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update

Background

The current body of research into rural health in Malaysia showed 41.3% of indigenous adults in Sabah [1], 33.6% of adults in rural Kedah [2], and 29.8% of adults in rural Penang [3] had hypertension. The nationally representative National Health and Morbidity Survey 2015 showed overall hypertension among adults aged 18 years and older was 33.5% (95%CI: 31.6–35.4) in rural areas compared to 29.3% in urban areas (95%CI: 28.2–30.4). At the national level, prevalence was higher in males (30.7, 95%CI: 29.5–32.2) compared to females (29.7% (95%CI: 28.5–30.9) [4]. The REDISCOVER study investigated hypertension in urban and rural Malaysian communities from 2007 to 2011. It also reported that rural communities had higher prevalence of hypertension (51.2, 95%CI: 49.8–52.4) compared to

Data for the state of Sabah might not give a representative idea on the health status of a rural coastal community such as Semporna. Semporna's most dominant and medical history data were obtained using interviewer-administered questionnaires. One researcher interviewed all respondents in their respective households. The socio-demographic data recorded were gender, age, ethnic group, religious affiliation, educational level, marital status, occupation, household income, household size and cigarette/tobacco smoking status. Medical history data were obtained using an adapted questionnaire [7]. Respondents were asked regarding family history and whether they had attended a health check in the past 12 months or diagnosed with hypertension, hypercholesterolem readings did not differ by more than 5 mmHg, the average of these values was used as the blood pressure value for that individual. If the readings from the initial two measurements differed more than 5 mmHg, subsequent measurements were taken 5–10 min later until two values within the acceptable difference were obtained. The Malaysian Ministry of Health's Clinical Practice Guidelines for Hypertension cut-offs for blood pressure were used: 'optimal' (< 120 mmHg for systolic and < 80 mmHg for diastolic), 'normal' (< 130 mmHg for systolic and < 85 mmHg for diastolic), 'high normal' (130–139 mmHg for systolic and/or 85–89 mmHg for diastolic), 'hypertension I' (140–159 mmHg for systolic and/or 90–99 mmHg for diastolic), 'hypertension II' (160–179 mmHg for systolic and/or 100–109 mmHg for diastolic) and 'hypertension III' (≥180 mmHg for systolic and/or ≥ 110 mmHg for diastolic) [22].

Blood glucose and lipids cut-offs

The Malaysian Ministry of Health's Clinical Practice Guidelines on type 2 diabetes mellitus cut-offs for fasting blood glucose were used: 'normal blood glucose' (< 7.0 mmol/L) and 'positive diabetes mellitus' (≥7.0) [23]. The blood lipids cut-offs from the National Cholesterol Education Programme were used. Total cholesterol cut-offs were: 'normal' (< 5.2 mmol/L), 'borderline high' (5.2–6.1) and 'high' (≥6.2). Triglyceride cut-offs were: 'normal' < 1.7 mmol/L, 'borderline high' (1.7–2.2 mmol/L), 'high' (2.3–5.6 mmol/L) and 'very high' (≥5.7 mmol/L). LDL cholesterol cut-offs were: 'normal' (< 2.6 mmol/L), 'above normal' (2.6–3.3 mmol/L), 'borderline high' (3.4–4.1 mmol/L), 'high' (4.2–4.8 mmol/L) and 'very high' (≥4.9 mmol/L). HDL cholesterol cut-offs were: 'low' (< 1.0 mmol/L), 'normal' (1.0–1.5 mmol/L) and 'high' (≥1.6 mmol/L) [24].

Statistical analyses

All data were analysed using IBM SPSS Statistics 24. Kolmogorov-Smirnov test was used to assess for the Normal distribution; $P > 0.05$ was considered to be Normally distributed. The results were presented as frequencies (N) and percentages (%) for categorical variables and as means and standard deviations (S.D.) for continuous variables. Chi-square test was used to determine associations between categorical variables. Binary logistic regression was attempted with each disease as the dependent variable; and gender, age group, education level, household income level, occupation categories, waist circumference and BMI as independent variables

Table 1 Socio-demographic characteristics of respondents

	a		44.1 ± 15.4[a]		43.7 ± 15.8[a] 19–59 60	
	a		618.8 ± 443.6[a]		671.7 ± 569.9[a]	
Hardcore poor	97	(72.9)	142	(72.1)	239	(72.4) Poor
	a		6.8 ± 3.2[a]		6.7 ± 3.2[a]	
1–5 6	59 74	(44.4) (55.6)	70 127	(35.5) (64.5)	129 201	(39.1) (60.9) Smoking status Sm
Non/Ex-smoker	102	(76.7)	190	(96.4)	292	(88.5)

Jawa
Suluk
Secondary school
High school certificate / Diplom
Bachelor's degree
Married
Divorced/Separated
Widow/Widower
Housewife
Self-employed

A total of 24 respondents (7.3%) were identified as diabetic; 19 respondents (5.8%) had never been diagnosed by a health professional. Of those who had been previously diagnosed (n = 5), 3 (60%) respondents had well controlled fasting blood glucose and 2 had poorly controlled levels (40%). There were 287 individuals (87.0%) who had not

Table 2 Prevalence of hypertension (HPN), hypercholesterolemia (HPC) and diabetes mellitus (DM) by socio-demography of respondents

Risk factors	Hypertension, N (row %)					

developing countries such as the South Pacific island countries [32] and China [33].

The occurrence of these three NCDs increased significantly with increasing age, BMI, percent body fat and waist circumference ($p < 0.05$). Other studies in Malaysia also reported similar observations [2, 3, 29, 34]. As waist circumference increased, the OR for hypertension (OR = 1.09, 95%CI: 1.04–1.14, $p < 0.001$) and for diabetes (OR = 1.07, 95%CI: 1.00–1.15, $p = 0.044$) increased (Table 3). In Asian populations, waist circumference might be a more appropriate indicator of obesity and insulin resistance [35]. Obesity had increased in Asian populations with the gap between rural and urban communities narrowing. In a longitudinal study on Filipino women,

Table 3 Odd ratios for hypertension, hypercholesterolemia and diabetes mellitus

	Hypertension (yes vs. no), Nagelkerke $R^2 = 0.351$), overall predictive accuracy = 75.5%			Hypercholesterolemia (yes vs. no), Nagelkerke $R^2 = 0.253$), overall predictive accuracy = 68.2%			Diabetes mellitus[a] (yes vs. no), Nagelkerke $R^2 = 0.270$, overall predictive accuracy = 93.0%		
	OR	(95% CI)	P value	OR	(95% CI)	P value	OR	(95% CI)	P value
Education level with undergraduate degree as the reference									
No formal education	40.1	(2.77–581.52)	0.007	2.66	(0.33–21.62)	0.361			
Primary	15.4	(1.09–217.12)	0.043	0.74	(0.10–5.64)	0.769			
Lower secondary	14.5	(1.06–197.14)	0.045	0.74	(0.10–5.40)	0.758			
Upper secondary	14.1	(1.02–196.13)	0.048	0.44	(0.06–3.30)	0.427			
High school certificate /diploma	13.7	(0.57–326.01)	0.106	0.24	(0.02–3.00)	0.262			
Household income with above PLI as the reference									
Hardcore poor	0.48	(0.18–1.27)	0.139	0.34	(0.14–0.85)	0.020	0.56	(0.09–3.36)	0.525
Poor	0.53	(0.17–1.60)	0.256	0.48	(0.17–1.34)	0.161	0.65	(0.08–5.20)	0.688
Occupation with public / private employee as the reference									
Unemployed	0.27	(0.05–1.47)	0.129	2.04	(0.42–9.79)	0.375	3.83	(0.15–99.29)	0.418
Home maker	0.29	(0.05–1.79)	0.182	2.23	(0.44–11.45)	0.336	3.43	(0.12–101.34)	0.476
Self employed	0.28	(0.06–1.31)	0.106	2.64	(0.62–11.22)	0.187	1.98	(0.12–33.22)	0.634
Age with ≥60y as the reference									
19 – 29y	0.37	(0.10–1.40)	0.143	1.70	(0.52–5.57)	0.384	0	0	0.997
30 – 59y	0.34	(0.14–0.79)	0.012	1.59	(0.71–3.58)	0.260	0.21	(0.06–0.75)	0.016
Gender with females as the reference									
Males	1.96	(0.62–6.15)	0.252	2.44	(0.92–6.48)	0.074	2.16	(0.26–17.67)	0.473
Waist circumference (cm)	1.09	(1.04							

diabetes was associated with higher waist circumference in relation to higher socioeconomic status and urbanisation [36]. An Indonesian cross-sectional study also showed waist circumference was associated with blood glucose levels [37]. Higher salt intake was associated with higher prevalence of hypertension in coastal rural communities in India [38, 39]. The most recent Malaysian nationally representative data (MANS 2014) on nutrient intake showed that the indigenous population in Sabah had a higher median sodium intake (2026 mg) compared to the national median (1935 mg) [40].

The prevalence of undiagnosed hypertension (24.5%), hypercholesterolemia (40.6%) and diabetes mellitus (5.8%) in this rural coastal community were comparable to the Malaysian national prevalence of undiagnosed NCDs in rural areas, which were 20.7, 40.5 and 9.5% respectively. In contrast, the Malaysian national prevalence of undiagnosed NCDs in urban areas were 16.1, 38.0 and 9.1% respectively [4]. The REDISCOVER study on hypertension in Malaysia found that awareness, treatment and control among hypertensive respondents were significantly lower in rural communities compared to their urban counterparts [5]. Similarly, rural hypertensive adults in China were 49.4% less likely to be detected and 89.5% less likely to be medicated than their urban counterparts [41].

The over-representations of individuals from hardcore poor households in the undiagnosed NCDs ($p < 0.001$) and among those who did not have a health check in the preceding 12 months ($p < 0.001$) are a matter of public health concern. Blood pressure is the easiest to administer compared to blood lipids and blood glucose checks. Yet, only 68.2% of adults in Semporna had access to a blood pressure check in the preceding 12 months. This rate of access had not improved over the 25 years since Gan & Chin reported an access rate of 70.4% for rural populations in Sabah [42]. At that time, the prevalence for hypertension in Kota Belud, another rural community in north-western Sabah was 20.1% [42], which was slightly lower than the prevalence of 24.5% reported for this Semporna study. The high prevalence of undiagnosed NCDs among respondents in the present study could be related to low health consciousness in the community. Results unaware of their health problems. Over the period of intervention, those families became more empowered to access health services and community resources such as welfare payments, and there were reductions in blood pressure and blood glucose levels [43].

Semporna has two publicly funded health clinics where such health checks are available for a minimal payment, one on the Semporna mainland and the other on the largest island opposite the mainland. However access to health clinics for NCD detection in this rural coastal community might have been a challenge. There are also eight publicly funded community clinics which are located nearer to the communities that they serve. Unlike the health clinics, community clinics are staffed by community nurses whose focus are on maternal and child health, contraception, immunisation and child developmental assessments [15]. Another issue that required attention is the access to NCD prevention and promotion strategy in rural coastal communities in Sabah. The cost of access to health checks at private clinics is beyond the reach of most individuals in this rural coastal community as median per capita household income was RM83.33/month (≈ USD 20). Public funded NCD prevention and health promotions, whilst they were free, they did not reach those who may not have a need to vi(ve)S-4(b)4irequ7t21lp7ai-35621lplr19ara2(in)enta 19a8ia17(fundT3(a)o)-36(he)-6(21lp7ai)5Tser-vices [10]. Tine NCDP-1 M with ves community partnering in NCD risk screening and in3(ealth)-280(promo)5(t)-2(ion)-275(w)-3(ere)-276(a)8(vail)6(ab)5(le)]TJ-0.0183TcT*[(in)-357(the)-358(r)-2(ura lar orent ethnic groupp. In the present study,

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