Independent population based centers
IQR	Interquartile Ranges
IU-HDSS	Ifakara Urban-Health and Demographic Surveillance System
IV	Indigenous Vegetables
LMIC	Low and Middle Income Countries

MOHSW	Ministry of Health and Social Welfare
MPA	Moderate Intensity Physical Activity
MVPA	Moderate to Vigorous Intensity Physical Activity
MZIMA	Swahili name given to the study cohort. It means “Life”
NCD	Non Communicable Diseases
NTC	Neglected Tropical Diseases
OR	Odds Ratio
PA	Physical Activity
SDG	Sustainable Development Goals
SES	Social Economic Status
SSA	Sub Saharan Africa
STATA	Statistics and Data
STPH	Swiss Tropical and Public Health Institute
TB	Tuberculosis
VPA	Vigorous Intensity Physical Activity
WHO	World Health Organization
WHO-STEPS	WHO STEPwise approach to Surveillance

Appendix 2 List of Tables

Appendix 3 List of Figures

Appendix 4 CV

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