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Community-Based Cross-Sectional Study of Hypertension and Diabetes Mellitus in Adults in A Rural Suco of Atauro, Timor-Leste

Marcelo Amaral Mali[1], Benjamin James Cresswell[2], Lois Hong[2], Romel Braz[1], Evaristo da Silva[1], Vivien Lee[2], Linus Chua[2], Oriana Pampolini-Roberts[2], Maya Trivedy[2], Noel Gama Soares.

[1]Instituto Nacional Saude Publica-Timor-Leste.
[2]Maluk Timor.
[3]National University of Singapore

Corresponding author: Marcelo Amaral Mali
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Abstract

Non-communicable diseases (NCDs) are a major public health threat in low- and middle-income countries worldwide. The burden of NCDs in Timor-Leste has been recognized nationally for some years. However, there is little public health strategy to address this issue, especially in rural areas where NCDs remain neglected. This study aims to estimate the prevalence of hypertension and diabetes mellitus and their risk factors in a rural community in Timor-Leste.

A cross-sectional study was conducted in a rural community on the island of Atauro. All adults over the age of 18 were invited to undergo screening for hypertension and diabetes mellitus using repeated blood pressure and random capillary glucose readings. The target sample size was 295, and participants were also asked to provide information on NCD risk factors such as smoking status, betel nut use, and alcohol consumption. Data analysis was performed using Microsoft Excel to calculate the prevalence of hypertension, diabetes mellitus, and associated risk factors.

A total of 320 participants were screened for raised blood pressure and elevated random capillary glucose levels in July 2021. The median (SD) age of participants was 43 (±16.3) years, and 187 (58.8%) were female. The overall prevalence of hypertension (including those with known hypertension) was 25.8% (CI 21.1-31.0). The prevalence of diabetes mellitus was 1.26% (CI 0.34-3.19), with just four cases identified. Smoking and alcohol use were the most common risk factors in men, whereas betel nut use was the most frequently reported risk factor in women.

The study indicates a significant burden of undiagnosed and uncontrolled hypertension in rural areas of Timor-Leste. Enhanced screening for hypertension, targeted health promotion, and strengthening of primary healthcare services are necessary to improve the diagnosis and management of NCDs in rural communities. Future research must explore factors associated with undiagnosed hypertension in rural areas.

Keywords: Undiagnosed Hypertension, Diabetes Mellitus, Rural NCDs, Timor-Leste

Introduction

Non-communicable diseases (NCDs) are a major public health threat to low and middle-income countries (LMICs) across the world, experts' analysis concluded that the growth of NDC's is fastest, specifically in countries with little forecasted change in health spending, and health system in LICs are well equipped (Bollyky et al., 2017)

Globally, NCDs cause 41 million deaths every year. 17 million people under the age of 70 die annually due to NCDs; it is thought that 77 % of these deaths occur in LMICs (World Health Organization, 2022). This has a significant impact on households and on a macro-economic level, as income loss and healthcare expenditure rise due to mortality and disability caused by these diseases. (Chaker et al., 2015), (Kazibwe, Tran and Annerstedt, 2021)

Timor-Leste continues to suffer from a high burden of infectious diseases; it has one of the highest incidences of tuberculosis in Asia and until recently was endemic for malaria. As a result, there has been a sustained focus on fighting communicable diseases which has left NCDs somewhat neglected in terms of research and funding. The only major study on NCDs in Timor-Leste was carried out in 2014 by the World Health Organization (WHO), in the form of a national survey to estimate the prevalence of NCDs and their risk factors in the general population (Martins et al., 2014). The survey identified 39.3% of the general population as having high blood pressure and 1.5% of the population having a raised fasting capillary glucose (defined as over 6.0mmol/L). Data was only presented about the national population as a whole and no data was presented about regional variations in findings. The only other epidemiological research on NCDs in Timor-Leste was a small cross-sectional study in Dili from 2013, which found that 15% of patients attending for cataract surgery were found to have diabetes mellitus (Martins, 2015). Both studies provided data about the prevalence of NCDs in urban populations, however the burden of NCDs in small, rural populations across Timor-Leste which make up most of the population, remains undocumented.

The national survey from 2014 identified that 48.6% of the general population were users of tobacco, whilst almost 20% used betel nut. The national survey also identified almost a third of the population consumed alcohol regularly and a fifth drank alcohol on 5 to 6 days per week.

Obviously, NCD's has multiple risk factors, the factors related to life style, toxic habits, stress, dietary habits, nutrition, and many others. Although, childhood nutrition remain high in

Timor Leste.(Provo et al., 2017) , the link between nutrition and hypertension is not well discussed, it can be a potential predictor for anticipating future increasing of NCD's in particular Hypertension, there is evidence of association between childhood undernutrition hypertension, for instance a study conducted in CHINA found that the chance of having hypertension in the middle age in the child with nutritional deficiency in childhood is higher than the good nutrition(Zhang et al., 2018),

The WHO Package of Essential Non-Communicable Disease Interventions (WHO PEN) is a set of primary care interventions designed to improve early detection and management of NCDs, yet does not offer policies to target NCD risk factors on a public health scale. A better understanding of local risk factors for NCDs in Timor-Leste's rural and most marginalized communities would allow for targeted, cost-effective public health interventions to reduce the burden of NCDs in the population. Therefore, this study was conducted aims to estimate the prevalence of hypertension and diabetes mellitus and their risk factors in a rural community in Timor-Leste.

Research Method

A cross-sectional study design with a quantitative-descriptive approach was deployed to calculate the prevalence of hypertension, diabetes mellitus, and their risk factors in a small rural community in Timor-Leste. It was a community-based cross-sectional study. Cross-sectional studies are observational studies that analyze data from a population at a single point in time (Wang and Cheng, 2020). Cross-sectional studies are often used to measure the prevalence of health outcomes, understand determinants of health, and describe features of a population at a single point. As there is no time dimension involved in cross-sectional studies and therefore no time interval between "exposure" and "outcome," causal inferences should not be made (Kesmodel and Kesmodel, 2018).

The population of interest was the community of Makili on the island of Atauro. Atauro has an area of just 140 square kilometers and an estimated population of 12,000. Access to primary healthcare is challenging due to mountainous terrain and limited infrastructure. Makili has a small health post, and the nearest community health center is a two-hour hike across uneven terrain. There are an estimated 2,500 inhabitants, and approximately 50% of the population is under the

age of 18. Most of the adult population are fishermen or farmers. Based on an estimated eligible population of 1,250, a sample size of 295 participants was calculated to estimate the prevalence of hypertension, diabetes mellitus, and their risk factors. Local community health workers and church leaders were recruited to sensitize the community, and villagers were invited to attend the local health post for screening over a three-day period in July 2021. Participants were recruited by convenience sampling if they met the following criteria. Inclusion criteria: All adults aged 18 years or above were eligible to enroll in the study. Exclusion criteria: Children under the age of 18 and pregnant women were excluded from participating in the study.

Basic demographic and risk factor information such as gender, age, smoking status, alcohol consumption, and betel nut use was collected. As Makili is a homogenous rural population, information was not collected on ethnicity, socioeconomic status, or education level. Participants then passed through three stations for blood pressure measurement, random capillary glucose measurement, and health promotion. Blood pressure measurement was carried out using a standardized and calibrated electronic sphygmomanometer. Participants were invited to sit down and rest their arm on a table for blood pressure measurement. If either the systolic or diastolic reading was 140mmHg or 90mmHg or above, respectively, the measurement was repeated after the participant sat still for three minutes. As many of the population had not had blood pressure checks before, we anticipated that the 'white coat' effect might be significant; therefore, the lower of the two values was recorded.

A random capillary blood glucose test was taken by a nurse using a True Metrix Air blood glucose monitoring meter (Trividia Health, Fort Lauderdale, USA). Capillary blood glucose measurement was chosen for this study due to logistical difficulties in processing venous blood glucose samples. Glycosylated hemoglobin (HbA1c) point-of-care testing is not validated in Timor-Leste, and anecdotally, the prevalence of anemia is high in the general population. The WHO has approved the use of capillary blood glucose to diagnose diabetes mellitus in rural populations in Timor-Leste, considering these issues. Participants with a random capillary blood glucose reading of 11.1mmol/L or above were asked about hyperglycemic symptoms of diabetes (polyuria, polydipsia, polyphagia, weight loss), and their test was repeated.

At the final and third station, participants were shown three posters on risk factor modification, hypertension, diabetes, and their potential long-term effects. Two local community

health workers were present to explain the health promotion materials and educate the participants based on their screening results. Participants with abnormal test results were handed an appointment card with details of their results and a date to see their local doctor at the health post for further management.

Cases of hypertension (Figure 1): Participants with a lowest blood pressure reading of over 140mmHg systolic or 90mmHg diastolic were considered hypertensive. These participants were given an appointment to attend the local health post to have their blood pressure re-checked on a separate day to confirm their diagnosis. All newly diagnosed hypertensive patients were assessed by the doctor at the health post and managed as per national guidelines. Participants on anti-hypertensive medication were included as hypertensive cases regardless of blood pressure readings.

Cases of diabetes mellitus (Figure 2): Participants with two consecutively elevated random capillary glucose results (11.1mmol/L to 17.9mmol/L) were given a hand-held record of their test results and an appointment to attend the local health post to have their fasting capillary glucose checked. Participants who had at least one elevated random capillary glucose result and were symptomatic (polyuria, polydipsia, polyphagia, and weight loss) were diagnosed with diabetes mellitus. New cases of diabetes mellitus were managed as per national guidelines.

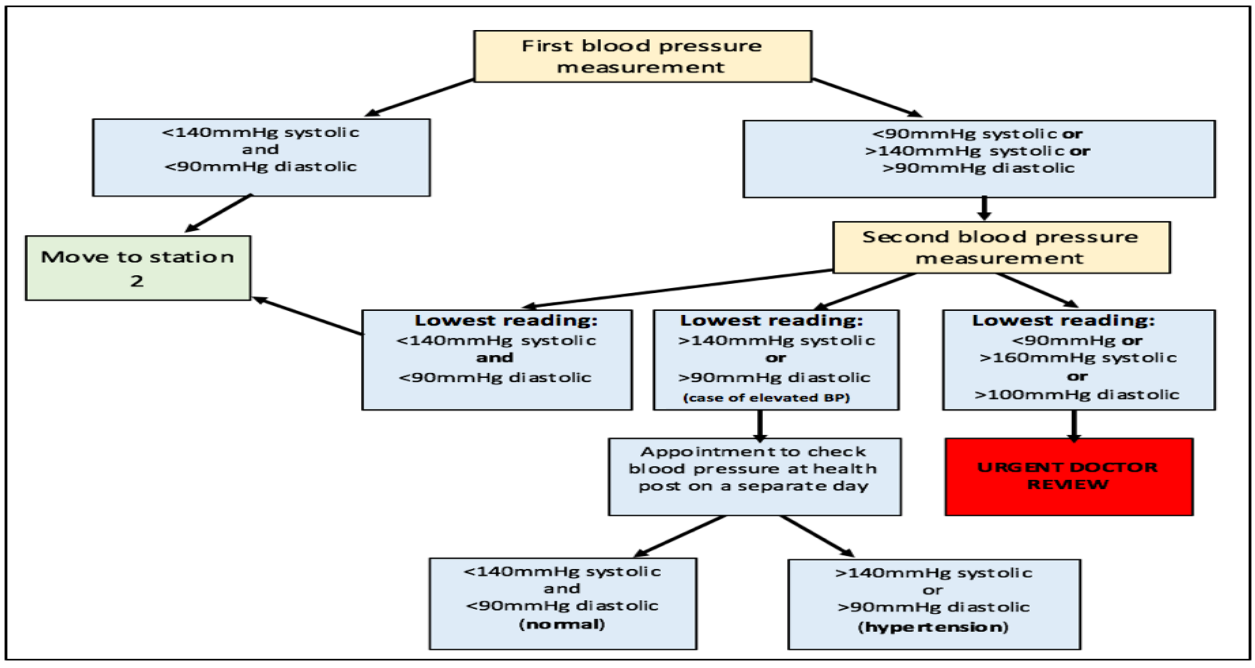

Figure 1. Flow chart for participants having their blood pressure measured. BP = blood pressure. Station 2 = random capillary glucose measurement. Blood pressure was checked twice, 3 minutes apart and the lowest reading was used to account for possible 'white coat syndrome'. Any patient with a dangerous blood pressure reading as detailed was reviewed by a doctor immediately.

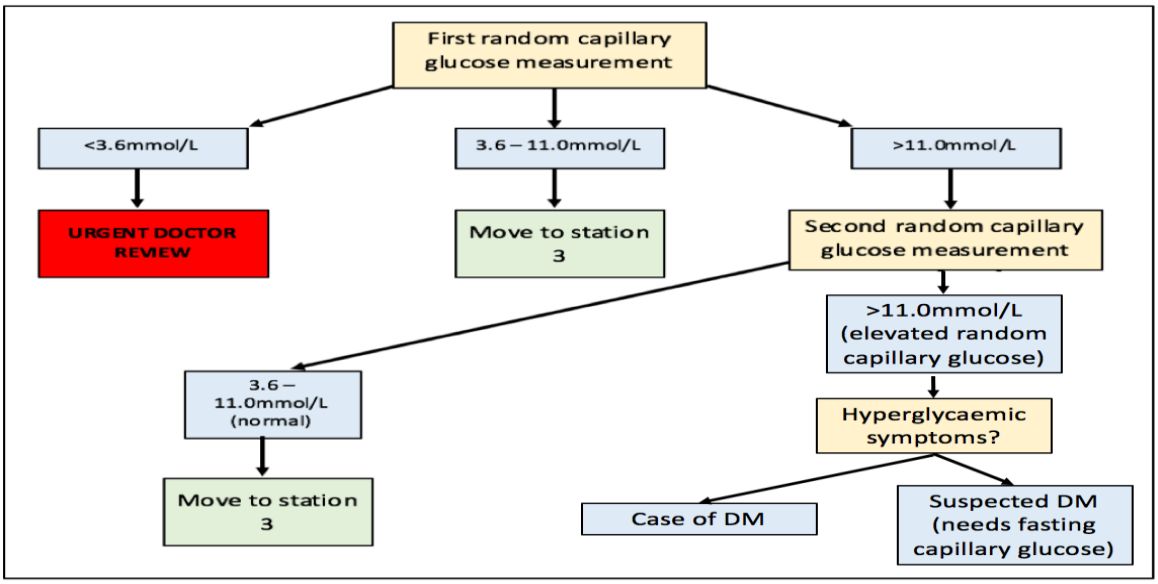

Figure 2. Flow chart for participants having their random capillary glucose measured. DM=diabetes mellitus. Station 3 = health promotion station. Any participant with a random capillary glucose measurement of over 17.9mmol/L was reviewed urgently by a doctor immediately.

Participants' details and test results were documented on standardized forms designed for this study. Participant data was then anonymized when these forms were converted to electronic format, and double data entry was employed before data analysis was carried out using Microsoft Excel.

Local ethical approval from the Instituto Nacional da Saúde was obtained prior to the initiation of the study (16/05/2021). All participants signed consent forms before entering the study, and thumbprint signatures were available for participants who were unable to provide a signature.

Results And Discussion

Table 1. Demographic data and characteristics of participants

	n=318	Percentage (%)	95% CI
Age			
18-35	103	32.4	27.3-37.8
36-50	100	31.4	26.4-36.9
>50	115	36.2	30.9-41.7
Gender			
Male	131	41.2	35.7-46.8
Female	187	58.8	53.2-64.3
Pre-existing diabetes			
Yes	3	0.9	0.19-2.73
No	315	99.1	97.3-99.8
Pre-existing hypertension			
Yes	20	6.3	3.88-9.55
No	298	93.7	90.5-96.1

A total of 320 individuals were screened for raised blood pressure and elevated random capillary glucose levels over a 3-day period in July 2021. Data was missing for 2 participants therefore these were excluded. Diastolic blood pressures were not recorded for a further 2 participants; their data was included for analysis without readings. The median (SD) age of participants was 43 (±16.3) years, whilst 187 (58.8%) of participants were female. There were 20 (6.3%) known cases of hypertension who were already taking anti-hypertensive medication. Only 3 (0.9%) participants were on anti-hyperglycaemic treatment for diabetes mellitus.

Table 2. Mean systolic, and diastolic Blood pressure

Age Group (years)	Men			Women			Both Sexes		
	N	**Mean**	**95% CI**	**n**	**Mean**	**95% CI**	**N**	**Mean**	**95% CI**
	Mean systolic blood pressure (mmHg)								
18-35	43	116.8	112.9-120.7	60	111.8	108.6-115.0	103	113.9	11.4-116.4
36-50	36	126.7	119.8-133.7	64	123.5	118.3-128.6	100	124.6	120.6-128.7

>50	52	133.2	127.1-139.2	63	134.5	128.7-140.3	115	133.9	129.8-138.0
All ages	**131**	**126.0**	**122.6-129.5**	**187**	**123.4**	**120.4-126.5**	**318**	**124.5**	**122.2-126.8**
	Mean diastolic blood pressure (mmHg)								
18-35	43	71.7	68.4-75.0	60	74.4	71.9-76.9	103	73.2	71.3-75.3
36-50	36	76.5	72.7-80.2	64	78.4	75.7-81.2	100	77.7	75.5-79.9
>50	52	73.3	69.4-77.3	63	75.5	72.0-79.0	115	74.5	71.9-77.1
All ages	**131**	**73.6**	**71.5-75.8**	**187**	**76.1**	**74.4-77.8**	**318**	**75.1**	**73.8-76.4**

Table 2 present mean blood pressure, as observed, mean systolic blood pressure measured was 124.5mmHg (95% CI 122.2-126.8mmHg) with a range from 88 to 219mmHg (SD 20.8). Mean diastolic blood pressure was 75.1 (95% CI 73.8-76.4mmHg) with a range from 49 to 112mmHg (SD 12.0).

Table. 3. Distribution of Hypertension by sex

Age Group (years)	**Men**			**Women**			**Both Sexes**		
	n	**%**	**95% CI**	**n**	**%**	**95% CI**	**n**	**%**	**95% CI**
SBP≥140 and/or DBP ≥90, excluding those with known hypertension									
18-35	4	9.5	2.66-22.6	5	8.2	2.72-18.1	9	8.8	4.11-16.1
36-50	5	15.1	5.11-31.9	6	10.7	4.03-21.8	11	12.4	6.33-21.0
>50	20	40.8	27.0-55.8	22	38.6	26.0-52.4	42	39.3	30.0-49.2
All ages	**29**	**24.0**	**16.8-32.5**	**33**	**19.1**	**13.5-25.7**	**62**	**20.8**	**16.3-25.9**
SBP≥140 and/or DBP ≥90, or known hypertension									
18-35	5	11.6	3.89-25.1	5	8.33	2.76-18.4	10	9.71	4.75-17.1
36-50	8	22.2	10.1-39.2	14	21.9	12.5-34.0	22	22.0	14.3-31.4
>50	22	42.3	28.7-56.8	28	44.4	31.9-57.5	50	43.5	34.3-53.0
All ages	**35**	**26.7**	**19.4-35.2**	**47**	**25.1**	**19.1-32.0**	**82**	**25.8**	**21.1-31.0**

As presented in above table 3, this study identified 35 cases of hypertension in men (prevalence 26.7%: 95% CI 19.4-35.2%), including 6 participants with known hypertension already established on anti-hypertensive medication (Appendix 1). There were 47 cases of hypertension in women (25.1%; 95% CI 19.1-32.0%), including 14 participants with known hypertension who were already established on medication. Of the hypertensive patients (n=82), only 20 (24.4%) were aware of their condition. Only 4 (20%) of participants with known hypertension had blood pressure reading of under 140mmHg and 90mmHg diastolic and would therefore have been classified as controlled hypertension according to local guidelines. The prevalence of hypertension was highest in participants of both sexes aged over 50 years with 50 cases (prevalence 43.5%; 95% CI 34.3-53.0%).

Table 4: Mean random capillary glucose readings by age and gender with 95% confidence intervals.

Age Group (years)	Men			Women			Both Sexes		
	n	**Mean**	**95% CI**	**n**	**Mean**	**95% CI**	**n**	**Mean**	**95% CI**
Mean random capillary glucose (mmol/L)									
18-35	43	6.3	6.0-6.7	60	6.2	6.0-6.5	103	6.3	6.1-6.5
36-50	36	6.4	6.0-6.8	64	6.4	6.1-6.6	100	6.4	6.2-6.6
>50	52	6.7	6.3-7.1	63	6.6	6.4-6.9	115	6.7	6.4-6.9
All ages	**131**	**6.5**	**6.3-6.7**	**187**	**6.4**	**6.2-6.6**	**318**	**6.4**	**6.3-6.6**

Table 4 present mean random capillary glucose, the data shows that mean capillary glucose randomly tested was 6.4mmol/L (95% CI 6.3-6.6mmol/L) with a range from 4.0 to 13.2mmol/L (SD 1.1). Capillary glucose measurements are summarised by age and gender in appendix 2. Just 1 participant (0.31%, 95% CI 0.01-1.74%) was found to have elevated random capillary glucose readings and reported being symptomatic for diabetes mellitus. This individual was newly diagnosed with type 2 diabetes mellitus after review with the local healthcare team and was subsequently started on anti-hyperglycaemic medication. Overall, there were 4 cases of diabetes

mellitus in the population studied; 3 of whom (75%) were already aware of their condition prior to participating in the study. The prevalence of diabetes mellitus was therefore 1.26% (95% CI 0.34-3.19). Data on age and gender of cases of diabetes mellitus is summarized in appendix 3.

Risk factors recorded was smoking, betel nut use and alcohol intake, the data for both sexes presented in Figure 4 and Figure 5, and Tabulated data for both sexes can be found in appendix 4.

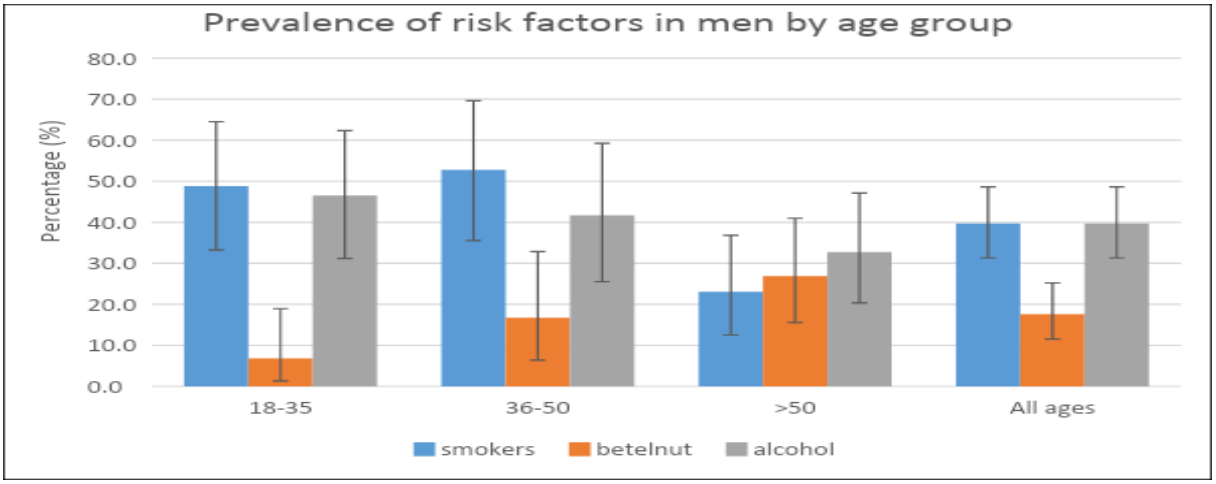

Figure 4. Prevalence of risk factors for NCDs in men by age group, with 95% confidence intervals.

Smoking and alcohol intake were the most common risk factors reported in men **(figure 4).** Of 131 male participants, 52 reported being current smokers, giving a prevalence of 39.7% (95% CI 31.3-48.6%). 52 male participants also reported drinking alcohol at least once a week, giving a prevalence of 39.7% (95% CI 31.3-48.6%). 23 participants reported using betelnut, giving a prevalence of 17.6% (95% CI 11.5-25.2%).

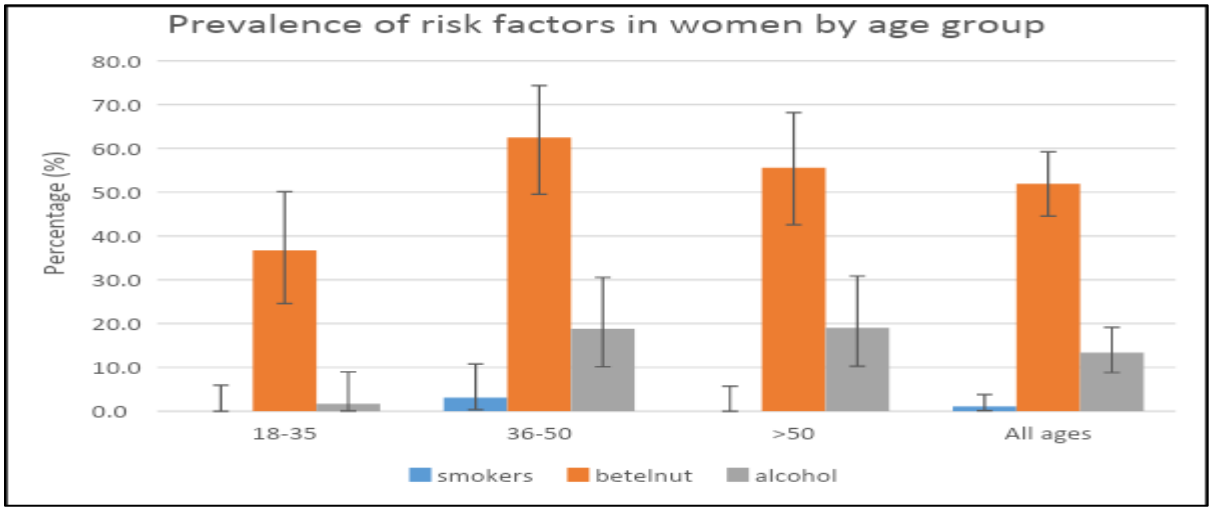

Figure 5. Prevalence of risk factors for NCDs in women by age group, with 95% confidence intervals.

Of 187 female participants **(Figure 5),** just 2 indicated they were current smokers (mean 1.1%, 95% CI 0.13-3.81%). Betel nut use was by far the most common reported risk factor, as demonstrated in figure 5. 97 female participants reported using betel nut, giving a prevalence of 51.9% (95% CI 44.5-59.2%). 25 women reported drinking alcohol at least once a week, giving a prevalence of 13.4% (95% CI 8.84-19.1%).

Discussion

This cross-sectional study was conducted in a rural village on the island of Atauro in Timor-Leste. Its purpose was to identify the prevalence of hypertension, diabetes mellitus, and their risk factors in a community with restricted access to healthcare. The prevalence of hypertension in the community that participated in the study was just over 25%, which is lower than the national mean prevalence of hypertension from the WHO-led national survey in 2014 (39.3%). Meanwhile, the estimated prevalence of diabetes mellitus in the community was just over 1%, compared to 1.5% in the aforementioned national survey.

Reasons for the lower observed prevalence of hypertension and diabetes mellitus might include the population's reliance on subsistence farming and, due to the isolated location of the community, reduced access to processed foods compared to urban areas. The islanders are also more likely to maintain active lifestyles due to the mountainous terrain and lack of operational transport infrastructure. It is also possible that the number of diabetics was low due to a higher rate of mortality in this group if left untreated.

The estimated prevalence of hypertension in this study was also lower compared to other Southeast Asian countries. For instance, a study in Cianjur District, West Java, Indonesia, found a high prevalence of hypertension among adults (Diana et al., 2018). The most recent published systematic review with a meta-analysis on the prevalence of NCDs across Southeast Asia identified a wide range in the reported prevalence of hypertension between and within countries (Neupane et al., 2014). This supports the notion that NCD prevention strategies should consider that risk factor profiles will be heterogeneously distributed even within countries and at a regional level.

Perhaps the most pertinent finding of this study was the number of participants who were unaware they had hypertension. Less than a quarter of participants found to be hypertensive knew of their diagnosis, while only a fifth of previously diagnosed participants had blood pressure readings within recommended targets as per local guidelines. There are several plausible reasons

for this. First, there is only one small health post in the village, which operates only on certain days of the week and is intermittently staffed. This results in fewer opportunities for health promotion, diagnosis, and ongoing management of known cases. Locals are also anecdotally reported to be more likely to seek advice from traditional healers initially rather than attend the health post. Other factors, such as age, education, geographical location, and economic conditions, were found to be associated with undiagnosed hypertension (Mahwati, Nurrika, and Latief, 2022).

Non-adherence to medication is also a recognized problem due to supply issues and a lack of understanding that hypertension is a chronic health condition requiring long-term treatment to prevent serious outcomes.

Risk factor analysis in the study suggests that the risk factor profile for NCDs differs considerably between men and women in the population of interest. Men reported significant use of cigarettes and alcohol, whereas women of all ages were much more likely to report betel nut use. Interestingly, the national survey carried out in 2014 identified that 57.5% of women over the age of 49 used betel nut at the time. The findings in this study suggest that betel nut use continues to be a prevalent risk factor and would be a worthwhile target for public health interventions to reduce the risk of future cardiovascular disease.

Betel nut is grown throughout the country and is a highly addictive stimulant that is chewed. It has been associated with cardiovascular diseases, arterial stiffness (Wei et al., 2017), and a greater risk of cardiovascular disease (CVD) and all-cause mortality in recent meta-analyses (Yamada, Hara, and Kadowaki, 2013). A recent study also suggested an association between betel nut chewing and kidney disease, which can be a secondary cause of hypertension (Chang et al., 2022). Additionally, a longitudinal study conducted in Taiwan observed a significant association between betel nut chewing history and metabolic syndrome (Huang et al., 2022).

Timor-Leste continues its fight against communicable diseases while balancing efforts and strategies to address the increasing burden of NCDs. In particular, ischemic heart disease and stroke were reported as the top three causes of death (after tuberculosis) (WHO, 2020). Targeted health promotion towards men should focus on smoking and alcohol use, as these were the predominant risk factors across all age groups. Increasing awareness through health promotion is necessary to reduce undiagnosed hypertension (Mahwati, Nurrika, and Latief, 2022).

Despite the national implementation of the WHO PEN interventions, the study identifies that there is likely to be a significant burden of undiagnosed and uncontrolled hypertension in Timor-

Leste. NCD care must be accessible and extended to marginalized populations in rural areas. Although WHO PEN recommends domiciliary visits as a method of tackling this issue, these are labor- and time-intensive. The findings in this study suggest that a model entailing village screening over one to two days may yield the highest number of new cases and provide a useful opportunity for high-impact health promotion.

Strength and limitations of the study

As this study was carried out during the COVID-19 pandemic, resources and time were limited to several days of screening only. It was not possible to obtain results from repeat clinic blood pressure readings or glucose readings at a later date to confirm cases of hypertension and diabetes mellitus. Confirmatory testing through ambulatory blood pressure monitoring and oral glucose tolerance tests would have allowed for a more accurate estimation of the prevalence of hypertension and diabetes mellitus. However, these methods would not be replicable going forward and do not form part of local guidelines due to a lack of equipment and capacity.

The questionnaire on NCD risk factors was prone to recall and social desirability bias, meaning that some respondents might have been less likely to disclose behaviors such as smoking or alcohol consumption.

Conclusion

This is the first focused epidemiological study from Timor-Leste that describes the prevalence of hypertension and diabetes mellitus and their risk factors in a rural community. This study suggests that hypertension remains prevalent in the community and that most cases are undiagnosed, while the prevalence of diabetes mellitus is low. Blood pressure control in known cases of hypertension is also poor. Smoking and alcohol consumption are common risk factors, especially among male adults, while betel nut use appears to be the most significant risk factor among female adults.

Increased screening for hypertension and diabetes mellitus in rural communities, targeted health promotion focusing on lifestyle modifications, and education about medication adherence are needed alongside the strengthening of primary healthcare services to improve the diagnosis and management of NCDs in rural areas of Timor-Leste. Future research needs to focus on exploring and analyzing the factors associated with undiagnosed hypertension in rural areas.

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