

118 STEPS, were trained to be in charge of the biochemical station. Because all of the biochemical
119 devices and their reagents were purchased from Japan, we translated the manuals into English
120 for the instruction. Under the supervision, these two members repeated calibration, sample
121 loading, result reading, and error shooting on the devices until they could handle the operations
122 independently.

123

124 *Participant recruitment and informed consent*

125 Before the study began, this research project was reported in the local press, Island Times,
126 describing the aims and the importance of monitoring the risk factors of NCDs. Promotion and
127 recruitment fliers were distributed to all faculties of PCC and posted up on the periodical, PCC
128 Newsletter, and bulletin boards throughout the campus before and during the survey. Outside
129 the campus, information was accessible through public and private informational boards,
130 government offices in Koror, as well as all popular online social networking groups. The
131 recruitment lasted for a period of one month from the beginning of October, 2013. A prepaid
132 cell phone card to the value of ten dollars was given as an incentive measure for voluntary
133 participation in this survey.

134 New participants of the survey were asked to go to the interview room first (Step 1). Prior
135 to the interviews, adequate explanations of the purpose and the procedures of the study were
136 given from the staff, and written consent forms were obtained from each of the entrants. After

137 the face-to-face interviews, participants were directed to the room for physical measurements
138 (Step 2). Following previous two Steps, all participants were instructed to fast overnight starting
139 at 8 pm and return the next morning to complete biochemical measurements (Step 3). Those
140 who failed to return next morning for the final step were reminded via the given phone numbers
141 or emails.

142

143 *Data entry*

144 The data entry was conducted by using the standard software, EpiData Entry 3.1. A
145 programmed data entry template was developed and pretested by technical staff of the Ministry
146 of Health, and the accuracy of the data entry was verified using a double-entry method.

147

148 *Data analysis*

149 We categorized all continuous readings taken from both physical and biochemical
150 measurements according to well-defined standards (see Table 2). Body mass index (BMI) was
151 calculated as weight in kilograms divided by height in meters squared, and then grouped as
152 underweight, normal weight, overweight and obese, by applying the WHO criteria.
153 Hypertension was defined as systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90
154 mmHg, or use of antihypertensive medication, based on the Seventh Report of the Joint
155 National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood

156 Pressure (JNC 7).⁷ According to WHO 2006 criteria, fasting blood glucose levels were
157 classified into three groups as normal (<110 mg/dL), impaired fasting glucose: IFG (110-125
158 mg/dL) and diabetes mellitus (\geq 126 mg/dL).⁸ Fasting glucose levels were also categorized
159 using American Diabetes Association (ADA) criteria with a lower cutoff value of 100 mg/dL
160 for normal, and 100-125 mg/dL for prediabetes. The classification of blood lipids was
161 performed using the cutoffs, as in the following, presented by the Third Report of the National
162 Cholesterol Education Program Expert Panel on Detection, Education, and Treatment of High
163 Blood Cholesterol in Adults (NCEP ATP III).⁹ Categories for triglyceride levels were normal
164 (<150 mg/dL), borderline-high (150-199 mg/dL) and high (\geq 200 mg/dL). For total cholesterol
165 levels, desirable (<200 mg/dL), borderline-high (200-239 mg/dL) and high (\geq 240 mg/dL) were
166 adopted. As for HDL-cholesterol, low (<40 mg/dL) and high (\geq 60 mg/dL) levels were defined.
167 Because the portable device employed in our survey had a lower limit of detection of 50 mg/dL
168 for triglycerides, assays below the limit were assigned a value of 50 mg/dL for subsequent
169 analyses. We conducted all data analyses using the statistical software, IBM SPSS Statistics 21.

170

171 *Ethical considerations*

172 This study was reviewed and approved by the Bioethics Review Committee of Nagoya
173 University School of Medicine and Institutional Review Board of the Ministry of Health,
174 Republic of Palau. Written informed consent was obtained from all of the participants after

175 adequate explanations of the study.

176

177 **RESULTS**

178 A total of 356 adults between 18 and 24 years, with a mean age of 20.2 years, voluntarily
179 participated in the survey. Although all participants completed the questionnaire-based
180 interviews and physical measurements, 13 of them (3.7%) failed to come back for the
181 biochemical measurements. The majority (n=268) of the participants were PCC students, and
182 46 entrants to the survey (12.9%) were non-Palauan nationals. Pregnancies were reported from
183 two females, and consequently their biological data were excluded from the analyses for this
184 paper. Across the survey, distinct gender differences in participation were not observed.

185 Table 2 displays the percentages of biological indicators classified by appropriate criteria. In
186 both sexes, nearly half of the participants were found to be overweight or obese. About one in
187 six male subjects was hypertensive. The prevalence of hypertension was much higher in males
188 than in their female counterparts (17.6% vs. 1.7%: $P < 0.001$). Among the normotensive young
189 people, one male reported his antihypertensive use during the past two weeks. According to the
190 WHO criteria, 3.5% and 5.2% of the total participants showed fasting blood glucose levels of
191 diabetes mellitus and IFG, respectively; however, prevalence of prediabetes by ADA was 24.2%.
192 Of the 340 valid subjects, 20.9% had borderline-high or high total cholesterol levels (≥ 200
193 mg/dL). If the WHO recommended classification (≥ 190 mg/dL) was adopted, 123 (36.2%)

194 young people had raised levels of total cholesterol. Borderline-high or high level of triglycerides
195 (≥ 150 mg/dL) was 7.6%, and low level of HDL-cholesterol was 1.2%.

196 Approximately 40% of male and 12% of female respondents answered that they currently
197 smoke cigarettes (Table 1). As regards the use of all kinds of tobacco products, 80% males and
198 61% females were current tobacco users at the time of the survey. A quarter of the participants
199 did not eat fresh fruit and vegetables at least one serving a day. It was only 9.2% that they ate 5
200 servings of fresh fruit and vegetables or more per day, a WHO recommended lower limit. About
201 8% of the young population responded that they did not have any vigorous- or moderate-
202 intensity physical activities, including activities at work, traveling to and from places and
203 recreational activities in their daily life.

204

205 **DISCUSSION**

206 This is the first comprehensive survey for NCD risk factors, targeting the young age group of
207 18-24 years in Palau. Not only the information on behavioral risk factors collected via
208 questionnaire-based interviews but also the biological data taken from physical measurements
209 and blood tests can provide the baseline data for the population burdened with NCDs.

210 Our findings revealed an alarming high prevalence of overweight/obesity in both male and
211 female subjects of the survey. The percentage was even higher than the statistics reported from
212 a previous national NCD STEPS carried out in another Micronesian country, the Marshall

213 Islands.¹⁰ As compared with that survey, in which 23.9% of the age group of 15-24 years was
214 overweight and 10.6% was obese, Palau might have a double percentage of obesity (BMI \geq 30
215 kg/m²) in the young people. Given that Palau and the Marshall Islands are at the same income
216 level, upper middle income, further studies to investigate the potential related risk factors in
217 lifestyle of these two populations could provide useful clues for NCD prevention and control
218 in this region. With regard to the prevalence of hypertension, male subjects were higher than
219 females (17.6% vs. 1.7%). Such distinct gender difference has not been reported from other
220 previous surveys, *e.g.* that in the Marshall Islands (15-24 years, 2.2% vs. 1.7%) or in the USA
221 (20-34 years, 5.8% vs. 3.9%).¹¹ Interpretation of this result might require further analysis or
222 additional studies on this specific age group. The prevalence of raised blood pressure, raised
223 blood glucose or abnormal blood lipids was not as high as that of overweight/obesity. This
224 might be due to the young age of the participants; however, as they become middle-aged, the
225 problems connected with these risk factors are expected to gradually begin coming to light. The
226 most pressing need for this young age group is, therefore, to have effective public health
227 interventions in body weight control or further obesity prevention.

228 Among behavioral risk factors for the young people, tobacco use is the most obvious and
229 serious problem based on our findings. The proportion of cigarette-smoking in the current
230 survey was almost at the same level with that in the Marshall Islands or in Japan,¹² of which
231 22.7% (40.8% of males and 4.5% of females) in the group aged 15-24 and 24.5% (39.2% of

232 males and 12.8% of females) in the group aged 20-29, respectively, were reported as current
233 smokers. However, if we took account of all types of tobaccos, including smoking and chewing,
234 Palau had an extremely high proportion (70.2%) of tobacco use. Betel nut chewing, a local
235 custom in Palauan society, accounts for the high proportion, because almost all of the young
236 chewers (96.3%) added tobacco to their betel nuts. Thus, to deal with the high rate of tobacco
237 use in Palau, which was rarely observed in other countries of the region, a higher priority should
238 be attached to targeting the population of betel nut chewers. With regard to the other behavioral
239 risk factors, *i.e.* excessive alcohol drinking, infrequent consumption of fresh fruit and
240 vegetables and physical inactivity, subsequent analyses of the association with biological risk
241 factors are required to examine their impacts on the population's health status.

242 The young people aged 18 to 24 years old are the population always omitted from most of
243 the surveys in Pacific island countries, despite many of the NCD risk factors might be
244 manifested in the young stage of life. By targeting at the young age group of adults, our study
245 might provide comparative information for the authorities to combat NCDs in the region. In
246 Palau, there is no continuous health monitoring system, such as a regular health checkup in the
247 college or workplaces, available for adults. Hence, our survey also made the first attempt to
248 introduce a health checkup system into PCC, the only college-level educational institution in
249 this country. Based on the high turnout (57% of PCC students) in this survey, a regular health
250 checkup system with the WHO STEPS instrument was considered feasible in the college

251 campus. We highly recommend that PCC or the government have to take the initiative in
252 establishing a regular health monitoring system, at least covering behavioral (Step 1) and
253 physical (Step 2) measurements, for their members.

254 Because of the convenient sampling applied in our survey, a major weakness remained in
255 the data set, namely low participation of non-PCC students (25%). It might be possible that the
256 college students had better access to the information of the survey and more free time to join in
257 than the other young people outside the college. This concern might make it inadequate to
258 generalize the findings to all Palauan population at the 18-24 age group. Although probability
259 sampling was not employed for the current study, its results still could reflect the current status
260 of NCD risk factors and provide valuable information for this specific age group.

261 In conclusion, the current survey revealed a high prevalence of risk factors for NCDs among
262 young people in Palau. It indicates that swift measures against NCDs are required even for the
263 young age group of 18-24 years, which was not included in the Palauan national STEPS. The
264 findings can serve as a baseline epidemiological data and help the policymakers in devising
265 proper strategies against NCDs for the population. Moreover, this first-time comprehensive
266 survey will also offer a reference for the further development of NCD surveillance systems in
267 Palau.

268

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277 Conflicts of interest: None declared.

278

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Table 1 Percentages of behavioral factors among adults aged 18-24 years in Palau, 2013

Factor		Male (n=174)		Female (n=182)		Total (n=356)	
		n	(Valid %)	n	(Valid %)	n	(Valid %)
Alcohol drinking	current drinker ^a	116	(66.7)	66	(36.3)	182	(51.1)
	ex-drinker	46	(26.4)	69	(37.9)	115	(32.3)
	non-drinker	12	(6.9)	47	(25.8)	59	(16.6)
Smoking	current smoker	71	(40.8)	22	(12.1)	93	(26.1)
	ex-smoker	63	(36.2)	63	(34.6)	126	(35.4)
	non-smoker	40	(23.0)	97	(53.3)	137	(38.5)
Betel nut and tobacco chewing	current chewer	109	(62.6)	98	(53.8)	207	(58.1)
	non-chewer	65	(37.4)	84	(46.2)	149	(41.9)
Tobacco product use	current user	139	(79.9)	111	(61.0)	250	(70.2)
	non-user	35	(20.1)	71	(39.0)	106	(29.8)
Fruits/Vegetables (servings/day)	<1	34	(20.0)	50	(27.9)	84	(24.1)
	1-2.9	85	(50.0)	93	(52.0)	178	(51.0)
	3-4.9	31	(18.2)	23	(12.8)	54	(15.5)
	≥5	20	(11.8)	13	(7.3)	33	(9.5)
	missing	4		3		7	
Physical activity	no	5	(2.9)	25	(13.7)	30	(8.4)
	yes ^b	169	(97.1)	157	(86.3)	326	(91.6)

^a Those who answered that they consumed an alcoholic drink within the past 30 days or 1 month.

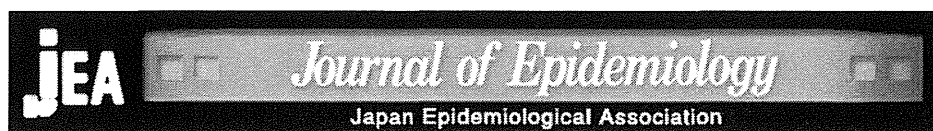
^b Those who answered that they have vigorous- or moderate-intensity physical activities in their daily life.

Table 2 BMI, blood pressure, blood levels of glucose and lipids among adults aged 18-24 years in Palau, 2013

		Male (n=174)		Female (n=180)		Total (n=354)	
		n	(Valid %)	n	(Valid %)	n	(Valid %)
Body mass index (kg/m ²)	<18.5	11	(6.5)	13	(7.3)	24	(6.9)
	18.5-25	79	(46.7)	75	(41.9)	154	(44.3)
	25-29.9	45	(26.6)	50	(27.9)	95	(27.3)
	≥30	34	(20.1)	41	(22.9)	75	(21.6)
	missing	5		1		6	
Systolic blood pressure (mmHg)	<120	30	(17.6)	100	(55.9)	130	(37.2)
	120-129	49	(28.8)	54	(30.2)	103	(29.5)
	130-139	63	(37.1)	23	(12.8)	86	(24.6)
	140-159	27	(15.9)	1	(0.6)	28	(8.0)
	≥160	1	(0.6)	1	(0.6)	2	(0.6)
	missing	4		1		5	
Diastolic blood pressure (mmHg)	<70	67	(39.4)	65	(36.3)	132	(37.8)
	70-79	68	(40.0)	76	(42.5)	144	(41.3)
	80-89	28	(16.5)	35	(19.6)	63	(18.1)
	90-99	6	(3.5)	2	(1.1)	8	(2.3)
	≥100	1	(0.6)	1	(0.6)	2	(0.6)
	missing	4		1		5	
Hypertension	no	140	(82.4)	176	(98.3)	316	(90.5)
	yes	30	(17.6)	3	(1.7)	33	(9.5)
	missing	4		1		5	
Fasting glucose (mg/dL)	<100	112	(67.9)	136	(76.4)	248	(72.3)
	100-109	36	(21.8)	29	(16.3)	65	(19.0)
	110-125	6	(3.6)	12	(6.7)	18	(5.2)
	≥126	11	(6.7)	1	(0.6)	12	(3.5)
	missing	9		2		11	
Triglycerides (mg/dL)	<100	122	(74.4)	136	(77.3)	258	(75.9)
	100-149	30	(18.3)	26	(14.8)	56	(16.5)
	150-199	6	(3.7)	8	(4.5)	14	(4.1)

	≥200	6 (3.7)	6 (3.4)	12 (3.5)
	missing	10	4	14
Total cholesterol (mg/dL)	<160	23 (14.0)	29 (16.5)	52 (15.3)
	160-189	77 (47.0)	88 (50.0)	165 (48.5)
	190-199	31 (18.9)	21 (11.9)	52 (15.3)
	200-239	32 (19.5)	37 (21.0)	69 (20.3)
	≥240	1 (0.6)	1 (0.6)	2 (0.6)
	missing	10	4	14
HDL-cholesterol (mg/dL)	<40	3 (1.8)	1 (0.6)	4 (1.2)
	40-49	10 (6.1)	8 (4.5)	18 (5.3)
	50-59	27 (16.5)	17 (9.7)	44 (12.9)
	≥60	124 (75.6)	150 (85.2)	274 (80.6)
	missing	10	4	14

HDL indicates high density lipoprotein.



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Profile of Non-communicable Disease (NCD) Risk Factors among Adults in the Republic of Palau: Findings of a National STEPS Survey

Berry Moon Watson^{1*}, Chifa Chiang^{2*}, Edolem Ikerdeu¹, Hiroshi Yatsuya^{2,3}, Kaori Honjo⁴, Takashi Mita^{4,5}, Renzhe Cui⁶, Sherilynn Madraisau¹, Gregorio Ngirmang¹, Hiroyasu Iso⁶, Atsuko Aoyama²

¹ Ministry of Health, Republic of Palau, Koror, Palau

² Department of Public Health and Health Systems, Nagoya University School of Medicine, Nagoya, Japan

³ Department of Public Health, Fujita Health University School of Medicine, Toyoake, Aichi, Japan

⁴ Global Collaboration Center, Osaka University, Suita, Osaka, Japan

⁵ Institute for Academic Initiatives, Osaka University, Suita, Osaka, Japan

⁶ Public Health, Graduate School of Medicine, Osaka University, Suita, Osaka, Japan

Correspondence: Chifa Chiang, PhD

Department of Public Health and Health Systems, Nagoya University School of Medicine
65 Tsurumai-cho, Showa-ku, Nagoya 466-8550, Japan (email: keihatsu@med.nagoya-u.ac.jp)

*B.M. Watson and C. Chiang contributed equally to this work.

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1 ABSTRACT

2 **Background:** Palau, similar to other Pacific island countries, is currently highly burdened
3 with non-communicable diseases (NCDs). The WHO STEPS was launched in 2011 to
4 comprehensively survey indicators for NCDs in the country. This paper aims to describe the
5 prevalence of key NCD risk factors assessed by the survey.

6 **Methods:** The WHO instrument, including behavioral, physical and biochemical
7 measurements, was adopted to the nationwide survey for all residents aged 25 to 64 years. A
8 cluster-based sampling method was performed to obtain a national representative data.

9 **Results:** Valid data from 2,184 individuals were selected for the analyses, of which 75% were
10 Palauans and 19% were Filipinos. Prevalence of current cigarette smoking was 25% in men
11 and 10% in women. Betel nut chewing with tobacco was prevalent particularly among
12 Palauans (58% in men, 69% in women) compared to the other ethnic groups. In terms of all
13 types of tobacco use, 60% of men and 58% of women were current users. Overweight or
14 obesity was very common among Palauans (84% in men, 86% in women) as well as Filipinos
15 (52% in men, 40% in women). Hypertension was found in 55% of men and 49% of women,
16 with the stage 2 hypertension being 21% and 19%, respectively. The prevalence of diabetic
17 level hyperglycemia was more than 20%. Raised total cholesterol was detected in 16% of men
18 and 20% of women.

19 **Conclusions:** This survey revealed an alarmingly high prevalence of NCD risk factors,

20 especially tobacco use, obesity, hypertension and raised blood glucose. The data would be
21 useful baseline information to develop effective NCD strategies in Palau.

22

23 **Key words:** Non-communicable disease, WHO STEPS, obesity, hypertension, betel nut and
24 tobacco chewing

25 INTRODUCTION

26 Non-communicable diseases (NCDs) have undoubtedly become a major challenge in the
27 Pacific Islands, which account for around 70% of all deaths in the region, including a high
28 percentage of premature deaths (before the age of 60).^{1,2} The Republic of Palau, a small island
29 country in the western Pacific bears a high burden of NCDs, as well as other Pacific island
30 countries and territories. According to the data released by the Ministry of Health of Palau in
31 2011, cardiovascular disease (24.3%), cancer (21.4%), chronic respiratory diseases (12.7%),
32 and diabetes (9.8%) are the leading four causes of death in the country.³ Being aware of the
33 seriousness of the issue, the President of Republic of Palau signed an executive order
34 declaring a state of health emergency on NCDs in 2011. However, the authorities did not have
35 valid population baseline data of key indicators for NCDs to establish evidence-based
36 strategies for controlling NCDs. Although several previous population-based surveys were
37 conducted in Palau, none of them could provide complete information, including behavioral
38 and biological risk factor of NCDs. For example, the Palau Health Survey in 1991 did not
39 include blood tests, and the Palau Community Health Assessment in 2003 or the behavioral
40 risk factor surveillance system (BRFSS) in 2010 and 2012 did not include physical and
41 biochemical measurements. The Ministry of Health, therefore, collaborated with the World
42 Health Organization (WHO) to start the WHO STEPwise approach to risk factor Surveillance
43 (STEPS) in late 2011, which would be the first comprehensive national survey for NCD risk

44 factors in Palau.

45 This paper aims to perform a preliminary analysis on the population representative dataset
46 and describe the prevalence of each major common risk factor for NCDs.

47

48 **METHODS**

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

57 A population-based survey for NCD risk factors, referred to as Palau NCD STEPS Survey,
58 was started in September 2011 by adopting the WHO STEPS Instrument,⁴ and the data
59 collection was completed in June 2013. Two-stage cluster random sampling was designed to
60 select 2,807 households nationwide, based on the 2009 Household Survey. One resident aged
61 25 to 64 years within each of the households was recruited for the survey using the Kish
62 methods.