

Prevalence Of Cardiovascular Risk Factors In A Semi-Urban Population In Indonesia [Early Detection of Cardiovascular Risk Factors as Primary Prevention amongst North Sumatera Adults (ECARDIA-NS) study]

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Abstract

Background

Controlling cardiovascular risk factors (CVRF) such as hypertension, hyperlipidemia, diabetes, obesity and smoking has been shown to be effective in reducing the risk of developing cardiovascular diseases such as ischaemic heart disease and stroke. However, previous nationwide health surveys were conducted some time ago and largely relied on surveys and interviews with only a limited subset of subjects undergoing formal testing with oral glucose tolerance tests and biochemical lipid profiling.

Methods

This study aimed to provide a more accurate estimation of the prevalence of CVRFs in a population of adults in the province of North Sumatera. 1208 adults (80% female) aged 40 years and older with no apparent cardiovascular disease were recruited via a community-based cross-sectional opportunistic survey. Participants underwent anthropomorphic and blood pressure measurements, followed by a single lead electrocardiogram and blood draw for biochemical analysis of HbA1c and lipid panel. Subjects were surveyed regarding their demographics, medical history. A subset of participants was interviewed and scored on their knowledge, attitudes and practices (KAP) with a 14-point questionnaire.

Results

Overall, 56% of the population had hypertension, 44% had dyslipidemia and 17% had diabetes. Most of these subjects were newly diagnosed based on measurements obtained during this screening study. 69% of participants were obese, a further 15% were overweight and 83% had elevated waist circumference. 1.3% of subjects had atrial fibrillation. Multivariable logistic regression showed significant associations between presence of CVRF and older age, obesity and elevated waist circumference. The median knowledge score was 5/10 and the median combined KAP score was 9/14. Regression analysis suggested that KAP scores were not influenced by occupation or education level. We also did not find any significant relationship between KAP score and presence of CVRFs.

Conclusions

There remains a high burden of cardiometabolic disease in a semi-urban population in Indonesia as well as gaps in knowledge amongst the public regarding CVRFs and how they should be screened and treated. Screening programmes such as the one conducted as part of this study may be useful in addressing these gaps.

INTRODUCTION

Cardiovascular disease (CVD) in the form of stroke and ischaemic heart disease were the top 2 contributors to disability adjusted life years in Indonesia in 2019, and have increased in prevalence by 20% from 2009–2019. (1) Control of cardiovascular risk factors (CVRF) such as hypertension, hyperlipidemia, diabetes, obesity and smoking reduces risk of atherosclerosis and consequently CVD (2–4) and receive strong recommendations as primary prevention interventions in both American and European guidelines. (5, 6) Addressing underlying CVRF is a highly cost-effective strategy (7–9) and its importance in low-resource healthcare settings cannot be overstated.

Whilst there have been previous nationwide surveys such as the Indonesian Family Life Survey (10) and the Indonesian Basic Health Survey (Riskesdas), (11) these were completed some time ago in 2014 and 2018 respectively. Since then, the Indonesian government has established various Integrated Development Posts (known in Bahasa Indonesia as *Pos Pembinaan Terpadu*, abbreviated *POSBINDU*) at the community level for screening and early detection of CVRF and to promote dissemination of health education. (12) It is unclear how the burden of CVRF has changed in the intervening years and the impact which these community-based interventions may have had. The 2023 Indonesian Health Survey (SKI) conducted by the Ministry of Health (13) provides a more contemporary snapshot; but importantly this nationwide survey relied mostly on self-report of diagnoses of diabetes and dyslipidemia by respondents with only a subset of subjects undergoing formal testing with oral glucose tolerance tests and biochemical lipid profiling. It is also unclear how knowledge, attitudes and practices (KAP) of Indonesian adults relates to the prevalence of cardiometabolic disease.

Specifically, identifying the local prevalence of CVRF at the state level is vital in providing an accurate baseline from which local health authorities and physicians can focus primary prevention efforts and set realistic goals. It was with this objective in mind that the Early Detection of Cardiovascular Risk Factors as Primary Prevention amongst North Sumatera Adults (ECARDIA-NS) study was established. ECARDIA-NS aims to characterise the prevalence of CVRF in North Sumatera, which is Indonesia's fourth most populous province. This study is a partnership between Universitas Sumatera Utara in Indonesia (USU) and the Duke-NUS Global Health Institute (SDGHI) in Singapore and is funded by the SDGHI Pilot Grant.

METHODS

Study Design, Oversight and Population

ECARDIA-NS is a community-based cross-sectional opportunistic survey that recruited adults aged 40 years and older with no apparent cardiovascular disease from 3 districts (Kota Medan, Kota Tebing Tinggi, Kabupaten Langkat) in the province of North Sumatera in Indonesia. These districts were chosen as they represented the most populous areas of North Sumatera and had a relatively short travel distance from the core laboratory in Kota Medan such that blood draw samples could be delivered and processed within the day. A further 5 *Puskesmas* (Primary Health Centres) were identified in each district to act as study sites from which participants would be recruited (total 15 sites), with questionnaires, medical examinations and blood draw taking place within the *Puskesmas*. A target recruitment of 1200

participants was set for this pilot programme (160–180 participants per site). Screening took place over 10 months from March to December 2024. The campaign was advertised through announcements by Primary Healthcare Workers to the public as well as face-to-face on-site by investigators to passers-by, and participants were offered 50,000 IDR (roughly equivalent to 3 USD) to incentivise recruitment.

Adults with a history of ischaemic heart disease, heart failure, stroke, renal failure requiring dialysis or who were currently pregnant were excluded from this study. Additionally, participants who were unable to complete all steps of the screening process were excluded. Recruited participants had 1 set of blood pressure readings taken using an OMRON JPN-600 or BP7900 machine (Omron Healthcare, Kyoto, Japan), along with a single-lead electrocardiogram (ECG) via an OMRON JPN-600 machine or AliveCor Kardia ECG. Anthropomorphic measurements were obtained including weight, height, abdominal/waist circumference, hip circumference and body mass index. Health interviews were conducted in Bahasa Indonesia to collect information on participant demographics (name, age, sex, educational background, occupation), past medical history and current medications. Participants underwent blood draw with serum samples transported to a core laboratory in USU for analysis (lipid panel and HbA1c) on the same day. All investigators received standard training before the study commenced, including on the questionnaire, blood pressure measurement and blood draw. Broadly, the same study team carried out surveys at all locations to ensure consistency of measurements. Subjects identified to have hypertension, diabetes, dyslipidemia or atrial fibrillation from the screening were referred to local primary care physicians for further evaluation and treatment.

This study was conducted in accordance with principles of the Declaration of Helsinki and informed consent was obtained from all participants. The study received ethical approval from the ethics committee of USU (CIRB 126/KEPK/USU/2024).

Knowledge, Attitudes And Practices Survey

A subset of the participants (n = 773) were further interviewed on their knowledge, attitudes and practices (KAP) with a series of True/False or Yes/No questions with a single correct answer. There were 10 knowledge questions and 4 practices questions; participant responses were tabulated against a maximum “correct” score of 14. Full survey questions can be found in Supplementary Table 1.

Cardiovascular Risk Factors And Outcomes Definitions

CVRF were categorised with the use of targets based on major guidelines. (5, 6) Arterial hypertension was defined by a systolic blood pressure of ≥ 140 mmHg or self-reported previous diagnosis of hypertension. Diabetes was defined by a HbA1c reading of $\geq 6.5\%$ or self-reported previous diagnosis of diabetes. Dyslipidemia was defined as low density lipoprotein (LDL) ≥ 130 mg/dL or self-reported history of dyslipidemia in accordance with guidelines from the Indonesian Society of Endocrinology (14) and aligned with cut-offs used in previous national surveys. (11) Elevated waist circumference was defined

as > 80cm and > 90cm for women and men respectively, based on the World Health Organisation obesity criteria. (15) Body Mass Index (BMI) cut offs of < 18.5; ≥ 18.5 to ≤ 22.9 ; > 22.9 to ≤ 24.9 and > 24.9 were used to define categories of underweight, normal, overweight and obese respectively. World Health Organisation (WHO) CVD risk scores were calculated using risk charts produced by WHO and the International Society of Hypertension. (16)

Statistical Analysis

Data was cleaned and harmonised prior to analysis, with age categorised into predefined groups and sociodemographic variables recoded as appropriate. Participant characteristics were summarised descriptively overall and by district, with categorical variables presented as counts and percentages and prevalence estimates reported with 95% confidence intervals. Multivariable logistic regression was used to examine associations with hypertension, dyslipidemia, and diabetes mellitus. Models were adjusted for region, age group, sex, education level, ethnicity, occupation, smoking status, body mass index category and waist circumference, and results were reported as adjusted odds ratios with 95% confidence intervals. Analyses of KAP were limited to participants with complete data. Multivariable logistic regression evaluated associations between KAP score and cardiometabolic outcomes, adjusting for relevant covariates. All analyses were two-sided with statistical significance set at $p < 0.05$ and performed using R.

RESULTS

A total of 1208 participants were recruited, of whom 80% were female. Majority (43%) of the subjects were in the 40–49 age group, and most (43%) had a medium educational level. 38% of participants were unemployed or homemakers whilst 5% were retired, with the remainder working in predominantly white-collar jobs. 84% of all participants had never smoked before, although when breaking this down by sex it was notable that only 31.2% of males were never-smokers as compared to 96.3% of females. Overall, 56% of the population had hypertension, whilst 44% had dyslipidemia and 17% had diabetes. 69% of subjects were obese whilst a further 15% were overweight. Waist circumference was elevated in 83% of subjects. 1.3% of participants were found to have atrial fibrillation. When translating this to WHO cardiovascular risk scores, 50% of subjects had very low (< 5%) risk, 26% had low (5–10%) risk, 30% had moderate (10–20%) risk, 3.2% had high (20–30%) risk and 0.6% had very high (> 30%) risk. A full summary of demographic data, including district-specific data, can be found in Table 1. Comparisons of burden of cardiovascular risk factors by sex is summarized in Fig. 1.

Table 1
Baseline Demographics And Burden Of Cardiovascular Risk Factors

Characteristic	Overall	Langkat	Medan	Tebing Tinggi
	N = 1,208	N = 445	N = 344	N = 419
Sex				
Female	971 (80%)	362 (81%)	260 (76%)	349 (83%)
Male	237 (20%)	83 (19%)	84 (24%)	70 (17%)
Age group (years)				
40–49	524 (43%)	190 (43%)	181 (53%)	153 (37%)
50–59	425 (35%)	162 (36%)	110 (32%)	153 (37%)
60–69	208 (17%)	76 (17%)	39 (11%)	93 (22%)
70–79	47 (3.9%)	16 (3.6%)	12 (3.5%)	19 (4.5%)
80+	4 (0.3%)	1 (0.2%)	2 (0.6%)	1 (0.2%)
Education level [†]				
High	368 (30%)	116 (26%)	133 (39%)	119 (28%)
Medium	521 (43%)	168 (38%)	175 (51%)	178 (42%)
Low	319 (26%)	161 (36%)	36 (10%)	122 (29%)
Ethnicity				
Batak	503 (42%)	98 (22%)	216 (63%)	189 (45%)
Javanese	490 (41%)	268 (60%)	67 (19%)	155 (37%)
Malay	172 (14%)	69 (16%)	43 (13%)	60 (14%)
Other	43 (3.6%)	10 (2.2%)	18 (5.2%)	15 (3.6%)
Occupation				
Government	359 (30%)	123 (28%)	125 (36%)	111 (26%)
Health/Edu	47 (3.9%)	21 (4.7%)	14 (4.1%)	12 (2.9%)
Home/Unemp	461 (38%)	181 (41%)	82 (24%)	198 (47%)
Baseline demographics and burden of cardiovascular risk factors in the overall North Sumatera population and within each precinct. Values shown are n (% of population).				
[†] Education level defined as follows. Low: SD, SMP, Elementary, Elementary school, Middle school. Medium: SMA, High school, Diploma 3, Diploma 4. High: S1, Bachelor / Bachelor's degree, S2 / Master's degree, S3 / Doctoral				

Characteristic	Overall	Langkat	Medan	Tebing Tinggi
	N = 1,208	N = 445	N = 344	N = 419
Manual	52 (4.3%)	31 (7.0%)	5 (1.5%)	16 (3.8%)
Private	192 (16%)	64 (14%)	78 (23%)	50 (12%)
Retired	60 (5.0%)	17 (3.8%)	14 (4.1%)	29 (6.9%)
Other	37 (3.1%)	8 (1.8%)	26 (7.6%)	3 (0.7%)
Smoking habit				
Ever	198 (16%)	58 (13%)	79 (23%)	61 (15%)
Never	1,010 (84%)	387 (87%)	265 (77%)	358 (85%)
Raised Waist Circumference	1,001 (83%)	359 (81%)	295 (86%)	347 (83%)
Obesity (BMI category)				
Underweight (< 18.5)	20 (1.7%)	7 (1.6%)	5 (1.5%)	8 (1.9%)
Normal Range (18.5–22.9)	166 (14%)	52 (12%)	40 (12%)	74 (18%)
Overweight (23–24.9)	186 (15%)	73 (16%)	44 (13%)	69 (16%)
Obese (≥ 25.0)	836 (69%)	313 (70%)	255 (74%)	268 (64%)
Hypertension	676 (56%)	261 (59%)	168 (49%)	247 (59%)
Dyslipidemia	532 (44%)	168 (38%)	97 (28%)	267 (64%)
Diabetes Mellitus	203 (17%)	74 (17%)	55 (16%)	74 (18%)
Atrial Fibrillation	16 (1.3%)	0 (0%)	3 (0.9%)	13 (3.1%)
WHO Cardiovascular Risk Score				
Very Low (< 5%)	600 (50%)	221 (50%)	188 (55%)	191 (46%)
Low (5%-10%)	319 (26%)	120 (27%)	94 (27%)	105 (25%)
Moderate (10%-20%)	243 (20%)	86 (19%)	54 (16%)	103 (25%)
High (20%-30%)	39 (3.2%)	16 (3.6%)	8 (2.3%)	15 (3.6%)
Very High (> 30%)	7 (0.6%)	2 (0.4%)	0 (0%)	5 (1.2%)
Baseline demographics and burden of cardiovascular risk factors in the overall North Sumatera population and within each precinct. Values shown are n (% of population).				
† Education level defined as follows. Low: SD, SMP, Elementary, Elementary school, Middle school. Medium: SMA, High school, Diploma 3, Diploma 4. High: S1, Bachelor / Bachelor's degree, S2 / Master's degree, S3 / Doctoral				

Multivariable logistic regression was performed to identify factors that were associated with the presence of cardiometabolic disease in the form of hypertension, dyslipidemia and diabetes (Table 2). Dyslipidemia varied significantly by region. Compared with Kota Medan, participants from Kota Tebing Tinggi had markedly higher odds of dyslipidemia (Odds Ratio [OR] = 3.81, 95% Confidence Interval [CI] 2.75–5.31). Regional differences in hypertension and diabetes were not significant. A summary of the distribution of CVRF amongst the surveyed provinces can be found in Fig. 2. Age showed a strong, graded association with all three outcomes. For hypertension and dyslipidemia, odds of developing adverse cardiometabolic outcomes increased progressively from the 40–49 age group reference to the 70–79 age group. In the 70–79 age group OR for developing hypertension was 7.35 (95% CI 3.29–18.3); OR for developing dyslipidemia was 2.22 (95% CI 1.11–4.50) and OR for developing diabetes was 3.05 (95% CI 1.43–6.32). Obesity (BMI $\geq$ 25.0) nearly doubled the odds of hypertension (OR = 1.99, 95% CI 1.26–3.17) relative to the normal BMI range, and similar positive relationships were seen with elevated waist circumference and hypertension (OR 1.95, 95% CI 1.27–3.00, $p = 0.002$) and diabetes (OR 1.98, 95% CI 1.12–3.62, $p = 0.019$).

Table 2
Multivariable Logistic Regression For Cardiometabolic Factors

Characteristic	Hypertension (HTN)			Dyslipidemia (HLD)			Diabetes Mellitus (DM)		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Region			0.072			< 0.001			> 0.9
Medan	—	—		—	—		—	—	
Langkat	1.46	1.04, 2.05		1.26	0.90, 1.78		1.04	0.68, 1.60	
Tebing Tinggi	1.36	0.98, 1.89		3.81	2.75, 5.31		1.05	0.70, 1.60	
Sex			0.055			> 0.9			0.14
Female	—	—		—	—		—	—	
Male	1.61	0.99, 2.62		1.01	0.62, 1.64		1.56	0.87, 2.76	
Age group (years)			< 0.001			< 0.001			0.007
40–49	—	—		—	—		—	—	
50–59	2.58	1.96, 3.41		1.73	1.31, 2.30		1.66	1.15, 2.40	
60–69	4.38	2.86, 6.82		2.97	1.97, 4.51		1.61	0.96, 2.67	
70–79	7.35	3.29, 18.3		2.22	1.11, 4.50		3.05	1.43, 6.32	
Education level			0.6			0.2			0.6
Low	—	—		—	—		—	—	
High	0.82	0.51, 1.31		1.48	0.93, 2.37		0.78	0.43, 1.39	
Medium	0.84	0.59, 1.20		1.10	0.78, 1.57		0.83	0.54, 1.28	
Ethnicity			0.4			0.2			> 0.9
Javanese	—	—		—	—		—	—	
Batak	1.18	0.87, 1.62		0.74	0.54, 1.01		0.96	0.65, 1.42	
Abbreviations: CI = Confidence Interval, OR = Odds Ratio									

Characteristic	Hypertension (HTN)			Dyslipidemia (HLD)			Diabetes Mellitus (DM)		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Malay	0.85	0.58, 1.25		0.98	0.67, 1.43		0.90	0.54, 1.46	
Other	1.04	0.52, 2.12		0.90	0.45, 1.81		0.77	0.28, 1.85	
Occupation			0.3			0.034			0.6
Government	—	—		—	—		—	—	
Health/Edu	1.11	0.58, 2.13		0.99	0.51, 1.89		0.51	0.15, 1.34	
Home/Unemp	1.50	1.02, 2.22		1.44	0.97, 2.13		0.83	0.50, 1.37	
Manual	1.20	0.59, 2.48		0.61	0.29, 1.25		0.62	0.24, 1.50	
Other	1.35	0.64, 2.86		0.71	0.29, 1.61		1.21	0.47, 2.84	
Private	1.74	1.10, 2.76		0.87	0.54, 1.39		0.80	0.44, 1.43	
Retired	1.22	0.61, 2.50		0.57	0.29, 1.12		1.29	0.60, 2.71	
Smoking habit			0.10			0.4			> 0.9
Ever	—	—		—	—		—	—	
Never	1.50	0.92, 2.43		1.25	0.77, 2.04		1.00	0.56, 1.78	
Obesity (BMI category)			0.025			0.2			0.9
Normal Range (18.5–22.9)	—	—		—	—		—	—	
Underweight (< 18.5)	1.12	0.40, 3.14		0.36	0.11, 1.06		0.63	0.09, 2.46	
Overweight (23–24.9)	1.46	0.89, 2.41		1.12	0.68, 1.83		0.90	0.48, 1.68	
Obese (≥ 25.0)	1.99	1.26, 3.17		1.15	0.73, 1.83		0.84	0.48, 1.50	
Abbreviations: CI = Confidence Interval, OR = Odds Ratio									

Characteristic	Hypertension (HTN)			Dyslipidemia (HLD)			Diabetes Mellitus (DM)		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Raised Waist Circumference			0.002			0.5			0.019
No	—	—		—	—		—	—	
Yes	1.95	1.27, 3.00		1.17	0.76, 1.80		1.98	1.12, 3.62	
Abbreviations: CI = Confidence Interval, OR = Odds Ratio									

Occupation type appeared to be significantly related to dyslipidemia ($p = 0.034$), with homemakers/unemployed individuals appearing to be at elevated risk (OR 1.44, 95% CI 0.97–2.13). However, when breaking this down by individual component occupations, all the confidence intervals for OR crossed 1, suggesting that this finding may be due to statistical chance. Otherwise, there were no significant interactions between ethnicity, educational level and smoking habit with the development of hypertension, dyslipidemia or diabetes.

A subgroup ($n = 773$) of subjects had data collected about their knowledge, attitude and practices of healthy living. A summary of the distribution of KAP scores is given in Fig. 3, with further breakdown of KAP scores by education level and occupation given in Fig. 4. Linear regression analysis of KAP scores against education and occupation showed no clear associations with either. In the subset of patients with KAP scores, we tested if KAP score was associated with differences in prevalence of hypertension, dyslipidemia or diabetes (Supplementary Table 2). Regression models were adjusted for age group, sex, ethnicity, smoking status, BMI category and waist circumference, with region excluded because availability of KAP scores differed strongly by region. We found that KAP scores were not significantly associated with any of the three CVRF. For each 1-point increase in KAP score, the adjusted ORs were close to 1: hypertension OR 1.01 (95% CI 0.94–1.09; $p = 0.7$); dyslipidemia OR 1.03 (95% CI 0.97–1.09; $p = 0.4$); diabetes OR 0.98 (95% CI 0.92–1.03; $p = 0.4$). These findings suggest that within this KAP subset, higher KAP scores were not clearly linked to lower or higher odds of any of these three diseases.

DISCUSSION

In this cross-sectional opportunistic screening survey of adults aged 40 years and older with no apparent cardiovascular disease in the state of North Sumatera in Indonesia, we found a high prevalence of CVRF despite surveying a predominantly female population. Our study provides a few notable findings. Firstly, prevalence of CVRF in this semi-urban population remains high when quantified objectively with anthropomorphic and biochemical measurements. Prevalence is especially high in the case of obesity and elevated waist circumference. Secondly, knowledge about cardiometabolic disease remains generally poor, although we did not find a significant relationship between KAP scores and presence of CVRF.

The high prevalence of hypertension (56%) found in this study is broadly comparable to previous large national surveys. For example, the Indonesian Family Life Survey conducted in 2007 found an overall hypertension prevalence of 46.4% (17) and specifically close to 60% in the North Sumatera province. (18) The subsequent IFLS 5 conducted between 2014–2015 reported a national prevalence of 33.4%, (19) whilst the more recent SMARThealth Extend study of 22093 participants conducted in 2016 reported a hypertension prevalence of 55.8% in villagers aged 40 and above in Malang District in East Java. (20) National surveys conducted by the Ministry of Health in the form of Riskesdas in 2018 (11) and SKI (13) in 2023 reported hypertension prevalence of 33.1% and 32.4% respectively, although this was based on a population of all adults 18 years old and above. A closer examination of the 2023 SKI data suggests hypertension prevalence ranging from 39.1% in the 45–54 age group to 64.0% in the 75+ age group based on blood pressure results measured during the survey.

This study showed a diabetes prevalence of 17%, which was higher than reported in other studies. The 2016 SMARThealth Extend study reported a diabetes prevalence of 9.8%, (20) whilst larger national surveys such as the 2018 Riskesdas survey (11), the 2021 report by the International Diabetes Federation (21) and the 2023 SKI survey (13) estimated diabetes prevalence of 10.9%, 10.8% and 11.3% respectively. (21) The higher diabetes prevalence in this study may be related to our use of HbA1c measurements to diagnose diabetes, whereas the other studies relied on either random blood glucose readings or oral glucose tolerance tests.

Whilst this study found a dyslipidemia prevalence of 44%, the 2018 Riskesdas survey reported a prevalence of 37.3% (11, 14). The 2023 SKI survey reported that 33.7%-39.9% of subjects ≥ 45 years old had measured LDL which was borderline-high or worse (corresponding to LDL levels $\geq 130\text{mg/dL}$). We also observed a prevalence of 69% for obesity which was higher than the 57.2% reported by Riskesdas 2018 (22) and the 41.2% (specifically in North Sumatera) reported by SKI 2023 (13), with the caveat that these studies included adults from 15 years and above. Our survey found a 1.3% prevalence of AF, which approximates a community-based study based on a survey of 12 lead ECGs obtained between 2014–2018 which reported an AF prevalence of 0.93%. (23)

Across the board, the prevalence of CVRF found in this study appears to be in line with or higher than estimates from previous surveys. Compared to other surveys, our study mandated biochemical assessment for diabetes and dyslipidemia for all participants, which may account for the higher prevalence reported in our study. Combining patients with historical diagnoses of these conditions along with those newly diagnosed on the basis of our screening programme likely provides a more accurate reflection of the true prevalence of these CVRF in the general population. Even with this definition, the majority of patients in our study classified as being positive for hypertension, dyslipidemia and diabetes were new diagnoses picked up through our screening efforts; and additionally a large proportion of those with existing diagnoses had insufficient CVRF control based on our measurements (Table 3). This suggests that despite the ongoing efforts of the Indonesian Ministry of Health in promoting a healthy lifestyle, burden of cardiometabolic disease remains high, with limited improvement over the years. Our findings also highlight that a significant majority of patients with CVRF remain undiagnosed in the

community, echoing findings by the 2023 SKI that showed a substantial difference between prevalence of CVRF based on historical doctors’ diagnosis versus prevalence estimated by measurement result. However, the high prevalence of these CVRF did not necessarily translate to high WHO cardiovascular risk scores, likely because of the low rates of smoking in our predominantly female subject population.

Table 3

Breakdown Of Prevalence Of Cardiovascular Risk Factors (Hypertension, Dyslipidemia, Diabetes) By Historical Diagnosis Versus Measurement

HTN	Overall prevalence (historical diagnosis or positive measurement)	Measured prevalence only (positive measurement at screening)	Historical diagnosis only (self-reported diagnosis)	Suboptimal control among those with historical diagnosis [†]
	59.3%	39.3%	16.6%	95.2%
HLD	49.2%	38.1%	1.8%	38.9%
DM	48.3%	40.5%	6.5%	92.3%
[†] Suboptimal control defined as the intersection of historical diagnosis and positive measurement. Values in this column expressed as % of population diagnosed by historical diagnosis (i.e. self-reported diagnosis).				

Of particular concern are findings of an extremely high prevalence of subjects who had an elevated waist circumference (83%) and who were overweight (15%) or obese (69%). Obesity has been shown to contribute directly to CVRFs such as hypertension, diabetes and hyperlipidemia, and separately act as an independent risk factor for development of cardiovascular disease, heart failure, arrhythmia and sudden cardiac death. (24, 25) Given the increasing focus on obesity as emphasised by the World Heart Federation and World Obesity Federation as a risk factor that is eminently modifiable by lifestyle changes or even medical therapy, (26) results from our study highlights that much more can be done to address these cardiometabolic diseases in this population.

Multivariable logistic regression analysis confirmed previously well-established associations between increasing age, elevated waist circumference and presence of obesity with development of CVRF. (17, 19, 20, 22, 27). Data from our survey did not show any significant relationship between occupation or education level with presence of individual CVRF, a finding which differed from the SMARThealth Extend survey (20) where employment status (self-employed / not working) and a lower educational level were found to be positively associated with higher 10-year WHO cardiovascular risk. The lack of a positive relationship may be explained by the smaller sample size in our study. Given that the prevalence of primary cardiometabolic disease is affected by a myriad of factors including non-modifiable contributors such as age, sex, ethnicity and genetics, it may be that differences in lifestyle or socioeconomic status did not eventually prove to be significant in our population when weighted against other factors. By contrast, we anticipate a clearer and more direct relationship between *control* of CVRF following a

positive diagnosis and education level or employment status (17) in the form of better medication adherence and better lifestyle choices – this is a target for future studies.

Interestingly, we found no relationship between KAP scores and presence of CVRF. As above, it may be that KAP is more predictive of *control* of CVRF than *diagnosis* of CVRF itself which is also influenced by a multiplicity of non-modifiable factors. Nevertheless, it is worth noting that in our study the median knowledge score was 5/10 and the median combined KAP score was 9/14, suggesting that more can still be done to improve knowledge and recognition of disease. We interpret the lack of relationship between education level and occupation with KAP score as suggesting that the need for health education and promotion is ubiquitous irrespective of socioeconomic background.

As an opportunistic survey, our study is not free from selection bias, and the predominantly female population recruited may not be entirely representative of the larger North Sumatera community. Our study is also limited by its smaller sample size as compared to other national surveys. Nevertheless, a significant strength of our study is the direct measurement of CVRF in all our subjects with objective biochemical profiling to screen and detect cardiometabolic disease, and our study provides a timely warning that burden of CVRF remains high.

CONCLUSION

This study reveals that prevalence of CVRF such as hypertension, dyslipidemia, diabetes, elevated waist circumference and obesity remains high in Indonesia, even within a population of adults with no known ischaemic heart disease, heart failure, stroke or renal failure. Biochemical analysis of all participants revealed a significant proportion of undiagnosed cardiometabolic disease, and when combined with previous diagnosis of disease resulted in estimates of prevalence that were higher than that reported in previous studies or national surveys. In particular, close to 85% of participants were overweight or obese. Concomitant KAP surveys demonstrated a knowledge gap regarding cardiometabolic disease and how to manage it. This study also demonstrates the feasibility of a screening programme conducted in conjunction with local healthcare providers (Puskesmas) at the district level. Our findings lend support for screening and health education efforts such as *POSBINDU* which can improve diagnosis of CVRF in the general population, provide timely primary prevention interventions and improve overall health literacy.

Abbreviations

CVD

Cardiovascular disease

CVRF

Cardiovascular Risk Factors

POSBINDU

Pos Permbinaan Terpadu Integrated Development Posts

SKI

Survei Kesehatan Indonesia Indonesian Health Survey (2023)

KAP

Knowledge, Attitudes and Practices

ECARDIA-NS

Early Detection of Cardiovascular Risk Factors as Primary Prevention amongst North Sumatera Adults

PUSKESMAS

Pusat Kesehatan Masyarakat

USU

Universitas Sumatera Utara

SDGHI

Duke-National University of Singapore Global Health Institute

ECG

Electrocardiogram

CIRB

Centralised Institution Review Board

BMI

Body Mass Index

LDL

Low Density Lipoprotein

WHO

World Health Organisation

OR

Odds Ratio

CI

Confidence Interval

Declarations

Ethical Statement

This study was conducted in accordance with the principles of the Declaration of Helsinki and informed consent was obtained from all participants. The study received ethical approval from the ethics committee of Universitas Sumatera Utara (Centralised Institution Review Board 126/KEPK/USU/2024)

Data Availability

The datasets used and analysed during the current study are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare no competing interests or financial relationships.

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Author Contributions

All authors were involved in the conceptualisation of the study, led by J.W.C.T., A.S.K. and A.C.L.. Y.F.S., K.K.I., A.H.R., Y.S., T.B.H., C.A.A., F.H., R.H., D.I.S.S. and A.C.L. were involved in primary data collection. P.J.W.T. wrote the manuscript and J.L. performed statistical analysis. All authors reviewed the final manuscript.

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Figures

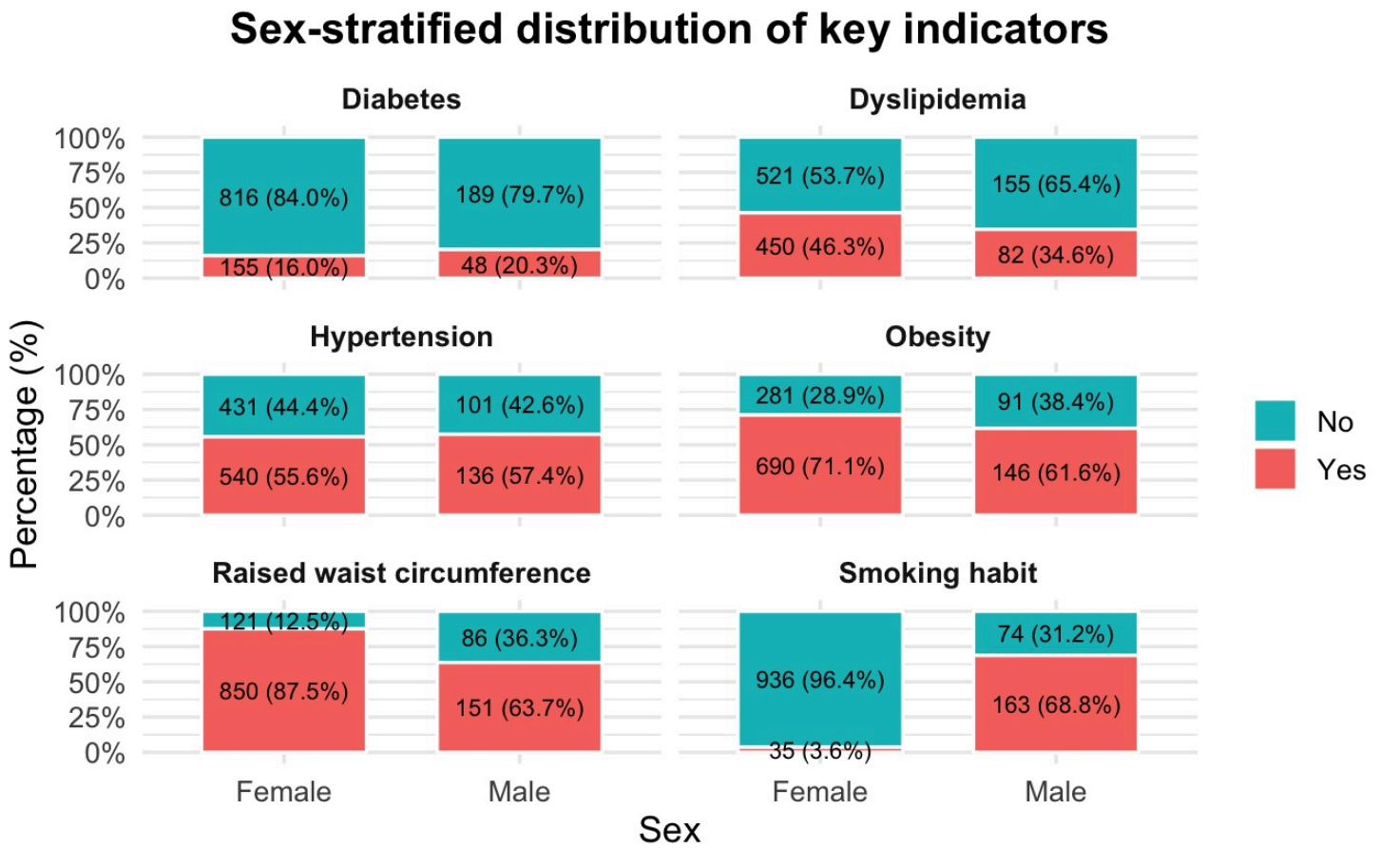


Figure 1

Burden Of Cardiovascular Risk Factors By Sex

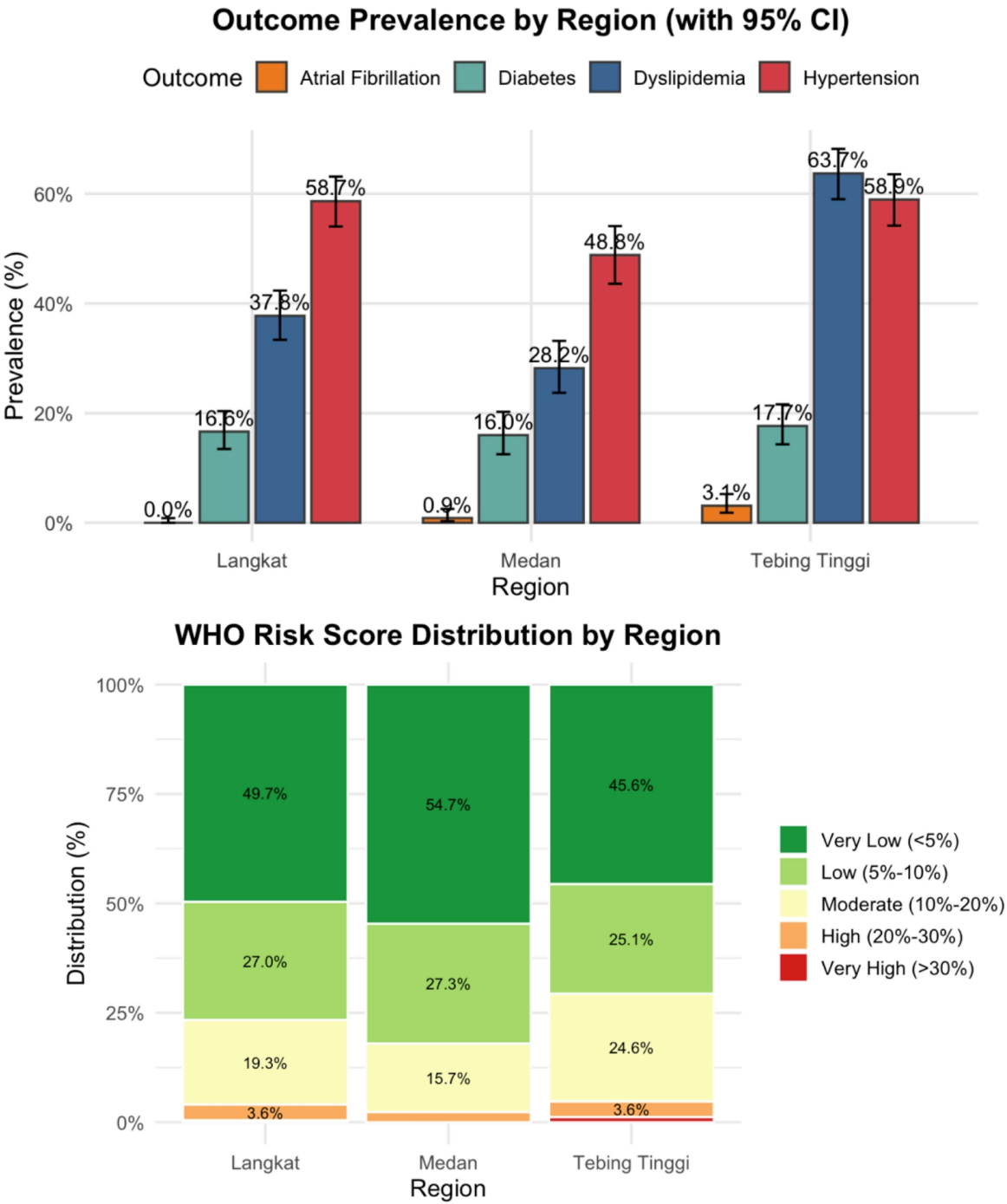


Figure 2

Distribution Of Cardiometabolic Disease And WHO Risk By Province

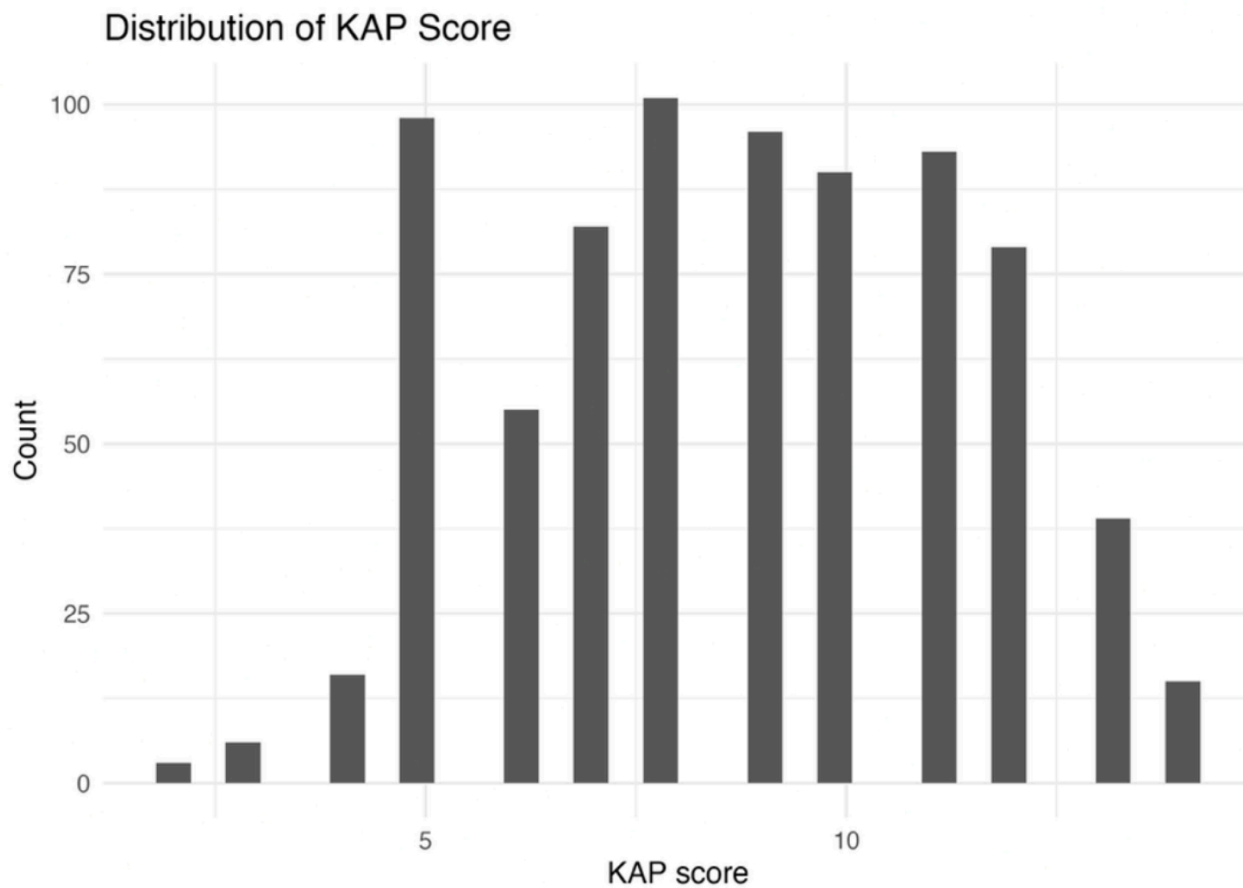


Figure 3

Distribution Of Scores On Survey Of Knowledge Attitudes And Practices (KAP) Of Healthy Living

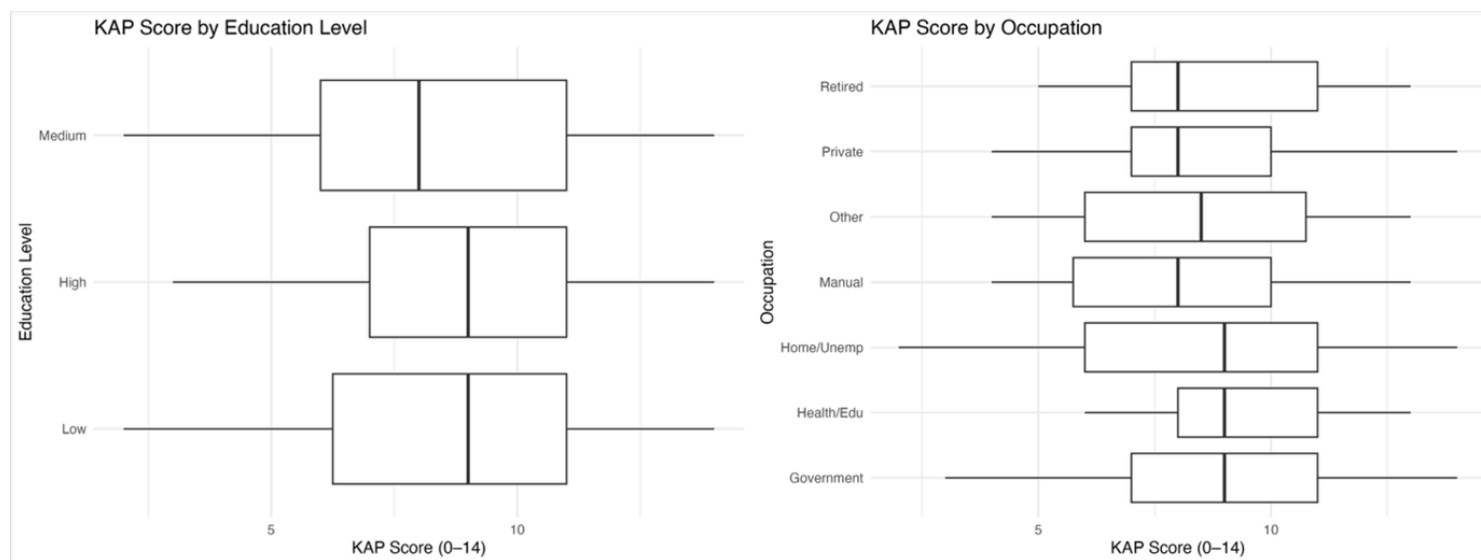


Figure 4

Distribution Of KAP Scores By Education Level And Occupation

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