# Prevalence and associated factors of ideal cardiovascular health: A cross-sectional national population-based study of adults in the Marshall Islands

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## ABSTRACT

**INTRODUCTION** This study aimed to determine the prevalence, distribution, and correlates of ideal cardiovascular health (CVH) among adults in Marshall Islands.

**METHODS** This population-based cross-sectional study included 2688 people aged ≥18 years with complete CVH measurements in the Marshall Islands in 2017–2018. Ideal CVH measures included non-smoking, healthy diet, physical activity, body mass index (<25 kg/m$^2$), blood pressure <120/<80 mmHg, total cholesterol <200 mg/dL, and fasting blood glucose <100 mg/dL). Sociodemographic covariates included age, sex, household income, education level, ethnicity, and work status. Logistic regressions were used to estimate associations between sociodemographic factors and meeting 5–7 CVH metrics.

**RESULTS** Almost one in four (24.8%) of respondents had poor CVH (0–2 ideal metrics), 55.9% intermediate CVH (3–4 ideal metrics), and 19.4% ideal CVH (5–7 ideal metrics), and only 0.2% had ideal CVH (all 7 metrics). In adjusted logistic regression analysis, older age (30–49 years and ≥50 years) (adjusted odds ratio, AOR=0.41; 95% CI: 0.32–0.51, and AOR=0.20; 95% CI: 0.15–0.29) and male sex (AOR=0.72; 95% CI: 0.58–0.89) were negatively associated with meeting 5–7 ideal CVH metrics. In addition, in unadjusted analysis, more than high school education level, not knowing their household income, unemployed, and home maker, student, retired or non-paid work status, were positively associated with meeting 5–7 ideal CVH metrics.

**CONCLUSIONS** The proportion of meeting 5–7 ideal CVH metrics was low among adults in the Marshall Islands. Primary and secondary prevention programs should be implemented to increase CVH in the Marshall Islands. Several factors associated with ideal CVH were identified that can be targeted in public health interventions.

**ABBREVIATIONS** AHA: American Heart Association; BP: blood pressure; BMI: body mass index; CVD: cardiovascular disease; CVH: cardiovascular health; DALYs: disability adjusted life years; FBG: fasting blood glucose; FV: fruit and vegetables; NCD: non-communicable disease; PA: physical activity; STEPS: STEPwise approach to Surveillance; TC: total cholesterol

## INTRODUCTION

Globally, 31% of all deaths have been attributed to cardiovascular diseases (CVDs) in 2016, mainly because of heart attacks and stroke[1]. In persons aged ≥50 years in 2019, ischemic heart disease and stroke caused major disability-adjusted life years (DALYs)[2]. More than three-quarters of deaths from CVDs occur in low- and middle-income countries[1]. CVDs contributed to 40.0 of mortality in 2008 in Marshall Islands[3]. Population-based studies among adults in Marshall Islands showed that the prevalence of overweight/obesity was 62.5% and the prevalence of diabetes was 19.6%[4]. Noncommunicable disease (NCD) risk factors are on the rise in the Marshall Islands, including physical inactivity, inadequate fruit/vegetable intake, high dietary salt, high tobacco use, and high alcohol consumption[5]. These NCD risk factors often cluster together, increasing the risk of developing CVDs, and should be prioritized in the prevention of CVDs[6,7]. Key strategies to reduce risk factors of

CVDs in the Marshall Islands include tobacco free initiative, nutrition (food safety and salt reduction), physical activity, and Implementation of Package of Essential NCD (PEN) Services[5].

In an effort to prevent the development of CVDs, the American Heart Association (AHA) developed the concept of 'ideal cardiovascular health (CVH)', including seven metrics to ascertain ideal health behaviors and factors: smoking, body mass index, nutritional intake, physical activity, blood pressure, blood glucose level, and total cholesterol level[8,9]. Using these seven metrics, the population cardiovascular health status can be defined as ideal (5–7 ideal metrics), intermediate (3–4 ideal metrics) or poor (0–2 ideal metrics)[10]. Having a higher number of ideal CVH metrics has been shown to be protective against morbidity and mortality[11]. To our knowledge, there are no national data on CVH in Pacific Island countries, such as the Marshall Islands, an upper middle-income country.

Globally, mainly in high-income countries, 32.2% of participants had overall poor (0–2 ideal metrics) and 19.6% ideal (5–7 ideal metrics) CVH[10]. Supplementary file Table 1 shows two different classifications of ideal CVH.

**Table 1. Sample characteristics of participants aged ≥18 years, Marshall Islands, 2017 (N=2688)**

| Variables | Total (n=2688) | Men (n=1255; 46.7%) | Women (n=1433; 53.3%) |
|---|---|---|---|
| **Sociodemographic** | % | % | % |
| **Age** (years) | | | |
| 18–29 | 27.7 | 27.2 | 28.1* |
| 30–49 | 49.1 | 47.0 | 50.9 |
| ≥50 | 23.2 | 25.8 | 20.9 |
| **Education level** | | | |
| <High school | 25.7 | 24.4 | 26.9* |
| High school | 55.9 | 54.5 | 57.2 |
| >High school | 18.3 | 27.1 | 15.9 |
| **Past year household income** (US$) | | | |
| <10000 | 38.1 | 41.4 | 35.2* |
| ≥10000 | 16.4 | 20.2 | 13.0 |
| Do not know/refused to answer | 45.5 | 38.4 | 51.8 |
| **Work status** | | | |
| Employed | 51.0 | 67.0 | 36.9* |
| Unemployed | 22.3 | 19.0 | 29.1 |
| Other[a] | 26.8 | 14.0 | 38.0 |
| **Ethnicity** | | | |
| Marshallese | 97.3 | 96.4 | 98.0* |
| Other[b] | 2.7 | 3.6 | 2.0 |
| **Medical** | % | % | % |
| Self-reported cardiovascular disease | 4.2 | 4.2 | 4.1 |
| Use of anti-hypertensive drug | 0.4 | 0.6 | 0.3 |
| Use of hypoglycemic drug | 0.4 | 0.6 | 0.3 |
| Use of lipid-lowering drug | 0.2 | 0.3 | 0.1 |
| **Measurements** | Mean (SD) | Mean (SD) | Mean (SD) |
| Systolic blood pressure (mmHg) | 120.4 (19.7) | 124.4 (18.3) | 116.9 (20.2)* |
| Body mass index (kg/m$^2$) | 30.0 (8.3) | 28.8 (8.1) | 31.1 (8.4)* |
| Total cholesterol (mg/dL) | 165.0 (106.1) | 162.8 (124.4) | 166.9 (87.0) |
| Fasting blood glucose (mg/dL) | 133.2 (121.3) | 135.7 (137.9) | 131.0 (104.7) |

a Home maker, student, retired, or non-paid. b Kiribati, Filipino, Caucasian, Fijian, Tuvaluan, etc. *p<0.05, men compared with women. SD: standard deviation.

Fewer studies have been conducted on CVH in East Asian, Southern Asian and Pacific low- and middle-income countries. Several studies in China found that: 0.05% of people Shandong (aged 18–69 years) had all 7 ideal metrics[12]; in rural Northwest China (people aged 20–80 years) 0.0% had all 7 ideal metrics, 18.0% had intermediate (no poor CVH metrics and at least one intermediate), and 82% poor (any poor CVH metric)[13]; in rural Northeast China (people aged ≥35 years) there was 0.1% prevalence of 7 ideal CVH, 11.7% intermediate CVH (at least one health metric at intermediate level, but no poor health metrics), and 88.2% poor CVH (at least one of seven health metrics at poor level)[14]; and in a nationally representative sample in China (people aged ≥20 years), 33.0% had 5–7 ideal CVH[15]. In South Asia, in Nepal (people aged 15–69 years), 51.6% had 5–7 ideal CVH metrics[16], in semi-urban Western Nepal (people aged ≥25 years), 14.3% had 6 or 7 ideal metrics[7], and in urban India (people aged 20–75 years), <0.1% had 7 ideal metrics and 7.1% had ≥6 ideal metrics[17]. Globally, smoking had the highest prevalence of ideal CVH status (69.1%), followed by fasting blood glucose (FBG) (67.7%), total cholesterol (TC) (51.7%), physical activity (40.6%), body mass index (BMI) (40.3%), blood pressure (BP) (34.6%), and dietary pattern (12.1%)[10].

Sociodemographic factors associated with ideal CVH may include female sex[10,16,18], younger age[10,13,16,18,19], ethnicity[18], higher education[12,18,19], higher income[12,18], lower income[19], rural residence[20,21], and geographical region[22]. This study aimed to estimate the prevalence, distribution, and correlates of ideal CVH among adults in the Marshall Islands in 2017.

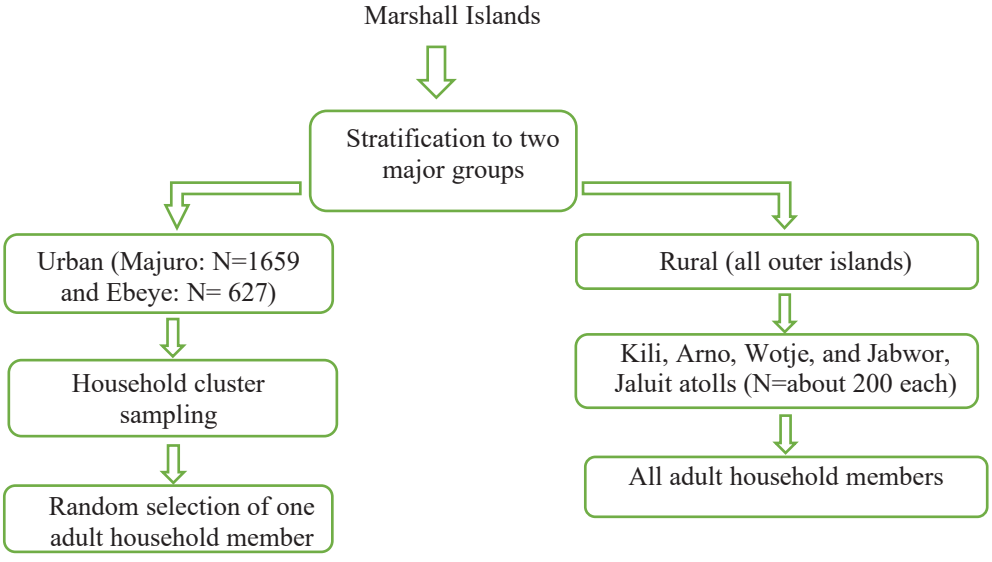
## METHODS

*Study design and participants*

Secondary data were utilized from the 'STEPwise approach to Surveillance' (STEPS) cross-sectional survey in the Marshall Islands in 2017–2018[23]. People aged ≥18 years took part in the study that used a multistage sampling design (Figure 1). In the urban islands household cluster sampling was used to randomly select one adult household member and in the rural or outer islands all adult household members were included[24]. Survey inclusion criteria were: being a Marshall Islands resident, aged ≥18 years, able to comprehend English or Marshallese, and provision of consent[24]. Trained surveyors conducted structured interviews, as well as physical and biochemical measurements[24]. The inclusion criteria for the present analysis were participants with no missing data on smoking status, BMI, PA, diet, total TC, FBG, and BP measurements. From the total sample of 3029 adults, 2688 participants with full required information were included. Comparing participants with complete AHA metrics data with participants with incomplete AHA metrics data, older and male participants had significantly more missing AHA metrics data than younger and female participants, while there were no significant differences for (in)complete AHA metrics data regarding education level, household income, work status and ethnicity (Supplementary file Table 2). The Marshall Islands Ministry of Health and Human Services approved the study protocol, and written informed consent was obtained from the participants[24].

Data collection followed the WHO three STEPS methodology. Step 1: structured questionnaire administration (sociodemographics, medical history, medication use, and health risk behavior); step 2: blood pressure and anthropometric measurements; and step 3: biochemical tests (blood glucose and blood lipids)[23]. Anthropometric measurements were taken with a portable electronic weighing scale and measuring inflexible bars[24]. Of the three blood pressure measurements using digital BP machines (Omron M4-I), the last two readings were averaged[24]. For glucose and triglycerides (TC), finger blood samples for biochemistry tests were taken, providing that instructions for

**Figure 1. Sampling flowchart, Marshall Islands, 2017–2018**



fasting overnight were followed, and fasting blood glucose (FBG) and TC were measured using CardioChek[23].

**Measures**

Poor, intermediate and ideal CVH levels for smoking, BMI, PA, diet, TC, BP, and FBG were determined, based on modified AHA definitions[8,9] for adults aged ≥18 years.

**Cardiovascular health behavior**

*Smoking status*

Smoking status is defined as poor if a current smoker (in the past 12 months), and ideal if self-report of not being a past 12-month (current) smoker[25].

*Body mass index (kg/m²)*

BMI is defined as poor for a value ≥30 , intermediate for 25.0–29.9, and ideal for <25.

*Healthy diet*

Poor healthy diet is defined as <2 servings of fruit and vegetables (FV)/day, intermediate as 2 to <4.5 FV/day, and an ideal diet as ≥4.5 FV servings/day[25].

**Table 2. Cardiovascular health (CVH) metrics distribution**

| Health metrics component | Metrics level | Total (n=2688) % | Men (n=1255) % | Women (n=1433) % | Chi-squared p |
|---|---|---|---|---|---|
| **Smoking** | Poor | 24.1 | 45.2 | 5.7 | <0.001 |
| | Intermediate | - | - | - | |
| | Ideal | 75.9 | 54.8 | 94.3 | |
| **Body mass index** | Poor | 45.3 | 35.3 | 54.0 | <0.001 |
| | Intermediate | 28.3 | 33.1 | 24.1 | |
| | Ideal | 26.4 | 31.6 | 21.9 | |
| **Diet** | Poor | 80.4 | 80.9 | 80.0 | 0.048 |
| | Intermediate | 13.1 | 13.9 | 12.5 | |
| | Ideal | 6.4 | 5.3 | 7.5 | |
| **Physical activity** | Poor | 33.6 | 24.6 | 41.5 | <0.001 |
| | Intermediate | 31.0 | 33.5 | 28.8 | |
| | Ideal | 35.4 | 41.8 | 29.8 | |
| **Total cholesterol** | Poor | 5.8 | 4.5 | 7.0 | <0.001 |
| | Intermediate | 9.2 | 7.1 | 11.1 | |
| | Ideal | 84.9 | 88.4 | 81.9 | |
| **Blood pressure** | Poor | 18.6 | 20.2 | 17.2 | <0.001 |
| | Intermediate | 34.7 | 42.5 | 27.8 | |
| | Ideal | 46.7 | 37.3 | 55.0 | |
| **Fasting blood glucose** | Poor | 26.8 | 26.1 | 27.4 | 0.690 |
| | Intermediate | 3.8 | 3.7 | 3.9 | |
| | Ideal | 69.4 | 70.2 | 68.7 | |
| **CVH** | | | | | |
| Poor (0–2 ideal metrics) | | 24.8 | 28.6 | 21.4 | <0.001 |
| Intermediate (3–4 ideal metrics) | | 55.9 | 55.1 | 56.6 | |
| Ideal (5–7 metrics) | | 19.4 | 16.3 | 22.1 | |
| Ideal[a] | | 0.2 | 0.1 | 0.3 | <0.001 |
| Intermediate[b] | | 26.6 | 22.8 | 30.0 | |
| Poor[c] | | 73.2 | 77.1 | 69.8 | |

a All 7 CVH metrics at ideal levels in the absence of CVD. b At least 1 of 7 CVH metrics at intermediate levels, no poor CVH metrics in participants without cardiovascular disease (CVD) history or if all 7 CVH metrics are ideal among persons with a CVD history. c At least 1 of 7 CVH metrics at a poor level in participants without a CVD history or at least 1 metric is intermediate or poor among persons with a CVD history[13,23].

*Physical activity (PA)*
Number of days of physical activity were ascertained by the question: 'During the past 30 days, other than your regular job, on how many days did you participate in any physical activities or exercises such as running, sports, walking, or going to the gym, specifically for exercise?'. The physical activity was then defined as: poor=0 days/month, intermediate=1–29 days/month, and ideal=30 days/month[24].

**Cardiovascular health factors**
*Total cholesterol (TC)*
TC is classified as poor for TC ≥6.3 mmol/L (≥240 mg/dL), intermediate for 5.2–6.2 mmol/L (200–239 mg/dL) or treated for TC <5.2 mmol/L (<200 mg/dL), and ideal for <200 mg/dL and without any cholesterol-lowering medication.

*Fasting blood glucose (FBG)*
FBG is defined as poor for glucose ≥ 7.0 mmol/L (≥126 mg/dL), intermediate for 5.6–6.9 mmol/L (100–125 mg/dL) or treated for <100 mg/dL, and ideal for <5.6 mmol/L (<100 mg/dL) and without any glucose-lowering medication.

*Blood pressure (BP)*
BP is defined as poor for systolic/diastolic pressures ≥140/≥90 mmHg, intermediate for 120–139 /80–89 mmHg or treated for <120/<80 mmHg, and ideal for <120/<80 mmHg and without any antihypertensive medication.

The seven CVH items were dichotomized as 1=ideal and 0=not ideal, and grouped into 0–2, 3–4, and 5–7 ideal CVH metrics; 5–7 ideal metrics includes the absence of any previous CVD. Furthermore, three additional CVH categories were created as follows: 1) ideal CVH is all seven health metrics at ideal levels in the absence of any previous CVD; 2) intermediate CVH is at least one health metric at the intermediate level, but no poor CVH metrics; and 3) poor CVH is at least one of seven CVH metrics at poor level[8,9,26]. Ideal health behavior was defined as the simultaneous presence of 4 ideal health behaviors (adequate PA, non-smoker, normal BMI, and healthy diet) and ideal health factors as the simultaneous presence of 4 ideal health factors (non-smokers, normal BP, normal FBG, and normal TC)[8,9,26].

History of CVDs included self-reported coronary heart disease: angina, also called angina pectoris; a heart attack (also called myocardial infarction); stroke; and any kind of heart condition, or other heart disease (yes/no responses)[23].

Sociodemographic covariates included age (years), sex (male, female), past year household income (US$: <5000, 5000–9999, 10000–14999, 15000–19999, and ≥20000), education level (none, primary school/elementary completed, middle school completed, high school completed, vocational or technical training school completed, college or university completed), ethnicity (Marshallese, other), and work status (government employee, non-government employee, self-employed, non-paid, retired, student, homemaker, unemployed–able to work, unemployed–unable to work)[23].

**Statistical analysis**
All statistical analyses were conducted with STATA software version 14.0 (Stata Corporation, College Station, TX, USA). Descriptive statistics were used to describe CVH metrics across ideal, intermediate, and poor CVH. Chi-squared tests were applied for assessing differences in proportions and Student's t-test for differences in means. Unadjusted and adjusted logistic regressions were used to assess the associations between sociodemographic factors and meeting 5–7 CVH metrics, overall and stratified by sex. Covariates in the multivariable logistic regression models were age, sex, education level, household income, work status, and ethnicity. A $p<0.05$ was accepted as significant, and missing values were excluded from the analysis.

## RESULTS

**Sample characteristics**
The sample included 2688 adults, aged ≥18 years with a median age of 37 years (IQR: 29–49), of which 46.7% were male. Majority (74.2%) had high school or higher education level, 51.0% were employed, 38.1% had a household income <US$10000, and 97.3% were of Marshallese ethnicity. The mean BMI of the respondents was 30.0 kg/m$^2$, the mean systolic BP was 120.4 mmHg, the mean FBG was 133.2 mg/dL, and the prevalence of self-reported CVD was 4.2%. Compared to men, women had a lower education level, lower employment status, lower household income, more likely to be Marshallese, lower systolic BP, and having a higher mean BMI (Table 1).

**Distribution of cardiovascular health metrics**
Approximately, 75.9% of Marshall Islands adults reported that they did not smoke (54.8% in men and 94.3% in women). About one in four participants (26.4%) had ideal BMI (31.6% in men and 21.9% in women), and 35.4% had ideal physical activity (41.8% in men and 29.8% in women). A low proportion of healthy diet (≥4.5 servings of fruit and vegetables/day) of 6.4% was reported (5.3% among men and 7.5% among women). Most Marshall Islands adults had ideal total cholesterol (84.9%) and fasting glucose levels (69.4%), while only 46.7% had ideal blood pressure. More women than men had ideal smoking, ideal diet, and ideal blood pressure, while men had significantly higher ideal BMI, PA, and TC, than women. Almost one in ten (24.8%) of respondents had poor CVH (0–2 ideal metrics), 55.9% intermediate CVH (3–4 ideal metrics), and 19.4% ideal CVH (5–7 ideal metrics). Only 0.2% had ideal CVH (all 7 metrics), 26.6% intermediate CVH (≥1 metric in the intermediate category and none in the poor category), and 73.2% had poor CVH (≥1 metric in poor category). Women had better CVH

**Table 3. Distribution of ideal cardiovascular health (CVH) metrics in percent among participants (N=2688)**

| Variable | Sample | Proportion of ideal CVH metrics | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **All** | 2688 | 0.6 | 4.4 | 16.6 | 30.7 | 27.6 | 15.7 | 4.2 | 0.2 |
| **Age** (years) | | | | | | | | | |
| 18–29 | 740 | 0 | 1.2 | 7 | 22.4 | 34.2 | 23.6 | 11.1 | 0.4 |
| 30–49 | 1314 | 0.7 | 3.7 | 16.7 | 34.3 | 27.7 | 14.8 | 2 | 0.2 |
| ≥50 | 620 | 1 | 10 | 28.1 | 32.9 | 18.9 | 8.2 | 1 | 0 |
| **Sex** | | | | | | | | | |
| Female | 1432 | 0.2 | 3.6 | 14 | 29.6 | 29.7 | 17.2 | 5.3 | 0.3 |
| Male | 1254 | 1 | 5.3 | 19.6 | 31.9 | 25 | 14 | 3 | 0.1 |
| **Education level** | | | | | | | | | |
| <High school | 691 | 0.7 | 4.3 | 20.7 | 30.8 | 27.9 | 13.2 | 2.3 | 0 |
| High school | 1499 | 0.5 | 4.4 | 14.8 | 30.6 | 28 | 16.5 | 4.8 | 0.3 |
| >High school | 492 | 0.4 | 4.7 | 16.7 | 30.9 | 25.6 | 16.7 | 5.1 | 0 |
| **Past year household income** (US$) | | | | | | | | | |
| <10000 | 1023 | 0.6 | 4.4 | 19 | 30.4 | 27.2 | 14.7 | 3.8 | 0 |
| ≥10000 | 440 | 0.9 | 6.4 | 17.3 | 30.9 | 23.9 | 17.7 | 2.5 | 0.5 |
| Do not know/refused to answer | 1233 | 0.5 | 3.8 | 14.6 | 29.4 | 29.5 | 16.3 | 5.6 | 0.3 |
| **Work status** | | | | | | | | | |
| Employed | 1360 | 0.8 | 5.1 | 19.9 | 32.3 | 25.7 | 13.5 | 2.4 | 0.1 |
| Unemployed | 594 | 0.5 | 3.5 | 12.1 | 30.3 | 31 | 17.3 | 5.1 | 0.2 |
| Other | 715 | 0.1 | 3.9 | 14.3 | 27.8 | 28.1 | 18.3 | 7.1 | 0.3 |
| **Ethnicity** | | | | | | | | | |
| Marshallese | 2612 | 0.5 | 4.4 | 16.7 | 30.6 | 27.5 | 15.8 | 4.3 | 0.2 |
| Other | 73 | 1.4 | 5.5 | 16.4 | 32.9 | 30.1 | 11 | 2.7 | 0 |

metrics than men in the two measures (Table 2).

**Proportion of ideal cardiovascular health metrics**

In all, 0.6% had zero, 4.4% one, 16.6% two, 30.7% three, 27.6% four, 15.7% five, 4.2% six, and 0.2% all seven, ideal CVH metrics (Table 3). A total of 24.9% participants were ideal on all 4 health factors, but only 0.4% were ideal on all 4 health behaviors, the proportion of all 4 health factors was significantly higher among women (35.3%) than men (13.2%) ($p<0.001$) but were similar between the sexes for all 4 health behaviors (0.6% among women and 0.3% among men) ($p>0.05$).

**Associations with meeting 5–7 ideal CVH metrics**

In adjusted logistic regression analysis, older age (30–49 years and ≥50 years) (AOR=0.41; 95% CI: 0.32–0.51, and AOR=0.20; 95% CI: 0.15–0.29, respectively) and male sex (AOR=0.72; 95% CI: 0.58–0.89) were negatively associated with meeting 5–7 ideal CVH metrics. In addition, in unadjusted analysis, higher education level, not knowing their household income, unemployed, and home maker, student, retired or non-paid work status, were positively associated with meeting 5–7 ideal CVH metrics. Similar results were found for gender stratified analyses (Tables 4 and 5).

**Table 4. Associations with meeting 5–7 ideal cardiovascular health metrics for both sexes**

| Variables | OR (95% CI) | p | AOR (95% CI)* | p |
|---|---|---|---|---|
| **Age** (years) | | | | |
| 18–29 (Ref.) | 1 | | 1 | |
| 30–49 | 0.37 (0.30–0.46) | <0.001 | 0.41 (0.32–0.51) | <0.001 |

Continued

**Table 4.** Continued

| Variables | OR (95% CI) | p | AOR (95% CI)* | p |
|---|---|---|---|---|
| ≥50 | 0.18 (0.13–0.26) | <0.001 | 0.20 (0.15–0.29) | <0.001 |
| **Sex** | | | | |
| Female (Ref.) | 1 | | 1 | |
| Male | 0.69 (0.56–0.83) | <0.001 | 0.72 (0.58–0.89) | 0.003 |
| **Education level** | | | | |
| <High school (Ref.) | 1 | | 1 | |
| High school | 1.51 (1.18–1.93) | <0.001 | 1.22 (0.93–1.59) | 0.147 |
| >High school | 1.55 (1.15–2.19) | 0.005 | 1.28 (0.91–1.79) | 0.154 |
| **Household income** (US$) | | | | |
| <10000 (Ref.) | 1 | | 1 | |
| ≥10000 | 1.15 (0.86–1.52) | 0.351 | 1.24 (0.91–1.69) | 0.172 |
| Do not know/refused response | 1.30 (1.05–1.61) | 0.019 | 1.01 (0.79–1.27) | 0.963 |
| **Work status** | | | | |
| Employed (Ref.) | 1 | | 1 | |
| Unemployed | 1.55 (1.22–1.98) | <0.001 | 1.21 (0.91–1.61) | 0.198 |
| Other | 1.84 (1.47–2.30) | <0.001 | 1.29 (0.99–1.67) | 0.059 |
| **Ethnicity** | | | | |
| Other (Ref.) | 1 | | 1 | |
| Marshallese | 1.53 (0.77–2.99) | 0.22 | 1.23 (0.61–2.50) | 0.568 |

*AOR: adjusted odds ratio; adjusted for age group, sex, education level, household income, work status, and ethnicity.

**Table 5. Associations with meeting 5–7 ideal cardiovascular health metrics for men and women separately**

| Variables | OR (95% CI) | p | AOR (95% CI)* | p |
|---|---|---|---|---|
| **Women** | | | | |
| **Age** (years) | | | | |
| 18–29 (Ref.) | 1 | | 1 | |
| 30–49 | 0.34 (0.26–0.45) | <0.001 | 0.37 (0.28–0.50) | <0.001 |
| 50–69 | 0.13 (0.08–0.21) | <0.001 | 0.15 (0.09–0.24) | <0.001 |
| **Education level** | | | | |
| <High school (Ref.) | 1 | | 1 | |
| High school | 1.79 (1.30–2.47) | <0.001 | 1.28 (0.90–1.83) | 0.173 |
| >High school | 2.01 (1.34–3.02) | <0.001 | 1.49 (0.94–2.34) | 0.088 |
| **Household income** (US$) | | | | |
| <10000 (Ref.) | 1 | | 1 | |
| ≥10000 | 1.08 (0.72–1.61) | 0.727 | 1.05 (0.68–1.63) | 0.814 |
| Do not know/refused response | 1.14 (0.86–1.50) | 0.374 | 0.93 (0.69–1.26) | 0.635 |
| **Work status** | | | | |
| Employed (Ref.) | 1 | | 1 | |
| Unemployed | 1.35 (0.97–1.87) | 0.076 | 1.24 (0.85–1.81) | 0.263 |
| Other | 1.35 (1.01–1.81) | 0.046 | 1.09 (0.79–1.51) | 0.606 |

Continued

**Table 5.** Continued

| Variables | OR (95% CI) | p | AOR (95% CI)* | p |
|---|---|---|---|---|
| **Ethnicity** | | | | |
| Other (Ref.) | 1 | | 1 | |
| Marshallese | 1.55 (0.51–4.71) | 0.441 | 1.55 (0.51–4.71) | 0.441 |
| **Men** | | | | |
| **Age** (years) | | | | |
| 18–29 (Ref.) | 1 | | 1 | |
| 30–49 | 0.39 (0.28–0.55) | <0.001 | 0.49 (0.34–0.72) | <0.001 |
| 50–69 | 0.27 (0.18–0.43) | <0.001 | 0.28 (0.17–0.45) | <0.001 |
| **Education level** | | | | |
| <High school (Ref.) | 1 | | 1 | |
| High school | 1.20 (0.82–1.75) | 0.35 | 1.02 (0.68–1.52) | 0.94 |
| >High school | 1.19 (0.76–1.88) | 0.451 | 0.90 (0.54–1.50) | 0.686 |
| **Household income** (US$) | | | | |
| <10000 (Ref.) | 1 | | 1 | |
| ≥10000 | 1.31 (0.87–1.97) | 0.2 | 1.54 (0.99–2.40) | 0.057 |
| Do not know/refused response | 1.43 (1.01–2.03) | 0.046 | 1.14 (0.78–1.67) | 0.5 |
| **Work status** | | | | |
| Employed (Ref.) | 1 | | 1 | |
| Unemployed | 1.56 (1.07–2.29) | 0.022 | 1.13 (0.72–1.77) | 0.598 |
| Other | 2.59 (1.76–3.81) | <0.001 | 2.03 (1.28–3.20) | 0.002 |
| **Ethnicity** | | | | |
| Other (Ref.) | 1 | | 1 | |
| Marshallese | 1.02 (0.40–2.59) | 0.962 | 1.02 (0.40–2.59) | 0.962 |

*AOR: adjusted odds ratio; adjusted for age group, sex, education level, household income, work status, and ethnicity.

## DISCUSSION

The study presents, for the first-time, national data on the prevalence and distribution of CVH metrics in a national sample of adults in the Marshall Islands. The found prevalence of poor CVH (0–2 ideal metrics) (24.8%) and ideal CVH (5–7 ideal metrics) (19.4%), were similar to global estimates, mainly in high-income countries, of poor CVH (having 0–2 ideal metrics) (32.2%) and ideal CVH (having 5–7 ideal metrics) (19.6%)[10], but were lower than in China (33.0%, 5–7 ideal metrics)[15], and lower than in Nepal (51.6%, 5–7 ideal metrics)[16]. The proportions of ideal CVH metrics (all 7 metrics) (0.2%), intermediate CVH (≥1 metric in the intermediate category and none in the poor category) (26.6%) and poor CVH (≥1 metric in poor category) (73.2%) in this study, were similar to those in urban India (<0.1% had 7 ideal metrics)[17], Shandon in China (0.05% all 7 ideal metrics)[12], and those of rural area Northwest China, all 7 ideal metrics (0.0%), intermediate (no poor health metrics and at least one intermediate) (18.0%), and poor (any poor CV health metric) (82%)[13]. Our findings that the prevalence of ideal CVH is low indicate that significant efforts are needed to promote CVH to prevent CVD in the Marshall Islands.

Similar to the three best global estimates[10], this study showed that TC (84.9%), smoking (75.9%), and FGP (69.4%) had the highest prevalence of ideal status, while similar to the poorest global estimates[10], healthy diet (6.4%) had the poorest prevalence of ideal status in this study. The estimate of ideal PA (35.4%) in this study is similar to global estimates of PA (40.6%), and the ideal BMI (26.4%) is almost half of the global ideal BMI (40.3%)[10]. In the 2002 STEPS national survey (aged 15–64 years) in the Marshall Islands, a higher rate of ideal BMI (37.5%) was observed[27]. The high prevalence of ideal PA (35.4%) in this national study seems to be confirmed in the 2002 STEPS survey in the Marshall Islands (33.9% physically active, ≥600 MET-minutes/week)[28]. A low ideal healthy diet (fruit and vegetable consumption; 6.4%, <4.5 servings/day) was also found in the 2002 Marshall Islands STEPS survey (9.0%, <5 servings/day)[27]. The proportions of poor smoking were 45.2% among men and 5.7% among women in this study, which are similar to

those in the 2002 Marshall Islands STEPS survey (39.5% among men and 6.0% among women)[28]. Poor BP (18.6%) was in this study (aged ≥18 years) higher than in the 2002 Marshall Islands STEPS survey (10.5%, hypertension, aged 18–64 years)[27]. Poor FBG (26.8%) was similar to the 2002 survey (raised fasting blood glucose, capillary whole blood 6.1 mmol/L, or on medication, 29.8%)[27], and poor and intermediate TC (15.0%) was lower than in the 2002 survey (21.6% TC ≥5.2 mmol/L)[27]. Similar to the 2002 Marshall Islands STEPS survey, smoking and raised blood pressure were more frequent in men than in women, while obesity and raised TC occurred more often in women than in men[28].

A total of 24.9% participants were ideal on all 4 health factors, but only 0.4% were ideal on all 4 health behaviors; the proportion of all 4 health factors was significantly higher among women (35.3%) than men (13.2%) ($p<0.001$) but were similar between the sexes for all 4 health behaviors (0.6% among women and 0.3% among men) ($p>0.05$). Similar to a study in Northwest China[13], this study found that the proportion of having all 4 ideal health factors (24.9%) was significantly higher than those with all 4 ideal health behaviors (0.4%). The proportion of ideal CVH health factors was higher in women than in men, while the proportion of all 4 ideal CVH health behaviors did not significantly differ by sex. In a study in rural Uganda, ideal CVH health factors were higher in men than in women and ideal CVH health behaviors were higher in women than in men[19]. This result may indicate that the promotion of healthy behaviors should be emphasized to improve CVH[13]. A healthy diet (fruit and vegetable intake) was the least prevalent health metric (6.4%) in this study. Lack of affordability and availability of fruit and vegetables may be an influencing factor for the low intake of FV[29]. Consequently, a stark increase of the production and consumption of fruit and vegetable, and highlighting the benefits of the behavior through communication and education strategies, are urgently needed to improve CVH in the Marshall Islands[28].

Consistent with previous research[10,12,13,16,18,19], ideal CVH was higher among younger age groups (aged 8–29 years), among women, and those with higher education level in the unadjusted analysis. The overall better performance of women than men on ideal CVH may be largely explained by their high proportion of ideal smoking and ideal BP compared to men. Therefore, men should be particularly targeted, regarding tobacco and blood pressure control.

To improve CVH in the Marshall Islands, CVH behaviors should be improved through multidisciplinary interventions in individuals, health educators, policy makers, and public health professionals[30]. Comprehensive interventions may target promotion of body weight control, smoking cessation, healthy diets, and screening and control of high levels of blood sugar and blood pressure[7]. Study results may inform the NCD policy and plan of action in the Marshall Islands. Some NCD policies and legislation are in place in the Marshall Islands, but there are no policies or legislation on tobacco sales and licensing, tobacco industry interference, alcohol advertising, reduction of population salt consumption, controlling marketing of foods and drinks to children, and physical education in schools, and there is no enforcement of laws and regulations related to NCD risk factors in the Marshall Islands[31].

**Limitations**

Some variables were assessed by self-report, which may have biased responses, and the cross-sectional design precludes causative conclusions between assessed variables. Although 3029 adults participated in the survey, only 88.7% had complete information on all seven CVH metrics. Furthermore, we included only one healthy diet component (fruit and vegetable consumption) and not the original 5 components of the AHA healthy diet (≥4.5 cups/day fruits and vegetables, ≥3.5 ounce servings/week of fish, <1500 mg/day sodium, <450 calo¬ries/week of sweets/sugar, and ≥3 1-ounce servings/day whole grains)[8,9]. In addition, the physical activity definition was only based on one question on the frequency physical activity/exercise, not directly meeting the AHA definitions of: 'poor=none; intermediate=1–149 min/week, moderate intensity or 1–74 min/week vigorous intensity or 1–149 min/week moderate + vigorous; and ideal= ≥150 min/week moderate intensity or ≥75 min/week vigorous intensity or ≥150 min/week moderate + vigorous[8,9].

## CONCLUSIONS

The proportion of 5–7 ideal CVH metrics was low in Marshall Islands adults. Both primary and secondary prevention programs should be implemented to improve CVH in the Marshall Islands. The study found several factors associated with ideal CVH, which can be utilized in public health interventions. Future research may want to include more comprehensive measures on physical activity and healthy diet.

## REFERENCES

1. Cardiovascular diseases (CVDs). World Health Organization. June 11, 2021. Accessed November 11, 2020. https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds)
2. GBD 2019 Diseases and Injuries Collaborators. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10258):1204-1222. doi:10.1016/S0140-6736(20)30925-9
3. World Health Organization, Western Pacific Region. Noncommunicable Diseases in the Western Pacific Region: A Profile. World Health Organization, Western Pacific Region; 2012. Accessed April 18, 2022. https://apps.who.int/iris/bitstream/handle/10665/207510/9789290615637_eng.pdf?sequence=1&isAllowed=y
4. Ichiho HM, deBrum I, Kedi S, Langidrik J, Aitaoto N. An Assessment of Non-Communicable Diseases, Diabetes, and

Related Risk Factors in the Republic of the Marshall Islands, Majuro Atoll: A Systems Perspective. Hawaii J Med Public Health. 2013;72(5)(suppl 1):87-97. Accessed April 12, 2022. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3689459/pdf/hjmph7205_S1_0087.pdf

5. Ministry of Health, Republic of Marshall Islands. 'RMI NCD CRISIS RESPONSE PLAN': NCD EMERGENCY RESPONSE TOWARDS A HEALTHY RMI, Action Plan 2013-2018. April 12, 2017. Accessed July 5, 2021. https://www.iccp-portal.org/system/files/plans/MHL_B3_CRP_Final%20Draft_October%202013%20%281%29%20%281%29.pdf
6. D'Agostino RB, Vasan RS, Pencina MJ, et al. General Cardiovascular Risk Profile for Use in Primary Care: The Framingham Heart Study. Circulation. 2008;117(6):743-753. doi:10.1161/CIRCULATIONAHA.107.699579
7. Gyawali B, Mishra SR, Virani SS, Kallestrup P. Low levels of ideal cardiovascular health in a semi-urban population of Western Nepal: a population-based, cross-sectional study. Heart Asia. 2019;11(1):e011131. doi:10.1136/heartasia-2018-011131
8. Lloyd-Jones DM, Hong Y, Labarthe D, et al. Defining and Setting National Goals for Cardiovascular Health Promotion and Disease Reduction: The American Heart Association's Strategic Impact Goal Through 2020 and Beyond. Circulation. 2010;121(4):586-613. doi:10.1161/CIRCULATIONAHA.109.192703
9. Huffman MD, Capewell S, Ning H, Shay CM, Ford ES, Lloyd-Jones DM. Cardiovascular Health Behavior and Health Factor Changes (1988–2008) and Projections to 2020: Results From the National Health and Nutrition Examination Surveys. Circulation. 2012;125(21):2595-2602. doi:10.1161/CIRCULATIONAHA.111.070722
10. Peng Y, Cao S, Yao Z, Wang Z. Prevalence of the cardiovascular health status in adults: A systematic review and meta-analysis. Nutr Metab Cardiovasc Dis. 2018;28(12):1197-1207. doi:10.1016/j.numecd.2018.08.002
11. Younus A, Aneni EC, Spatz ES, et al. A Systematic Review of the Prevalence and Outcomes of Ideal Cardiovascular Health in US and Non-US Populations. Mayo Clin Proc. 2016;91(5):649-670. doi:10.1016/j.mayocp.2016.01.019
12. Ren J, Guo XL, Lu ZL, et al. Ideal cardiovascular health status and its association with socioeconomic factors in Chinese adults in Shandong, China. BMC Public Health. 2016;16(1):942. doi:10.1186/s12889-016-3632-6
13. Zhao Y, Yan H, Yang R, et al. Status of cardiovascular health among adults in a rural area of Northwest China: Results from a cross-sectional study. Medicine (Baltimore). 2016;95(28):e4245. doi:10.1097/MD.0000000000004245
14. Chang Y, Guo X, Chen Y, et al. Prevalence and Metrics Distribution of Ideal Cardiovascular Health: A Population-based, Cross-sectional Study in Rural China. Heart Lung Circ. 2016;25(10):982-992. doi:10.1016/j.hlc.2016.02.007
15. Bi Y, Jiang Y, He J, et al. Status of Cardiovascular Health in Chinese Adults. J Am Coll Cardiol. 2015;65(10):1013-1025. doi:10.1016/j.jacc.2014.12.044
16. Ghimire U, Shrestha N, Gyawali B, Pradhan PMS, Mishra SR. Prevalence of American Heart Association defined ideal cardiovascular health metrics in Nepal: findings from a nationally representative cross-sectional study. Int Health. 2020;12(4):325-331. doi:10.1093/inthealth/ihz088
17. Gupta B, Gupta R, Sharma KK, Gupta A, Mahanta TG, Deedwania PC. Low Prevalence of AHA-Defined Ideal Cardiovascular Health Factors: A Study of Urban Indian Men and Women. Glob Heart. 2017;12(3):219-225. doi:10.1016/j.gheart.2014.09.004
18. Machado LBM, Silva BLS, Garcia AP, et al. Ideal cardiovascular health score at the ELSA-Brasil baseline and its association with sociodemographic characteristics. Int J Cardiol. 2018;254:333-337. doi:10.1016/j.ijcard.2017.12.037
19. Magodoro IM, Feng M, North CM, et al. Female sex and cardiovascular disease risk in rural Uganda: a cross-sectional, population-based study. BMC Cardiovasc Disord. 2019;19(1):96. doi:10.1186/s12872-019-1072-9
20. van Nieuwenhuizen B, Zafarmand MH, Beune E, et al. Ideal cardiovascular health among Ghanaian populations in three European countries and rural and urban Ghana: the RODAM study. Intern Emerg Med. 2018;13(6):845-856. doi:10.1007/s11739-018-1846-6
21. Benziger CP, Zavala-Loayza JA, Bernabe-Ortiz A, et al. Low prevalence of ideal cardiovascular health in Peru. Heart. 2018;104(15):1251-1256. doi:10.1136/heartjnl-2017-312255
22. Velasquez-Melendez G, Felisbino-Mendes MS, Matozinhos FP, Claro R, Gomes CS, Malta DC. Ideal cardiovascular health prevalence in the Brazilian population - National Health Survey (2013). Rev Bras Epidemiol. 2015;18(suppl 2):97-108. doi:10.1590/1980-5497201500060009
23. Ministry of Health and Human Services. STEPS 2017: Marshall Islands, 2017 - 2018. World Health Organization, NCD Microdata Repository; 2020. Updated April 20, 2020. Accessed August 22, 2020. https://extranet.who.int/ncdsmicrodata/index.php/catalog/742
24. Ritz S, Cash H. Republic of the Marshall Islands Hybrid Survey, Final Report, 2018. Republic of the Marshall Islands, Ministry of Health & Human Services; 2018. Accessed January 3, 2021. https://cdn.who.int/media/docs/default-source/ncds/ncd-surveillance/data-reporting/marshall-islands/rmi-report-12_july_2018.pdf?sfvrsn=43cd8b6f_1&download=true
25. Pengpid S, Peltzer K. Ideal Cardiovascular Health in a Nationally Representative Population-Based Sample of Adults in Malawi. Glob Heart. 2021;16(1):24. doi:10.5334/gh.986
26. Folsom AR, Yatsuya H, Nettleton JA, et al. Community Prevalence of Ideal Cardiovascular Health, by the AHA Definition, and Relation to Cardiovascular Disease Incidence. J Am Coll Cardiol. 2011;57(16):1690-1696. doi:10.1016/j.jacc.2010.11.041
27. World Health Organization. Marshall Islands STEPS Survey Fact Sheet. Accessed January 3, 2021. https://catalog.ihsn.org/index.php/catalog/6965/related-materials
28. NCD Risk Factors STEPS Report 2002. Ministry of Health Republic of the Marshall Islands, World Health Organization

- Western Pacific Region; 2002. Accessed January 3, 2021. https://catalog.ihsn.org//catalog/6965/download/82541
29. Seron P, Irazola V, Rubinstein A, et al. Ideal Cardiovascular Health in the southern cone of Latin America. Public Health. 2018;156:132-139. doi:10.1016/j.puhe.2017.12.017
30. Moghaddam MM, Mohebi R, Hosseini F, et al. Distribution of ideal cardiovascular health in a community-based cohort of Middle East population. Ann Saudi Med. 2014;34(2):134-142. doi:10.5144/0256-4947.2014.134
31. Win Tin ST, Kubuabola I, Ravuvu A, et al. Baseline status of policy and legislation actions to address non communicable diseases crisis in the Pacific. BMC Public Health. 2020;20(1):660. doi:10.1186/s12889-020-08795-2

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The data supporting this research are available from the World Health Organization NCD Microdata Repository at https://extranet.who.int/ncdsmicrodata/index.php/catalog

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