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Profile of non-communicable disease risk factors among adults in the Republic of Palau: findings of a national STEPS survey

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ABSTRACT

Palau, similar to other Pacific island countries, is currently highly burdened with non-communicable diseases (NCDs). The WHO STEPS was launched in 2011 to comprehensively survey indicators for NCDs in the country. This paper aims to describe the prevalence of key NCD risk factors assessed by the survey. The WHO instrument, including behavioral, physical and biochemical measurements, was adopted to the nationwide survey for all residents aged 25 to 64 years. A cluster-based sampling method was performed to obtain a national representative data. Valid data from 2,184 individuals were selected for the analyses, of which 75% were Palauans and 19% were Filipinos. Prevalence of current cigarette smoking was 25% in men and 10% in women. Betel nut chewing with tobacco was prevalent particularly among Palauans (58% in men, 69% in women) compared to the other ethnic groups. In terms of all types of tobacco use, 60% of men and 58% of women were current users. Overweight or obesity was very common among Palauans (84% in men, 86% in women) as well as Filipinos (52% in men, 40% in women). Hypertension was found in 55% of men and 49% of women, with the stage 2 hypertension being 21% and 19%, respectively. The prevalence of diabetic level hyperglycemia was more than 20%. Raised total cholesterol was detected in 16% of men and 20% of women. This survey revealed an alarmingly high prevalence of NCD risk factors, especially tobacco use, obesity, hypertension and raised blood glucose. The data would be useful baseline information to develop effective NCD strategies in Palau.

Key Words: non-communicable disease, WHO STEPS, obesity, hypertension, betel nut and tobacco chewing

INTRODUCTION

Non-communicable diseases (NCDs) have undoubtedly become a major challenge in the Pacific

Islands, which account for around 70% of all deaths in the region, including a high percentage of premature deaths (before the age of 60).[1,2] The Republic of Palau bears a high burden of NCDs, as well as other Pacific island countries and territories. According to the data released by the Ministry of Health in 2011, cardiovascular disease (24.3%), cancer (21.4%), chronic respiratory diseases (12.7%), and diabetes (9.8%) are the leading four causes of death in the country.[3]

Palau is a Micronesian island country, located east of the Philippines, west of the Federated States of Micronesia (FSM) and northeast of Indonesia. It is classified as an upper middle income country by the World Bank and has relatively high living standards in comparison with other island countries in the region. According to the latest national population and housing census conducted in 2005, the total population is about 20,000, of which 73% are of Palauan descent and foreign nationals comprise the rest. Filipinos, estimated at 16% to roughly 20% of the total population, are the largest group of the foreign residents, and most of them are migrant workers from the Philippines after the 1990s, with a relatively young age distribution compared to local Palauans.

Being aware of the seriousness of the burden of NCDs, the President of Republic of Palau signed an executive order declaring a state of health emergency on NCDs in 2011. However, the authorities did not have valid population baseline data of key indicators for NCDs to establish evidence-based strategies for controlling NCDs.

Although several previous population-based surveys were conducted in Palau, none of them could provide complete information, including behavioral and biological risk factor of NCDs. For example, the Palau Health Survey in 1991 or the Palau Community Health Assessment in 2003 did not include blood tests, and the behavioral risk factor surveillance system (BRFSS) in 2010 and 2012 did not include either physical or biochemical measurements. The Ministry of Health, therefore, collaborated with the World Health Organization (WHO) to start the WHO STEPwise approach to risk factor Surveillance (STEPS) in late 2011, which would be the first comprehensive national survey for NCD risk factors in Palau.

This paper aims to perform an initial analysis before looking further into associations among various factors on the population representative dataset, and describe the prevalence of each major common risk factor for NCDs.

METHODS

A population-based survey for NCD risk factors, referred to as Palau NCD STEPS Survey, was started in September 2011 by adopting the WHO STEPS Instrument,[4] and the data collection was completed in June 2013. Based on the 2009 Household Survey, two-stage cluster random sampling was designed to cover the entire 16 states of Palau. Firstly, 75 enumeration areas (EAs) were selected using probability proportional to size (PPS) as the primary sampling units, followed by randomly selecting 2,807 households from them as the secondary sampling units. One resident aged 25 to 64 years within each of the households was recruited for the survey using the Kish method, which provides for random selection of one individual from a household.[5,6] The required sample size to detect statistically significant differences between eight sex-age groups were calculated as 2,807 individuals, within a margin of error of 5% and an anticipated 80% response rate.

As detailed below, there are three component parts, called "Steps", of the survey instrument, *i.e.* behavioral, physical and biochemical measurements. (1) Apart from questions for basic demographic information, a structured questionnaire was used to assess four common behavioral risk factors of NCDs by face-to-face interviews. Participants were asked about personal dietary

habits, particularly fruit and vegetable intakes, as well as tobacco use, alcohol consumption and physical activity in their daily lives. (2) The second Step consisted of measurements of height, weight, waist and hip circumferences, and resting blood pressure. The anthropometric measurements were taken in light indoor clothing, and without shoes or other heavy accessories. Waist circumference was measured at the midpoint between the lowest rib and the iliac crest. Blood pressure in the sitting position was measured three times in the upper arm, using an electronic sphygmomanometer (Omron HEM-7200). Three measurements of blood pressure were taken for each participant in the survey, and the arithmetic mean of the second and third readings were used. (3) Biochemical blood tests were performed in the morning after roughly 10 to 12 hours of fasting. Fresh capillary whole blood samples were drawn from the fingertip, followed by biochemical tests on portable devices, namely ACCU-CHEK Performa system (Roche Diagnostics, North America) for fasting blood glucose and Accutrend Plus system (Roche Diagnostics, North America) for blood levels of total cholesterol and triglycerides.

Data were entered by using the EpiData software and categorized into different groups for the analysis based on well-defined criteria. Body mass index (BMI) is defined as the weight in kilograms divided by the square of the height in meters. As the current WHO classification, cutoff points of 18.5, 25 and 30 kg/m^2 were used to define underweight, normal weight, overweight and obesity. Hypertension was defined as having a systolic blood pressure ≥140 mmHg, a diastolic blood pressure ≥90 mmHg, or currently being on antihypertensive medication. People with systolic blood pressure ≥160 mmHg or diastolic blood pressure ≥100 mmHg were grouped as stage 2 hypertension, by applying the criteria of the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7).[7] According to the recommendations by the WHO and American Diabetes Association (ADA), values of fasting blood glucose ≥126 mg/dL or those on diabetic treatment were categorized as diabetic. Two values for the upper limit of normal fasting blood glucose were used: 110 mg/dL by the WHO or 100 mg/dL by the ADA criteria.[8,9] The levels of blood lipids were classified as follows: normal (<150 mg/dL), borderline-high (150–199 mg/dL) and high (≥200 mg/dL) for triglycerides, and desirable (<200 mg/dL), borderline-high (200–239 mg/dL) and high (≥240 mg/dL) for total cholesterol.[10] To test the differences among ethnic groups on each categorical data, chi-square test was applied. A P value of less than 0.05 was considered statistically significant. We conducted all aforementioned data analyses using the statistical software, IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp, Armonk, NY, USA).

The survey proposal was reviewed and approved by the WHO and Institutional Review Board of the Ministry of Health, Republic of Palau prior to implementation (July, 2010). Written informed consent was obtained from all of the participants after adequate explanations of the objectives and procedures of the project. Data analysis of this study is also included in a joint research project between Palau and Japan, which was designed to investigate NCD risk factors among the younger adults aged 18 to 24 years.[11] The relevant research project was approved by the Bioethics Review Committee of Nagoya University School of Medicine (July, 2012).

RESULTS

From the selected 2,807 households (71% of the total households nationwide), 2, 212 individuals participated in this survey and completed all of the three Steps giving a response rate of 79%. Valid data of 2,184 individuals were finally selected for the analyses in this study, excluding those who were not within the target age range of 25–64 years, who did not give a clear answer of sex, and women who were pregnant at the moment of the survey. About 75% of the subjects

were Palauans and 19% were Filipinos, the main foreign population in the country. The mean age of the Palauan participants was 46.6 years (standard deviation, 10.2), while the mean age of the Filipinos was 42.4 years (standard deviation, 9.5). Table 1 shows the characteristics of participants by gender and age group, and Table 2 shows that by ethnic background.

Table 1 Characteristics of participants aged 25–64 years in Palau NCD STEPS survey 2011–2013, valid %

	Male					Female				
Age group of years	25–34	35–44	45–54	55–64	Total	25–34	35–44	45–54	55–64	Total
Number	193	295	318	240	1046	188	312	379	259	1138
Educational attainment										
primary or lower	18.5	15.4	19.9	16.8	17.7	11.8	12.8	13.4	20.2	14.5
secondary	40.7	45.1	38.3	41.2	41.3	31.0	41.0	42.2	34.2	38.2
college or higher	40.7	39.6	41.8	42.0	41.0	57.2	46.2	44.4	45.5	47.3
number of missing	4	2	2	2	10	1	0	5	2	8
Marital status										
single	53.9	22.1	16.7	8.8	23.3	43.5	19.9	10.6	7.4	17.9
married/cohabiting	44.5	71.4	72.2	76.9	68.0	51.1	69.6	69.6	62.1	64.8
divorced/separated	1.6	6.1	8.8	8.0	6.5	4.3	7.8	10.3	10.5	8.7
widowed	0.0	0.3	2.2	6.3	2.2	1.1	2.6	9.5	19.9	8.6
number of missing	2	1	1	2	6	2	6	1	3	12
Annual household income (USD) [a]										
<5000	35.5	24.1	22.3	26.5	26.2	31.6	27.3	26.3	27.0	27.6
5000–9999	34.3	36.0	35.7	29.6	34.1	28.3	25.4	23.1	19.5	23.7
10000–14999	7.2	14.9	15.9	16.1	14.1	18.4	15.4	18.3	19.1	17.7
15000–19999	8.4	7.7	7.1	7.6	7.6	9.9	8.5	8.9	8.8	8.9
≥20000	14.5	17.2	19.1	20.2	18.0	11.8	23.5	23.4	25.6	22.1
number of missing	27	34	35	17	113	36	52	41	44	173
Smoking										
non–smoker	41.5	47.5	43.1	41.3	43.6	60.1	63.1	60.9	62.2	61.7
ex–smoker	26.4	29.5	34.0	36.7	31.9	28.7	28.5	29.8	27.4	28.7
current smoker	32.1	23.1	23.0	22.1	24.5	11.2	8.3	9.2	10.4	9.6
Betel nut with tobacco chewing										
non–chewer	55.4	50.2	57.9	64.2	56.7	42.0	42.6	46.7	52.9	46.2
current chewer	44.6	49.8	42.1	35.8	43.3	58.0	57.4	53.3	47.1	53.8
Tobacco product use										
non–user	35.8	34.6	41.8	48.3	40.2	36.7	38.8	42.2	49.0	41.9
current user	64.2	65.4	58.2	51.7	59.8	63.3	61.2	57.8	51.0	58.1
Alcohol drinking										
non–drinker	19.7	17.3	23.6	24.6	21.3	31.9	35.3	35.9	45.6	37.3
ex–drinker	25.9	30.2	31.1	31.3	29.9	35.6	41.3	40.1	40.9	39.9
current drinker	54.4	52.5	45.3	44.2	48.8	32.4	23.4	24.0	13.5	22.8
Fruit intake (day/week)										
0–1	41.6	46.2	43.4	42.9	43.7	41.0	36.2	31.6	23.0	32.4
2–4	42.6	32.4	38.6	38.3	37.5	41.0	39.7	40.2	45.1	41.3
≥5	15.8	21.4	18.0	18.8	18.7	18.0	24.0	28.2	31.9	26.2
number of missing	3	5	7	0	15	5	0	3	2	10

Vegetable intake (day/week)										
0–1	9.9	12.6	15.7	20.2	14.8	10.8	8.7	8.8	8.1	8.9
2–4	39.1	42.5	44.1	42.9	42.4	37.6	36.5	37.9	36.4	37.2
≥5	51.0	44.9	40.3	37.0	42.8	51.6	54.8	53.3	55.4	53.9
number of missing	1	1	5	2	9	2	0	2	1	5
Body mass index (kg/m^2)										
<18.5	0.5	1.1	0.3	1.7	0.9	3.8	1.0	0.8	1.6	1.5
18.5–24.9	34.6	24.0	22.2	16.7	23.7	33.2	25.6	19.4	15.7	22.6
25–29.9	32.4	32.9	35.9	38.9	35.1	24.5	27.5	32.6	35.9	30.6
≥30	32.4	42.0	41.6	42.7	40.3	38.6	45.9	47.2	46.8	45.3
number of missing	5	12	3	1	21	4	7	8	11	30
Systolic blood pressure (mmHg)										
<120	16.2	11.5	8.5	5.8	10.2	53.7	29.1	18.6	5.8	24.4
120–129	29.8	23.1	20.6	8.8	20.2	22.3	28.5	15.9	10.5	19.2
130–139	23.6	28.5	19.3	17.5	22.3	11.2	20.4	18.0	17.9	17.5
140–159	27.2	26.1	30.1	38.3	30.3	9.6	16.2	27.9	30.7	22.3
≥160	3.1	10.8	21.5	29.6	17.0	3.2	5.8	19.6	35.0	16.6
number of missing	2	0	2	0	4	0	3	2	2	7
Diastolic blood pressure (mmHg)										
<80	49.2	27.5	25.9	25.4	30.5	52.1	40.8	32.1	31.9	37.8
80–84	16.8	18.0	13.6	17.1	16.2	13.3	16.8	14.1	21.0	16.3
85–89	11.5	14.6	17.7	18.8	15.9	13.3	14.6	18.6	15.2	15.8
90–99	14.7	28.1	26.3	26.3	24.7	17.6	21.4	21.2	19.1	20.2
≥100	7.9	11.9	16.5	12.5	12.7	3.7	6.5	14.1	12.8	10.0
number of missing	2	0	2	0	4	0	3	2	2	7
Hypertension										
≥140/90 mmHg	35.1	48.8	56.3	70.4	53.6	23.4	33.3	52.0	67.3	45.6
≥140/90 mmHg / medication	35.6	49.5	57.9	73.3	55.0	24.5	36.2	56.0	69.6	48.5
≥160/100 mmHg	9.9	14.9	25.0	32.9	21.2	5.9	8.7	22.0	37.4	19.2
Fasting glucose (mg/dL)										
<100	50.6	39.4	30.7	28.5	36.2	64.5	46.2	35.9	28.1	41.7
100–109	29.5	26.7	26.4	22.4	26.1	18.7	23.9	25.2	22.8	23.2
110–125	9.6	16.7	20.0	20.1	17.2	9.6	14.4	19.0	16.7	15.7
≥126	10.2	17.1	22.9	29.0	20.4	7.2	15.5	19.9	32.5	19.5
(≥126 mg/dL / medication)	10.2	17.5	23.9	29.4	21.0	7.2	15.5	20.9	34.6	20.3
number of missing	27	44	38	26	135	22	48	53	31	154
Triglycerides (mg/dL)										
<100	34.4	22.7	22.8	19.3	24.1	37.9	33.6	24.7	23.3	29.0
100–149	24.4	29.8	26.5	29.0	27.6	28.6	32.0	29.9	27.9	29.8
150–199	15.6	16.4	22.4	18.8	18.7	11.8	16.6	16.7	20.5	16.7
≥200	25.6	31.1	28.4	32.9	29.7	21.7	17.8	28.7	28.3	24.5
number of missing	33	57	50	33	173	27	53	55	40	175
Total cholesterol (mg/dL)										
<160	55.2	51.4	44.1	38.8	46.9	63.4	55.8	33.1	37.0	45.1
160–189	29.4	29.7	34.9	36.4	32.9	25.0	30.6	33.4	24.7	29.3

190–199	5.5	5.6	6.6	6.5	6.1	2.4	6.0	10.8	8.8	7.7
200–239	9.2	12.4	12.1	16.4	12.7	8.5	6.4	16.9	22.9	14.1
≥240	0.6	0.8	2.2	1.9	1.4	0.6	1.1	5.7	6.6	3.8
(≥200 mg/dL / medication)	9.8	13.7	17.6	22.0	16.1	9.8	8.3	24.7	34.8	20.1
number of missing	30	46	46	26	148	24	47	47	32	150

[a] USD indicates United States dollar

Table 2 Characteristics of participants by ethnic background, valid % (age–standardized %) [a]

	Male			P value	Female			P value
	Palauan	Filipino	Others		Palauan	Filipino	Others	
Number	751	200	93		875	206	56	
Age group of years				<0.001				<0.001
25–34	13.8	25.5	40.9		14.7	23.8	17.9	
35–44	26.1	33.0	33.3		26.9	31.6	21.4	
45–54	32.6	28.0	18.3		32.9	32.0	44.6	
55–64	27.4	13.5	7.5		25.5	12.6	16.1	
Educational attainment				0.017				0.146
primary or lower	19.0 (19.9)	10.7 (9.9)	22.0 (22.2)		15.3 (14.6)	10.3 (9.7)	18.2 (19.3)	
secondary	42.0 (43.4)	42.9 (42.2)	31.9 (30.5)		37.9 (37.4)	42.6 (41.7)	27.3 (25.5)	
college or higher	39.0 (36.7)	46.4 (47.9)	46.2 (47.3)		46.8 (48.0)	47.1 (48.6)	54.5 (55.2)	
Marital status				<0.001				0.008
single	20.5 (28.7)	28.1 (30.7)	35.9 (31.2)		16.3 (21.3)	26.3 (29.0)	10.9 (14.8)	
married/cohabiting	68.7 (63.3)	67.8 (65.5)	62.0 (66.1)		65.4 (64.6)	58.5 (57.3)	78.2 (76.5)	
divorced/separated	8.2 (6.7)	3.0 (3.1)	1.1 (1.4)		8.8 (7.8)	8.8 (8.2)	7.3 (6.6)	
widowed	2.7 (1.4)	1.0 (0.8)	1.1 (1.4)		9.5 (6.4)	6.3 (5.5)	3.6 (2.0)	
Annual household income (USD) [b]				<0.001				<0.001
<5000	17.3 (15.2)	51.4 (52.5)	44.0 (42.3)		19.4 (18.9)	62.1 (62.4)	22.7 (20.1)	
5000–9999	34.0 (37.4)	37.3 (35.9)	28.0 (30.5)		24.8 (26.9)	19.2 (18.8)	25.0 (32.3)	
10000–14999	18.8 (18.0)	2.2 (1.9)	2.7 (2.9)		19.8 (19.6)	10.4 (10.7)	13.6 (12.5)	
15000–19999	9.1 (9.4)	4.3 (5.0)	2.7 (2.5)		10.7 (11.1)	2.2 (2.1)	6.8 (9.5)	
≥20000	20.9 (20.0)	4.9 (4.7)	22.7 (21.8)		25.3 (23.5)	6.0 (6.1)	31.8 (25.6)	
Smoking				<0.001				<0.001
non–smoker	41.5 (40.4)	48.0 (48.1)	49.5 (48.0)		56.0 (55.4)	84.0 (83.5)	69.6 (73.1)	
ex–smoker	37.2 (36.5)	18.0 (18.0)	20.4 (22.7)		34.1 (34.8)	9.2 (9.5)	16.1 (10.9)	
current smoker	21.3 (23.1)	34.0 (33.9)	30.1 (29.3)		9.9 (9.7)	6.8 (7.0)	14.3 (15.9)	
Betel nut with tobacco chewing				<0.001				<0.001
non–chewer	42.3 (34.2)	97.5 (97.6)	84.9 (84.5)		31.4 (27.1)	98.5 (98.7)	83.9 (81.8)	
current chewer	57.7 (65.8)	2.5 (2.4)	15.1 (15.5)		68.6 (72.9)	1.5 (1.3)	16.1 (18.2)	
Tobacco product use				<0.001				<0.001
non–user	31.4 (24.3)	64.0 (64.2)	59.1 (59.7)		28.1 (24.0)	91.7 (91.7)	73.2 (71.5)	
current user	68.6 (75.7)	36.0 (35.8)	40.9 (40.3)		71.9 (76.0)	8.3 (8.3)	26.8 (28.5)	
Alcohol drinking				0.004				<0.001
non–drinker	19.7 (16.2)	21.0 (20.9)	35.5 (33.8)		32.5 (30.5)	57.3 (56.3)	37.5 (37.3)	
ex–drinker	30.8 (30.3)	32.5 (32.1)	17.2 (17.9)		43.0 (41.8)	31.6 (32.1)	23.2 (20.9)	
current drinker	49.5 (53.5)	46.5 (47.0)	47.3 (48.2)		24.6 (27.6)	11.2 (11.6)	39.3 (41.8)	
Fruit intake (day/week)				<0.001				<0.001
0–1	48.2 (49.3)	31.8 (32.8)	33.0 (34.6)		35.7 (39.7)	22.3 (22.2)	19.6 (22.6)	
2–4	35.4 (34.9)	43.9 (43.6)	41.8 (40.0)		40.1 (38.4)	47.1 (48.0)	37.5 (39.4)	
≥5	16.4 (15.8)	24.2 (23.6)	25.3 (25.4)		24.2 (21.9)	30.6 (29.8)	42.9 (38.0)	
Vegetable intake (day/week)				<0.001				<0.001
0–1	17.5 (16.0)	8.0 (8.0)	7.6 (8.8)		10.4 (11.3)	2.9 (2.9)	7.3 (4.4)	
2–4	44.1 (42.0)	42.2 (43.3)	29.3 (28.2)		40.3 (39.7)	30.1 (30.9)	14.5 (17.8)	
≥5	38.4 (42.1)	49.7 (48.7)	63.0 (63.0)		49.3 (49.0)	67.0 (66.2)	78.2 (77.7)	
Body mass index (kg/m²)				<0.001				<0.001
<18.5	0.5 (0.4)	1.0 (0.8)	3.4 (3.3)		0.9 (1.0)	4.0 (4.3)	1.8 (2.9)	

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				p				p
18.5–24.9	15.4 (16.5)	47.0 (47.7)	41.6 (40.7)		13.0 (14.0)	56.1 (56.7)	50.0 (55.2)	
25–29.9	33.2 (31.4)	42.9 (42.2)	34.8 (35.3)		31.4 (30.2)	30.3 (29.5)	19.6 (14.1)	
≥30	51.0 (51.7)	9.1 (9.3)	20.2 (20.6)		54.6 (54.8)	9.6 (9.4)	28.6 (27.8)	
Systolic blood pressure (mmHg)				<0.001				<0.001
<120	8.9 (10.7)	13.5 (14.5)	13.2 (13.0)		21.3 (27.6)	31.1 (34.4)	48.2 (54.2)	
120–129	17.9 (21.1)	24.0 (25.1)	30.8 (29.6)		18.8 (21.8)	19.9 (20.2)	23.2 (21.2)	
130–139	21.2 (23.4)	23.0 (23.2)	28.6 (28.9)		17.2 (16.7)	21.4 (20.5)	7.1 (6.1)	
140–159	32.4 (30.9)	25.0 (24.0)	25.3 (25.5)		24.8 (21.4)	15.5 (13.8)	8.9 (7.2)	
≥160	19.5 (13.9)	14.5 (13.1)	2.2 (2.9)		18.0 (12.4)	12.1 (11.1)	12.5 (11.3)	
Diastolic blood pressure (mmHg)				<0.001				<0.001
<80	27.1 (30.0)	39.0 (41.5)	40.7 (39.1)		33.8 (35.7)	50.0 (52.7)	55.4 (58.1)	
80–84	15.4 (16.0)	14.5 (13.8)	26.4 (26.2)		17.1 (16.6)	13.1 (12.4)	14.3 (14.7)	
85–89	16.6 (14.5)	15.0 (15.0)	13.2 (13.2)		16.1 (15.9)	16.0 (15.4)	10.7 (9.8)	
90–99	27.4 (26.8)	19.5 (18.5)	13.2 (14.5)		21.9 (22.5)	15.0 (14.2)	12.5 (11.0)	
≥100	13.6 (12.8)	12.0 (11.2)	6.6 (6.9)		11.2 (9.4)	5.8 (5.3)	7.1 (6.5)	
Hypertension								
≥140/90 mmHg	58.5 (53.0)	44.5 (42.1)	33.0 (34.6)	<0.001	50.6 (43.9)	31.6 (28.9)	21.4 (18.5)	<0.001
≥140/90 mmHg / medication	59.9 (54.1)	45.5 (43.1)	35.2 (37.4)	<0.001	53.5 (46.5)	34.0 (31.2)	25.0 (22.4)	<0.001
≥160/100 mmHg	23.6 (18.7)	19.0 (17.7)	6.6 (6.9)	0.001	21.2 (15.9)	12.6 (11.5)	12.5 (11.3)	0.008
Fasting glucose (mg/dL)				<0.001				0.008
<100	34.6 (38.8)	35.7 (36.7)	52.8 (51.1)		41.5 (47.3)	42.6 (45.1)	40.8 (46.8)	
100–109	24.4 (26.2)	33.9 (34.6)	23.6 (24.6)		20.9 (20.1)	29.0 (28.1)	34.7 (34.5)	
110–125	17.5 (14.8)	15.2 (15.0)	19.4 (20.3)		15.6 (14.6)	16.9 (15.9)	12.2 (7.2)	
≥126	23.5 (20.2)	15.2 (13.7)	4.2 (4.0)		22.0 (18.0)	11.5 (10.9)	12.2 (11.5)	
(≥126 mg/dL / medication)	24.0 (20.5)	16.4 (14.8)	4.2 (4.0)	<0.001	22.9 (18.5)	12.0 (11.3)	12.2 (11.5)	0.002
Triglycerides (mg/dL)				0.811				0.005
<100	23.0 (25.5)	26.1 (27.1)	29.2 (27.9)		26.2 (28.3)	37.4 (39.2)	42.0 (40.4)	
100–149	28.0 (27.2)	26.1 (26.6)	27.8 (28.4)		29.7 (30.2)	29.3 (28.6)	32.0 (32.6)	
150–199	19.5 (19.2)	16.1 (15.6)	16.7 (18.1)		18.7 (17.3)	11.5 (11.6)	6.0 (6.0)	
≥200	29.5 (28.1)	31.7 (30.8)	26.4 (25.6)		25.5 (24.1)	21.8 (20.6)	20.0 (21.1)	
Total cholesterol (mg/dL)				0.170				0.037
<160	48.9 (54.1)	41.2 (41.7)	42.3 (41.7)		47.1 (52.5)	38.0 (40.2)	41.2 (49.8)	
160–189	32.1 (29.8)	37.1 (37.1)	29.6 (29.9)		28.2 (27.4)	32.1 (32.8)	35.3 (32.1)	
190–199	6.4 (5.9)	5.3 (5.3)	5.6 (4.9)		6.5 (5.5)	13.6 (12.5)	3.9 (2.2)	
200–239	11.0 (8.8)	15.9 (15.5)	21.1 (22.0)		14.6 (12.1)	12.0 (11.0)	13.7 (12.3)	
≥240	1.7 (1.4)	0.6 (0.5)	1.4 (1.5)		3.6 (2.5)	4.3 (3.6)	5.9 (3.6)	
(≥200 mg/dL / medication)	14.9 (11.5)	17.6 (17.0)	23.9 (25.0)	0.122	20.7 (16.3)	17.4 (15.6)	21.6 (17.0)	0.577

a) Based on the age distribution of the whole population from 2005 Census of Population and Housing
b) USD indicates United States dollar

A quarter of male participants were current cigarette smokers, but female smokers were less than 10%. Betel nut with tobacco chewing was a common practice among Palauans, as 58% of men and 69% of women had the habit. In the total participants, 60% of men and 58% of women reported current use of any kind of tobacco products, including smoking and chewing. Infrequent fruit intake, namely one day or less per week, occurred in 44% of men and 32% of women. As for infrequent vegetable intake (≤1 day/week), it was observed in 15% and 9% of men and women, respectively.

Most of Palauan males (84%) and females (86%) were overweight or obese (BMI ≥ 25 kg/m^2), with the mean BMI being 30.8 kg/m^2 and 31.3 kg/m^2 in males and females, respectively. Filipino residents also had a high prevalence of overweight or obesity, *i.e.* 52% in males and 40% in females, and the mean BMI was 25.4 kg/m^2 in males and 24.5 kg/m^2 in females. As for percentage of obesity alone (BMI ≥ 30 kg/m^2), it is much higher among Palauan residents (51% in males and 55% in females) than that among Filipinos (9% in males and 10% in females).

Approximately 8% of males and 14% of females among the total adult subjects reported

that they had taken antihypertensive medication during the past two weeks. Including those who were on medication, more than half of Palauan males (60%) and females (54%) were considered hypertensive, followed by 46% of males and 34% of females in the Filipino population. Moreover, 20% of the total participants were stage 2 hypertensive (≥ 160/100 mmHg).

About one out of five participants in this survey were regarded as diabetic. The prevalence is higher in the older age group, *e.g.* 29% of males and 35% of females were diabetic among the oldest age group of 55–64 years.

Borderline-high or high levels of triglycerides were found in 48% of men and 41% of women in the total subjects, whereas borderline-high or high levels of total cholesterol including those on medication were observed among 16% of men and 20% of women.

DISCUSSION

This is the first comprehensive population based survey on risk factors of NCDs among adults in Palau, which included physical and biochemical measurements. The results revealed a high percentage on each of the major risk factors, especially tobacco use, overweight or obesity, hypertension, and raised blood glucose.

Findings of this survey confirmed that cigarette smoking was more prevalent among men than women in Palau (25% vs. 10%: *P* <0.001). The prevalence was almost the same as that reported in the Palau Community Health Assessment,[3] a national household survey in 2003, indicating that smoking rate of adults had hovered during the past decade in this country. Compared with the other Pacific island countries, the prevalence of smoking in Palau was not high.[12] For instance, it was much lower than the findings from a previous survey carried out in the adjacent Micronesian country, Federated States of Micronesia (FSM), in which 42% of men and 32% of women were reported as current smokers.[13]

However, cigarette smoking solely can hardly illustrate the fact of tobacco use in Palau. Chewing betel nut with tobacco, smokeless tobacco, is a broadly acceptable practice within all sectors of the population in Palau.[14] According to the results, Palauan adults, especially women, had an extremely high proportion of betel nut with tobacco chewing, which was not commonly observed in other ethnic groups living in this country. Although the neighboring country, FSM, has the same tradition of betel nut chewing, the percentage of smokeless tobacco users was significantly lower in comparison to Palau, namely 22% in men and 3% in women. As regards the gender difference in betel nut and tobacco chewing, Cambodia is the other country in the WHO Western Pacific Region which reported women had a significantly higher prevalence than men.[15] Three reasons for the use of chewing tobacco and betel nut among Cambodian women were suggested in a previous study: (1) as an addictive stimulant, (2) as part of a female rite of passage into adulthood and reproductive age, and (3) as a remedy to relieve pregnancy-related symptoms.[16] However, the reasons for the high prevalence of chewing betel nut with tobacco among Palauan women are still not clear. Further studies might be designed to gain insight into the social context. Based on the findings in this survey, the Palauan government may have to develop gender- and ethnic-specific tobacco control measures for the population.

Obesity is a common major challenge of public health in the Pacific region. More than half of adult population in each of the Pacific island countries are observed to be overweight or obese (BMI ≥ 25 kg/m^2), with the exception of Papua New Guinea.[17] Likewise, about three in four participants were considered as overweight or obesity in this survey. With regard to the difference by ethnic background, more than half of Palauan adults were obese (BMI ≥ 30 kg/m^2), whereas the proportions of obesity in both Filipino men and women were less than

10%. Even after adjusting for age, Palauans have a higher obesity prevalence than Filipinos either in men or in women ($P < 0.001$ for both). Since Most of the Filipinos living in Palau are migrant workers engaged in physical labors and having lower income levels than Palauans. (see Table 2). Considering the socio-economic background, lower prevalence of obesity among Filipinos than among Palauans might be attributable to the differences in dietary habits, physical activities, working conditions, etc. In comparison with the data reported from the Palau Health Survey in 1991, the mean BMI of adults aged 35–64 years had increased from roughly 27.6 to 29.6 kg/m² for men and 29.6 to 30.1 kg/m² for women over the past two decades.[18] Dietary patterns and lifestyle changes with the economic growth in Palau might explain the increased BMI. Subsequent analyses or further studies are required to investigate the factors contributing to overweight or obesity in the population.

This survey revealed an alarmingly high prevalence of hypertension in Palau, of which more than half of the adults had a raised blood pressure, particularly among ethnic Palauans. Even the youngest age group (25–34 years) demonstrated a high percentage of hypertension (36% in men and 25% in women). However, the proportion of participants who were on antihypertensive medication was relatively low (8% in men and 14% in women). As hypertension rarely causes symptoms in the early stages, those who have undiagnosed hypertension or ignore self-management of blood pressure should be targeted first in NCD control policies.[19] Among published data of WHO STEPS surveys for Pacific island countries and territories, Palau has the highest prevalence of hypertension in both sexes (55% in men and 49% in women), even though the prevalence of obesity is not noticeably high compared to the others.[20] Factors might contribute to this result, such as salt intakes, need to be investigated further.

Palau was the only country in Oceania which did not have any available data concerning the population prevalence of raised blood glucose prior to the present survey,[17] despite the fact that Pacific island countries have some of the highest rates of diabetes in the world.[1,2] This survey showed that more than 20% of the participants had diabetic level hyperglycemia, and more than 60% of the participants had ADA-defined impaired fasting glycemia (IFG) or diabetes (≥100 mg/dL). It is known that diabetes, if untreated for years, causes serious complications such as diabetic retinopathy, nephropathy, and neuropathy, as well as ischemic cardiac diseases. Urgent actions are needed to screen and control blood glucose of the population in Palau.

Although the evidence of health impacts of the given risk factors has been identified around the world, a limited number of those studies were conducted in the Pacific Islands. As of today, most of the countries and territories in the Pacific region have accessible data of the key NCD risk factors for their population, such as those from the WHO STEPS surveys. All of these data could be potentially used for further studies to investigate local characteristics of NCDs for the islanders. In addition, comparisons across the island countries have also become possible, because of the standardized methodology used for the data collection.

There are some limitations in the present survey that merit discussion. We could not obtain valid variables on fruit and vegetable intakes by servings, standard amounts of alcohol consumption, and quantity of physical activity due to inappropriate methods of the interviews. Regarding blood tests, capillary whole blood samples were applied to the dry chemistry method. Although the device has been calibrated for plasma automatically, the results might not correspond to those done by venous plasma samples at the laboratory, the standard method for measuring and reporting glucose concentrations in blood. Accordingly, the criteria of appropriate cutoffs might be different from those we adopted in this article.

In conclusion, this survey has provided useful baseline epidemiological data on the major NCD risk factors, with very high prevalence on both behavioral and biological risk factors. On the basis of this survey, policymakers could develop more effective and efficient NCD prevention

or control strategies for the public.

ACKNOWLEDGMENTS

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