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Carlen A. Stadnik Date

The Cascade of Diabetes Care in the Republic of the Marshall Islands: Investigation of the Gaps in Diabetes Screening and Management

By

Carlen A. Stadnik

Master of Public Health

Hubert Department of Global Health

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Shivani A. Patel, PhD

Committee Chair

____

Stacy De Jesus, MPH

Committee Member

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By

Carlen A. Stadnik

Bachelor of Science in Nutritional Sciences, 2015

The Pennsylvania State University

Committee Chair: Shivani A. Patel, PhD

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Abstract

The Cascade of Diabetes Care in the Republic of the Marshall Islands: Investigation of the Gaps in Diabetes Screening and Management

By Carlen A. Stadnik

Aims: The prevalence of diabetes in the Republic of Marshall Islands (RMI) has doubled in the past 25 years, yet there are few data regarding diabetes screening and self-management practices in RMI. We applied a Cascade of Care framework to understand diabetes detection and management among RMI adults.

Methods: Data were from RMI's 2018 population-based Hybrid Survey (n=2,869 aged 18+). This survey combined questionnaire data with physical (height, weight, and blood pressure) and biochemical (fasting blood glucose and blood cholesterol) measurements to assess prevalence of diabetes and related risk factors in RMI. All descriptive analyses were performed in the total sample and by socio-demographic characteristics. Diabetes status was classified as previously diagnosed, newly diagnosed at the time of survey, or no diabetes. We examined the prevalence of NCD risk factors and morbidities by diabetes status. We also described four indicators of the diabetes Cascade of Care: diabetes awareness, receipt of treatment, controlled fasting blood glucose, and multiple risk-factor control. Engagement with care and self-management behaviors by diabetes status were also described. We estimated unadjusted and adjusted multiple logistic regression models to evaluate the association between selected socio-demographic characteristics and multiple risk-factor control.

Results: The prevalence of diabetes was 24.7% (95% CI: 23.1-26.3) in the total sample. The prevalence of previously diagnosed diabetes was 12.5% while the prevalence of newly diagnosed diabetes was 15.7%. Among those with prevalent diabetes (n=810), 44.4% were aware that they had diabetes, 8.3% were receiving treatment for diabetes, 12.6% had controlled fasting blood glucose, and 10.2% had controlled multiple risk factors. We observed significant bivariate associations of age, sex, region of residence, and education level with multiple risk factor control. In fully adjusted analyses, only urban region of residence (OR: 2.7, 95% CI: 1.2-6.0; ref=rural) was statistically significantly associated with multiple risk factor control.

Conclusion: The prevalence of diabetes in RMI is double the global average. Less than half of RMI adults with diabetes are aware of their disease status, and fewer than one in ten adults is being treated for diabetes. Findings motivate urgent attention for proactive prevention, screening, and management interventions for diabetes.

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Background

Diabetes in the global context

An estimated 463 million adults, or 1 in 11 adults (aged 20-79 years), are living with diabetes mellitus worldwide. The epidemic of adult on-set type 2 diabetes mellitus affects nearly 285 million people, globally—forecasted to affect 438 million people by the year 2030 [26, 28], and 642 million by 2040 [30]. This non-communicable disease (NCD) displays ethnic and regional variability across the globe, especially in areas that have been rapidly industrialized [26]. Globalization, economic development, and changes in lifestyle (for example, diet and physical activity) have been associated with increased rates of diabetes mellitus [4, 23, 24].

Diabetes mellitus is a heterogeneous syndrome classified as several diseases—type 1, type 2, and gestational diabetes mellitus, as well as others. While these diseases have different etiologies, they share the same denominator of excess glucose in the blood stream and have similar signs, symptoms, and complications. Type 1 diabetes is a genetic disorder of the immune system, which can develop at any age but is more common in children [10]. Type 2 diabetes (90% of all diabetes cases), traditionally labeled as “adult on-set diabetes,” is largely characterized by insulin resistance [10]. Some individuals may also develop type 2 diabetes in adulthood due to insulin secretion deficiencies; common among South Asians [21]. There is still much that is not known about the causes of diabetes mellitus. The pathophysiology is complex and our understanding is always evolving [8, 21].

Without proper management, we know that diabetes can lead to life-threatening and disabling complications, such as the following microvascular diseases: neuropathy, nephropathy (for example, kidney failure and end-stage renal disease), adult on-set blindness, and limb amputations. Resulting macrovascular conditions include cardiovascular diseases (heart disease, myocardial infarctions, and more) [1, 3]. These complications cause an economic toll as well, by greatly increasing health care costs to account for therapies [1]. "Annual global health expenditure on diabetes is estimated to be USD 760 billion [10]." The ability to meet the complex needs of persons with diabetes is particularly constrained in settings with poor healthcare infrastructure, such as is the case in many low and middle income countries (LMICs).

Diabetes in the US-affiliated Pacific Islands

The US-affiliated Pacific Islands (USAPI) experience some of the highest levels of diabetes in the world. According to the International Diabetes Federation (IDF), about "163 million adults (aged 20-79 years) have diabetes in the Western Pacific Region; the highest of all IDF Regions. This is 33% of the world's total count of adults with diabetes, in this age group. Nearly 137 million adults aged 20-79 years have impaired glucose tolerance as well; also the highest of all IDF Regions [10]." The diabetes epidemic has been associated with lifestyle changes due to globalization and Western influence in the USAPI [4]. Pacific Islanders have experienced a disproportionally high burden of health disparities. They have one of the highest rates of type 2 diabetes in the world [7]; 23.7% were reported to have type 2 diabetes in 2010, according to the Centers for Disease Control and Prevention (CDC) [18]

The Republic of the Marshall Islands (RMI) belongs to the US-affiliated Pacific Islands (USAPI), holding a Compact of Free Association with the U.S. [27]. RMI is an independent, sovereign republic of Micronesia, as of 1986; classified as an upper-middle income country by The World Bank [13]. This family of islands covers approximately 70 square miles of land but spreads over 750,000 square miles over the central Pacific Ocean, with 23 inhabited islands and atolls (*i.e.* coral reef islands encircling a lagoon). [28]. The total population is about 59,246, and is rapidly growing [11]. Over 73% of the population resides in the urban capital of Majuro. Other district centers include: Ebeye, Wotje, and Jaluit [13]. A map of RMI is shown as *Figure 3* (*p.* 41) in the Appendix.

Historical context and the diabetes burden in The Republic of the Marshall Islands

Notably, the Marshallese have faced severe trauma throughout their history that has impacted their health. Shortly after World War II, the U.S. took control over the islands from the Japanese, who invaded their nation [19]. The U.S. Navy conducted nuclear tests in RMI, from 1946 to 1958 [11]. An equivalent of 7,200 Hiroshima-sized bombs were tested, which contaminated their wildlife, water, and food supply [12]. Hundreds had to relocate from their homes, and were exposed to radioactive fallout. Until this day, there are concerns about the effects of this nuclear testing on the health of Marshallese people [11]—who live in one of the highest levels of nuclear contamination in the world [30],which has intoxicated their food and water supply.

Along with the other USAPIs, RMI has declared a national emergency on NCDs, which have replaced infectious diseases as the leading causes of morbidity and mortality in RMI [4]. RMI national NCD policy has prioritized addressing diabetes as its primary focus [13]. The Marshallese refer to diabetes as the “silent-killer.” Many don’t realize they have it “until it strikes really bad [9].” Prior studies indicate that roughly 28%-32% of adults in RMI have diabetes [10]. Annual mortality for Marshallese with diabetes increased by 125%, from 52.2 deaths per 100,000 people, in 1990, to 11.7.3 per 100,000 people, in 2010 [6]. Type 2 diabetes has accounted for nearly 30% of deaths from 1996 to 2000, according to the RMI Bureau of Health Statistics—the leading cause of death [25]. Diabetes foot disease is among the most common diabetes complications in RMI, leading to amputations. Socio-demographics, such as socioeconomic status, region of residence (urban versus rural), access to health care, and more have been shown to affect the health status and prevalence of diabetes [13]. RMI's poor infrastructure, limited resources, and high health care costs have made managing diabetes difficult for this nation—all partly resulting from the traumatic history.

Marshallese cultural norms, beliefs, and perceptions

Diabetes, pronounced *"naninmij in tonal*" in Marshallese, is associated with stigma in RMI—including, shame, embarrassment, and perceived weakness when it comes to medication compliance. This stigmatized view of diabetes can lead to care delays—acting as a barrier that prevents people from seeking treatment, until severe treatment is necessary, such as amputation [4, 16].

Diet and physical inactivity are among the leading behavioral risk factors for the development of diabetes [23, 24]. When it comes to food, RMI has undergone a shift from local/traditional staples (such as breadfruit and taro) to food high in saturated fat, sugar, refined foods, and foods low in fiber [4, 29]. White rice is the staple/main starch for all three meals, and fruits and vegetables are not often consumed. Imported produce is costly, and there is a strong fear associated with eating locally sourced food due to nuclear soil, water, and fish contamination [28]. The majority of food products are imported via container ships, which provide the Islanders with cheaper packaged/processed food [28]

Poor nutritional value of the food supply has led to undernutrition in children and high obesity rates in adults [29]. Population-level dietary changes such as increased dietary fat intake, reduced fiber intake, and reduced physical activity are drivers of the rise of obesity. According to

Ritz and Cash [27], 73% of adults in RMI are overweight or obese. RMIs high prevalence of obesity is closely linked to diabetes, most likely the strongest modifiable/risk factor predictor for diabetes [13, 18]. In addition, larger body sizes are valued and perceived as attractive. This serves as a potential barrier for interventions seeking to prevent diabetes by addressing its primary risk factor, obesity [28, 4].

Engagement in care and risk-factor control

According to Bohanny W, *et al*. (2013), self-care behavior is defined as “decisions and actions that an individual can take to cope with a health problem to improve his or her health [3].” The American Diabetes Association (ADA), recommends the following standards for diabetes treatment, solely or in combination, to reduce the incidence of costly and disabling micro- and macrovascular diseases: improved glycemic control, healthy lifestyle and self-care behaviors, consisting of a eating a healthy diet, maintaining a healthy body weight, regular physical activity, limited alcohol consumption, abstention from tobacco, proper use of prescribed medication, daily monitoring of blood glucose levels, regular doctor visits, and foot exams [1, 7]. Although there is limited literature on Marshallese diabetes-related behaviors, we know that Marshallese living with type 2 diabetes have reported low levels of diabetes self-care activities [9, 7].

Multiple risk-factor control of improving glycemic control, lowering blood pressure, and reducing cholesterol levels, is associated with decreased incidence of mortality from diabetes and long-term reductions of macrovascular diseases [2]. Engagement with care has been proven to control risk factors, and slow the progression to complications. Therefore, guidelines for diabetes care are recommended for risk-factor control and regular screening for complications in order to treat conditions related to diabetes in the early stages [2].

The Cascade of Care framework applied to diabetes

The concept of the "Cascade of Care" visualizes estimates of people affected by a condition, and who are receiving the care and treatment they need [1]. It can aid in prioritizing efforts to address gaps in awareness of diabetes status, combined risk-factor control, and significant disparities by socio-demographic factors (for example age, sex, marital status, education level, household income, *etc*.). This approach was successful in monitoring and addressing the implementation gaps in the HIV/AIDS epidemic care (for example, diagnosis, engagement, care retention, adherence to treatment, and viral suppression). It has also been increasingly applied to diabetes, to better understand gaps in the care continuum, from detection of disease to disease control [1, 2, 15].

Objectives

Our aim with this research was to quantify the Cascade of Care using representative community data in the RMI—to visualize the gaps in diagnosis, awareness, treatment, control of fasting blood glucose and multiple risk factors, as well as the engagement in diabetes self-management. Understanding the cascade of diabetes care in RMI can aid public health professionals at organizations, such as the CDC and PIHOA, to target gaps by strengthening current projects/programs, as well as implementing new interventions.

Methods

Data source

The 2018 Republic of the Marshall Islands (RMI) Hybrid Survey was the first population-based survey assessing the prevalence of non-communicable diseases (NCDs) and risk factors in RMI. Partners include the Center for Disease Control (CDC; PI: Stacy De Jesus); World Health Organization (WHO; PI Dr. Wendy Snowdon); and the Pacific Island Health Officer's Association (PIHOA; PI Dr. Haley Cash). The hybrid survey was composed of questions from validated data collection instruments, including: the Behavioral Risk Factor Surveillance System (BRFSS), the STEPwise approach to surveillance (STEPS), and the National Health and Nutritional Examination Survey (NHANES). In addition to the survey, participants underwent physical and biochemical measurements [28]. Permission to access the de-identified hybrid survey data for conducting this secondary analysis was received from the RMI Bureau of Primary Health Care Services, Ministry of Health and Human Services on February 20th, 2020.

Sample selection

The inclusion criteria for eligible survey participants were RMI adult residents (age ≥18 yo, n = 3,107), residing in Majuro (n = 1,659), Kwajalein (n = 627), Arno (n = 207), Jaluit (n = 207), Wotje (n = 207), and Kili (n = 200) atolls, who were able to comprehend English or Marshallese (the local language), and provided consent. Sampling procedures occurred in two stages. In Stage 1, the country was stratified to urban islands (Majuro and Kwajalein) and rural outer atolls (Arno, Jaluit, Wotje, and Kili). Households were identified through random selection, using cluster sampling in the urban residential region [28]. For Stage 2, in the urban region, one participant was selected per household using the Kish method [14]. The adult populations were about 200 in each of these atolls; thus, all adults in the rural outer atolls were included in the sample. The final survey response rate was 92.3% (n = 2,869). Given the high response rate and the self-weighted sampling design, no survey weights were developed for the analysis [28]

Data collection

Data collection began on July 7th, 2017 and ended on April 5th, 2018. The survey was available in both English and Marshallese. Trained surveyors, recruited by the Marshall Islands Epidemiology Prevention Initiative (MIEPI), conducted household visits to collect hybrid survey data electronically, using a tablet. Data from the tablets were uploaded on a weekly basis at the MIEPI office. Throughout the questionnaire-processing phase, quality control was ensured at different stages. This was followed by fasting anthropometric/physical and biochemical measurements the next morning [28]

Diabetes status

Diabetes status was classified into three categories: those with previously diagnosed diabetes, those with newly diagnosed diabetes, and those with no diabetes. Previously diagnosed diabetes was defined as adults *with* a prior diabetes diagnosis. Newly diagnosed diabetes was defined as adults *without* a prior diabetes diagnosis *and* high fasting blood glucose (≥ 126 mg/dL). Total diabetes was defined as adults *with* a prior diabetes diagnosis *or* high fasting blood glucose (≥ 126 mg/dL). Adults *without* a prior diabetes diagnosis and low fasting blood glucose (< 126 mg/dL) were defined as not having diabetes.

Indicators of the diabetes care cascade

Among the total sample with diabetes, we examined four indicators of the Cascade of Care. These included diabetes awareness, receipt of treatment for diabetes, controlled fasting blood glucose, and multiple risk-factor control. Diabetes awareness was defined as being previously diagnosed with diabetes, given high fasting blood glucose ($\geq$ 126 mg/dL) at the time of survey. Receipt of treatment was defined as taking oral medication and/or insulin. Controlled fasting blood glucose (FBG) was defined as having FBG <126 mg/dL at the time of survey, conditional on having diabetes. Multiple risk-factor control was defined as achievement of combined glucose, blood pressure, and cholesterol control (FBG <126 mg/dL and BP <130/80 mm Hg, and total cholesterol <240 mg/dL).

Engagement with diabetes care

Engagement with care and self-management behaviors among the diabetes groups were also defined using indicators described in the literature [1, 2, 15]. Self-care variables included health care practices, such as annual general, diabetes, foot, and dental examinations; diabetes-related tests, such as blood pressure, blood glucose, total cholesterol, and HbA1c checks. Self-care variables also included lifestyle variables related to nutrition (intake of fruit and vegetables, processed meat, sugar-sweetened beverages, sodium, and local vs imported food), substance use (tobacco, betel nut, alcohol, or other drug use), as well as physical activity (days of physical activity in the last month and time spent sitting per day).

Demographic characteristics and health risk factors

Socio-demographic characteristics were also taken into account. The selected socio-demographic characteristics included in the analysis were the following: age, sex, region of residence, education level, marital status, employment, household income, and health status. Among adults belonging to the diabetes categories, the prevalence of risk factors/morbidities were calculated as well, which included: fasting blood glucose, blood pressure, total cholesterol, body mass index (BMI), and self-reported chronic conditions.

Statistical analyses

Descriptive analysis included summarizing the distribution of socio-demographic characteristics in the total population. The prevalence of risk factors and morbidities were estimated in the total population and by diabetes status categories (previously diagnosed, newly diagnosed, and no diabetes). We evaluated gaps in the diabetes care cascade by computing the proportion of those who were aware, treated, controlled, and multiple risk-factor controlled. Diabetes prevalence and the diabetes care continuum by socio-demographic characteristics were calculated. Engagement with care and self-management behaviors were calculated among those with diabetes prevalence and stratified diabetes status categories.

Multiple logistic regression was performed to estimate the relative odds of multiple risk-factor control associated with each socio-demographic characteristic separately. Unadjusted and adjusted analyses included multiple logistic regression of multiple risk factor control accounting for all socio-demographic characteristics simultaneously. “Don’t know” and “refused” responses were treated as missing and excluded from the analysis. Data were analyzed using SAS.9.4.M6 (SAS Institute Inc, Cary, NC, USA).

Results

Table 1. Socio-demographic characteristics of adults across the RMI population

Table 1 describes the socio-demographic characteristics of the total sample (n=2,869). Participants were mostly middle-aged (52.2%, 95% CI: 50.4-54.1), female (52.6%, 95% CI: 50.8-54.5), living in an urban area (66.5%, 95% CI: 64.8-68.3), with an education of high school or less (81.1%, 95% CI 79.7-82.5), married (67.3%, 95% CI: 65.6-69.1), employed (51.3%, 95% CI 49.5-53.2), and with a household income of less than $10,000 (69.8%, 95% CI: 67.4-72.1). Most respondents regarded their health status as good or excellent (67.5%, 95% CI: 65.8-69.2). Notably, few participants were divorced or separated (0.6%, 95% CI: 0.3-0.9).

Table 2. Health risk factors and morbidities of the RMI population by diabetes status

The prevalence of previously diagnosed diabetes, newly diagnosed diabetes, and no diabetes was 12.5%, 15.7% and 71.8%, respectively (n = 2,869; Table 2). Among all adults surveyed, 17.8% (95% CI: 16.4-19.2) had high blood pressure (≥130/80 mm Hg), and 4.6% (95% CI: 3.8-5.4) had high total cholesterol (≥240 mg/dL). Most strikingly, the average BMI was 29.4 kg/m2 (SD: 6.5), which is considered overweight. 41.4% (95% CI: 39.6-43.2) of respondents were obese, or had BMI > 30 kg/m2. The prevalence of having a chronic condition, other than diabetes, was 22.7% (95% CI: 21.1-0.24.2), with the highest being ulcer (6.7%, 95% CI: 5.8-7.6), gout (5.8%, 95% CI: 4.9-6.6), and arthritis (4.3%, 95% CI: 3.5-5.0).

Among respondents who were previously diagnosed with diabetes (n = 2,869; Table 2), the average fasting blood glucose (204.9 mg/dL, SD: 99.4), average systolic blood pressure (132.3 mm Hg, SD: 73.6), average total cholesterol (173.2 mg dL, SD: 50.7), and high total cholesterol ≥ 240 mg/dL (8.9%, 95% CI: 5.9-11.9) were higher than those who were newly diagnosed with diabetes or did not have indication of diabetes. The prevalence of fasting blood glucose ≥126 mg/dL was 71.7% (95% CI: 67.0-76.3). Those with previously diagnosed diabetes had the highest prevalence of having another chronic condition (31.1%, SD: 26.3-35.9), with gout (10.3%, 95% CI: 7.1-13.4) being the highest, followed by arthritis (7.5%, 95% CI: 4.8-10.2) and ulcer (6.9%, 95 CI: 4.3-9.6).

High blood pressure ≥ 130/80 mg/dL (26.7%, 95% CI: 22.6-30.8) was most prevalent among those with newly diagnosed diabetes (n = 2,869; Table 2). Compared with adults with previously diagnosed and no diabetes, adults with newly diagnosed diabetes also had the highest average BMI (31.2 kg/m2, SD: 6.5), with 53.8% (95% CI: 49.2-58.4) having a BMI greater than 30 kg/m2. Ulcer 8.0%, 95% CI: 5.5-10.5), gout 6.7%, 95% CI: 4.3-9.0), and arthritis 6.0%, 95% CI: 3.8-8.2) were the most common chronic diseases.

Among those with no diabetes (n = 2,059; Table 2), the average BMI was 29.0 kg/m2 (SD: 6.6), with 39.2% (95% CI: 37.1-41.4) having a BMI over 30 kg/m2. The most common chronic diseases included: ulcer 6.4%, 95% CI: 5.3-7.4), gout (4.8%, 95% CI: 3.8-5.7), and heart conditions (4.0%, 95% CI: 3.2-4.9).

Figure 2. Cascade of care of diabetes for RMI adults aged 18 years or older with any diabetes (n=810)

Figure 2 displays the cascade of care among RMI adults with diabetes (n=810; Figure 1). Among those with diabetes prevalence, 44.4% (95% CI: 41.0-47.9) were aware of having diabetes, 12.6% (95% CI: 10.3-14.9) had controlled fasting blood glucose, 10.2% (95% CI: 8.2-12.3) had controlled multiple risk-factor control, and 8.3% (95% CI: 6.4-10.2) were treated with medication or insulin. These results were significant, based on the 95% CIs.

Table 3. Diabetes prevalence and diabetes care cascade among adults with diabetes in RMI by socio-demographic factors.

Among all n = 2,869 adults studied, the prevalence of diabetes was 28.2%, (Table 3). The prevalence of diabetes was over 50% among those aged 65 years or older (56.0%, 95% CI: 48.0-64.0), those who were widowed (55.9%; 95% CI: 46.4-65.2) and those who were retired (60.7%; 95% CI: 51.5-69.9), at the time of survey. Prevalent diabetes was also higher in those without a high school education (29.2%, 95% CI: 27.3-31.1; reference=high school completion or above) and those in poor health (35.7%, 95% CI: 32.6-38.8; reference=those in good health). Generally, the prevalence of diabetes was largely comparable across groups defined by sex, income, and urban region of residence.

Among all n = 810 adults with any diabetes (i.e., previously or newly diagnosed), the prevalence of diabetes awareness was 44.4%, (Table 3). The prevalence of diabetes awareness was over 50% among those aged 65 years or older (58.3%, 95% CI: 47.6-69.1), those with a high school education or higher (53.%, 95% CI: 44.4-61.8), those who were divorced/separated (60.0, 95% CI: -8.0-128.0 ~ not significant), those who were retired (64.7%, 95% CI: 53.0-76.4), and those who made an income higher than $20,000 (53.5%, 95% CI: 38.0-69.0).

In contrast, the prevalence of diabetes awareness was lowest for those aged 18-34 (31.1%, 95% CI: 23.2-39.0), females (40.7%, 95% CI 36.1-45.4), those living in a rural region (38.7%, 95% CI: 32.9-44.6), those with a household income less than USD 10,000 (47.6%, 95% CI: 41.9-53.2), those with a household income between USD 10,000 and 20,000 (40.2%, 95% CI 30.0-50.4), as well as those with excellent or very good health (42.6%, 95% CI: 38.1-47.0).

Among all n = 810 adults studied, the prevalence of treatment was 8.3%, (Table 3). The prevalence of diabetes treatment was highest among those aged 65 years or older (22.6%, 95%

CI: 13.5-31.8), those residing in an urban area (9.3%, 95% CI: 6.8-11.7), those with a level of high school education or higher (10.8%, 95% CI: 5.4-16.2), those who were divorced/separated (20.0%, 95% CI: -35.5-75.5 ~ not significant), retired (17.6%, 95% CI: 8.4-26.9), those with an income between USD 10,000 and 20,000 (9.8%, 95% CI: 3.6-16.0), and those with fair or poor health (8.8%, 95% CI: 5.7-11.8)

Among all n = 810 adults studied, the prevalence of controlled fasting blood glucose was 12.6%, (Table 3). The prevalence of controlled fasting blood glucose was highest among those aged 18-34 (22.2%, 95% CI: 15.1-29.3), males (16.4%, 95% CI: 12.6-20.1), residing in an urban area (15.8%, 95% CI: 12.7-18.9), more than a high school education (19.2%, 95% CI: 12.4-26.1), single/never married (18.8%, 95% CI: 11.6-26.0), students (21.4%, 95% CI: -3.2-46.0 ~ not significant), household income lower than USD 10,000 (13.0%, 95% CI: 9.2-16.8), and excellent/good health (13.8%, 95% CI: 10.7-16.9).

Among all n = 810 adults studied, the prevalence of controlled multiple risk-factors was 10.2%, (Table 3). The trends were similar to controlled fasting blood glucose. The prevalence of controlled fasting blood glucose was highest among those aged 18-34 (19.3%, 95% CI: 12.5-26.0), males (13.9%, 95% CI: 10.4-17.5), residing in an urban area (12.8%, 95% CI: 0.0-15.6), more than a high school education (19.2, 95% CI: 12.4-26.1), single/never married (16.2%, 95% CI: 9.5-23.0), students (21.4%, 95% CI: -3.2-46.0 ~ not significant), household income lower than USD 10,000 (10.4%, 95% CI: 7.0-13.9), and excellent/good health 11.3% (95% CI: 8.5-14.2)

Table 4. Engagement with care and self-management behaviors among adults with diabetes in RMI by diabetes awareness

Adults with prevalent diabetes (n = 810; Table 4) reported an average of 13.3 days (SD: 13.6) of physical activity in the past 30 days, and spent an average of 10.1 hours (SD: 21.9) sitting per day, and 98.1% (95% CI: 97.2-99.1) did not use other drugs such as marijuana or inhalants.

Engagement with care: A higher proportion of adults with previously diagnosed diabetes compared with newly diagnosed diabetes reported annual examinations (64.7%, 95% CI: 59.8-69.7 versus 47%, respectively. The following is a pattern seen with most behaviors: diabetes exam (72.3%, 95% CI 66.9-77.6), eye exam (34.2%, 95% CI: 29.2-39.1), foot exam (12.5%, 95% CI: 7.9-17.1), and dental exam (46.7%, 95% CI: 41.5-51.8). Ever having blood pressure tested (85.0%, 95% CI: 81.3-88.7), cholesterol tested (40.8%, 95% CI: 35.7-45.9), and blood glucose tested (100%) were also higher, as well as daily blood glucose monitoring (63.7%, 95% CI: 57.2-70.2), and annual HbA1c checks (45.0%, 95% CI: 38.2-51.8),

Behavioral factors: Among those with previously diagnosed diabetes (n = 360; Table 4), 6.1% (95% CI: 3.5-8.7) consumed greater than 5 average servings of fruits and vegetables per day, 82.5% (95% CI: 78.6-86.4) watched sodium intake, 31.9% (95% CI: 27.1-36.8) consumed mostly local food, 88.2% (95% CI: 84.9-91.6) didn't use tobacco, 90.0%, (95% CI: 86.9-93.3) didn't use betel nut, and 6.7% (95% CI: 4.1-9.3) did not use alcohol.

Among those with newly diagnosed diabetes (n = 450; Table 4), 80.0% (95% CI: 68.5-91.5) consumed less than 1 processed meat per day, 86.8% (95% CI: 75.6-98.1) consumed less than 1 sugar-sweetened beverage, and the majority consumed imported food (32.2%, 95% CI: 27.9-36.6).

Figure 3. Diabetes care and control measures for RMI adults aged 18 years or older with total diabetes (n=810)

Figure 3 displays diabetes care and control for RMI adults with diabetes (n=810; Figure 2). Among those with diabetes prevalence, 91.4% (95% CI: 9.4-93.3) had controlled total cholesterol, 86.3% (95% CI: 83.9, 88.7) didn't use tobacco, 73.7% (95% CI: 70.7, 76.7) had controlled blood pressure, 63.7% (95% CI: 57.2, 70.2) monitored blood glucose daily, 55.1% (95% CI: 51.6, 58.5) had an annual general check-up with a physician, 45.0% (95% CI: 38.2, 51.8) had an annual HbA1c check, 27.3% (95% CI: 24.1-30.6) had an annual diabetes check-up, 17.7% (95% CI: 15.0-20.3) had a normal BMI, 15.2% (95% CI: 12.7-17.7) had an annual eye exam, 5.7% (95% CI: 4.1-7.3) didn't use alcohol, 4.9% (95% CI: 3.3-6.4) consumed more than 5 servings of fruits and vegetables per day, and 3.8% (95% CI: 2.3-5.3) and had an annual foot check; results were significant, based on 95% CIs.

Table 5. Multiple logistic regression analysis of multiple risk-factor control by socio-demographic factors

The unadjusted highest odds ratios for multiple risk factor control (defined as within-target levels of blood pressure, blood glucose, and total cholesterol) were over twice as high among younger adults than older adults (OR = 2.6; 95% CI: 1.5-4.3 for the 18-34 age group versus age 65+), and also over twice as high among students (OR=2.5; 95% CI: 0.7-9.0 versus retired). Additionally, being male (OR=2.1, 95% CI: 1.3-3.4 versus females) and residing in an urban region of residence (OR=2.7, 95% CI: 1.5-4.9 versus rural) were associated with relatively higher odds of multiple risk factor control. On the other hand, lower educational attainment was associated with lower odds of multiple risk factor control (OR=0.5, 95% CI: 0.3-0.8 less than high school versus more than high school education). No other socio-demographic factor was statistically significantly associated with multiple risk factor control in unadjusted models.

In analyses of multiple risk-factor control from fully adjusted models that accounted for all demographic factors simultaneously, only region of residence and income was statistically significantly associated with better risk factor control. Urban compared with rural residents had an OR of 2.7 (95% CI: 1.2-5.9) for multiple risk-factor control. Those with a household income less than $10,000 had higher odds of multiple risk-factor control compared to those in households with $20,000 or more (OR=4.5; 95% CI: 1.1-18.6) for those considering themselves as having excellent/good health – a surprising finding.

Discussion

Public health implications

We observed that 1 in 4 adults in the RMI had diabetes. Of these, less than half were aware of their condition. Even fewer were treated or controlled with respect to glucose. These gaps in screening and treatment existed across several demographic subgroups, indicating that this is not simply an issue of social disparities but possibly a larger health system failure.

Strengths and limitations

Using the first ever population-based, Hybrid Survey, we had an unprecedented opportunity to examine diabetes in the RMI. Our age and sex distribution were comparable to that reported in the RMI's 2011 Census data, which increases generalizability and suggests that that our sample was likely representative of RMI. In addition to the survey, physical/anthropometric and biochemical measurements were collected to limit bias introduced through self-report. Not many studies have investigated patterns related to diabetes prevalence and associated risk factors in RMI. Our work helped “illustrate the broader diabetes agenda of detecting who had asymptomatic hyperglycemia,” and added to current knowledge on diabetes risk factors and care among the Marshallese; an important initial step to understanding the diabetes care continuum in RMI [1].

While our analysis relied on the measured diabetes variables of the Hybrid Survey, some data were self-reported; a limitation of any survey. With a sample size of 2,869 participants, our results may not be generalized to the entire population of 59,246 residents in RMI [11]. Additionally, we were not able to distinguish between type 1 diabetes and type 2 diabetes from these data, which may call for different strategies to control. Estimates of prevalence and bivariate associations may also be influenced by the age distribution; age-standardization in future analyses will improve the interpretability of those data.

Remaining gaps in knowledge and future directions

This current project has the potential to be expanded to include the entire region of the U.S. Affiliated Pacific Islands (USAPIs). There is limited published literature related to diabetes in RMI, as well as the USAPIs. More efforts are needed to aid public health professionals at organizations, such as the CDC and PIHOA to target gaps by strengthening current projects/programs, as well as implementing new interventions.

The Cascade of Care visualizes and identifies gaps of the care continuum; helping “advocates, focused programs, partnerships, systems, research, and clinical activities” address the gaps. Our quantification of the gaps in care using this framework can serve as benchmarks for future planning to address the diabetes epidemic.[1] For example, cascade dashboards can be created to better inform individual USAPIs and their health systems. Performance measures combined with standardized cascade metrics can be used to compare systems and instigate quality improvement in risk factor control across the USAPIs [1].

A next step could be to better understand how the socio-ecological perspective affects health outcomes in RMI. The Social Ecological Model (SEM), a multi-dimensional focused model, allows researchers to examine individual-environment interactions, which self-management depends on [20]. Diabetes Self-Management Education (DSME), recommended by the American Diabetes Association, has been shown to improve diabetes self-care behaviors, such as increased engagement in glucose monitoring and doctor visits in RMI [7]. Thus, the evidence-based, DSME intervention should be tested in RMI as well [12]. Due to the historical trauma in RMI, community-based participatory research (CBPR) may be a helpful approach to ensure the community is involved and feels comfortable, as well as to ensure the research is culturally appropriate [17].

Conclusions

In this secondary analysis of the Hybrid Survey, we found a need for improved diabetes screening, treatment, and combined risk factor control, as well as disparities by socio-demographic characteristics across the RMI population. Those with diabetes (24.7%), previously diagnosed diabetes (12.5%), and newly diagnosed diabetes (15.7%) should be targeted for screening and treatment. Those with no diabetes (71.8%) should continue to be screened to prevent diabetes. Among those with diabetes prevalence (n=810), 44.4% were aware that they had diabetes. Low levels of awareness indicate the need for improved screening. Early detection of diabetes is crucially important to prevent serious, long-term health complications that can result from prolonged undiagnosed diabetes [10]. Diabetes awareness was lowest among ages 18-34 (31.1%), females (40.7%), those living in a rural region (38.7%) household income less than USD 10,000 (47.6%) as well as those with excellent or very good health (42.6%). Those with poor risk-factor control and poor adherence to taking medication should also be targeted.

These findings show that many Marshallese are not properly managing their diabetes and are unaware of having diabetes, which is concerning since this condition is the leading cause of morbidity and mortality in RMI [13]. Given that there are so many undetected cases, there is a need for prioritizing efforts to address these gaps in diabetes screening and management in RMI.

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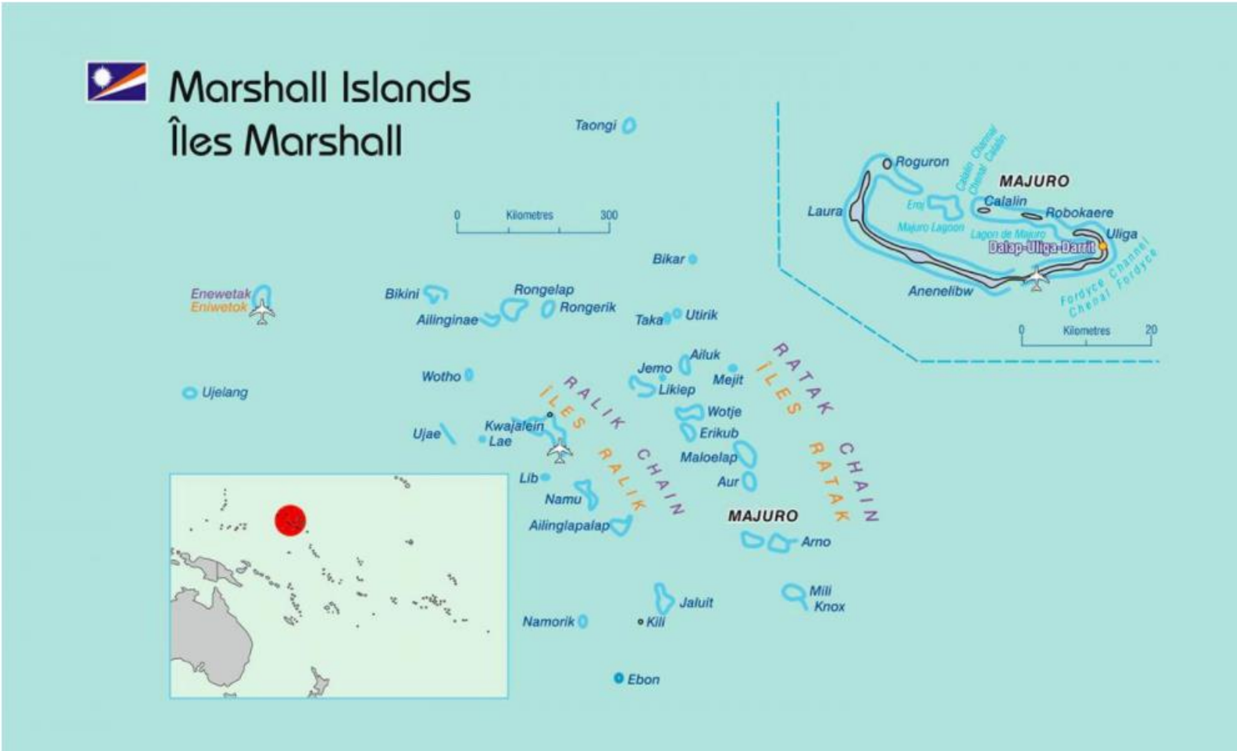

Figure 1. Map of RMI. Retrieved from the Pacific Community [22]

Figure 2. Cascade of diabetes care for RMI adults aged 18 years or older with any diabetes (n=810), Hybrid Survey 2017-2018

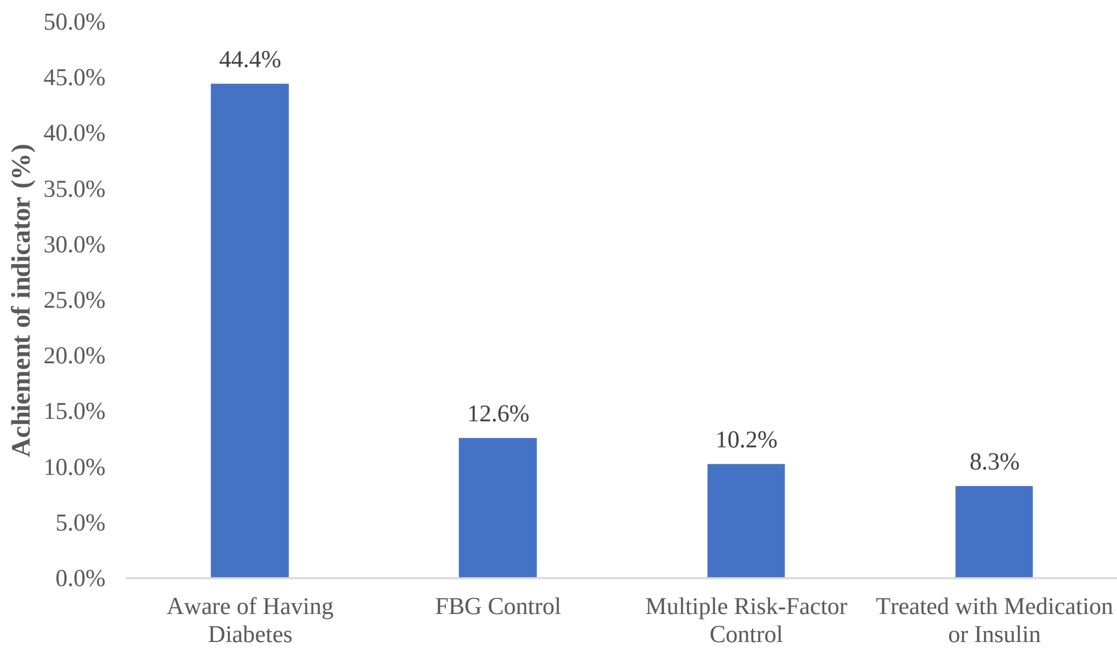

Figure 3. Diabetes care and control measures for RMI adults aged 18 years or older with total diabetes (n=810), Hybrid Survey 2017-2018

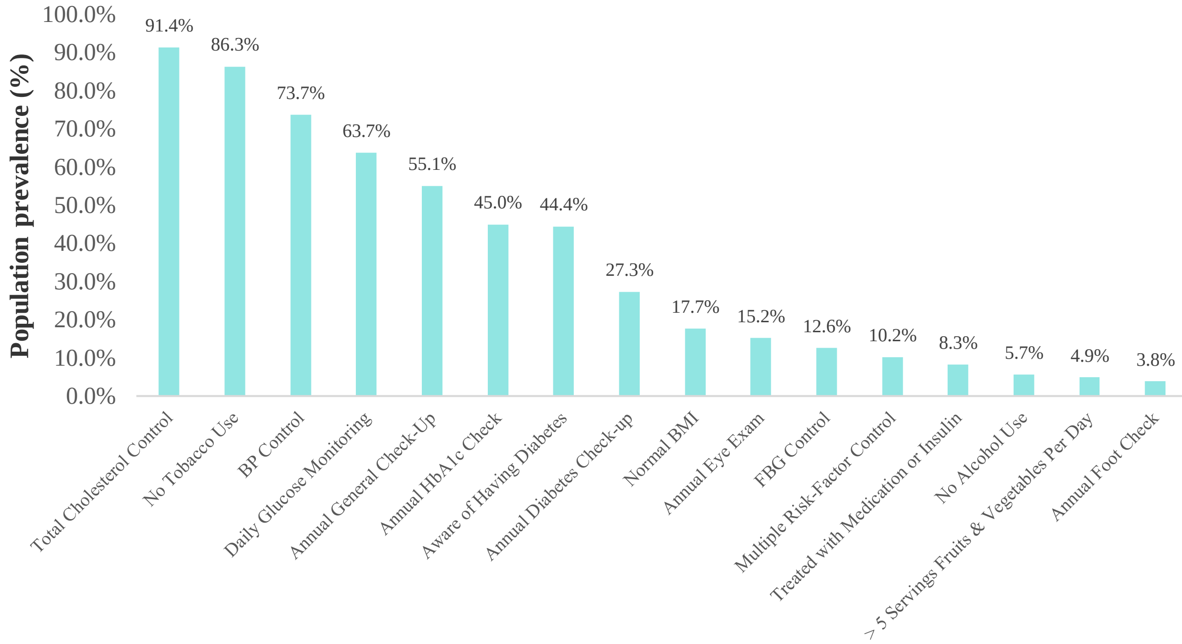

Table 1. Socio-demographic characteristics of adults across the RMI population

Socio-demographic characteristics	Population* (n = 2,869) Prevalence % (95% CI)
Age	
18-34	42.5 (40.7-44.3)
35-64	52.2 (50.4-54.1)
65+	5.2 (4.4-6.0)
Sex	
Male	47.4 (45.5-49.2)
Female	52.6 (50.8-54.5)
Region of residence	
Urban †	66.5 (64.8-68.3)
Rural ‡	33.4 (31.7-35.2)
Education level	
High school or less	81.1 (79.7-82.5)
More than high school	33.5 (31.7-35.2)
Marital status	
Single/never married	27.9 (26.2-29.5)
Married or domestic partnership	67.3 (65.6-69.1)
Widowed	3.8 (3.2-4.6)
Divorced/separated	0.6 (0.3-0.9)
Employment	
Employed	51.3 (49.5-53.2)
Unemployed	39.4 (37.6-41.2)
Student	5.3 (4.5-6.2)
Retired	3.9 (3.2-4.6)
Household income	
<$10,000	69.8 (67.4-72.1)
$10,000 - <$20,000	20.9 (18.8-22.9)
≥$20,000	9.4 (7.9-10.8)
Health status	
Excellent/very good health	67.5 (65.8-69.2)
Fair/poor health	32.5 (30.8-34.2)

Abbreviations: CI = confidence interval, RMI = Republic of the Marshall Islands
* Total RMI population
† Reside in Majuro or Kwajalein island
‡ Reside in the outer atolls: Arno, Jaluit, Kili, and Wotje

Table 2. Health risk factors and morbidities of the RMI population, stratified by diabetes diagnosis

Risk factors/morbidities	Mean (SD) or % (95% CI)			
	Total Population[a] (n = 2,869)	**Previously Diagnosed Diabetes[b] (n = 360)**	**Newly Diagnosed Diabetes[c] (n = 450)**	**No Diabetes[d] (n = 2,059)**
FBG mg/dL, *mean (SD)*	121.9 (70.3)	204.9 (99.4)	196.2 (74.2)	89.4 (18.4)
FBG ≥126 mg/dL, %	24.7 (23.1-26.3)	71.7 (67.0-76.3)	100	0
SBP mm Hg, *mean (SD)*	122.9 (45.9)	132.3 (73.6)	126.4 (22.9)	120.4 (43.1)
BP ≥130/80 mm Hg, %	17.8 (16.4-19.2)	25.8 (21.3-30.4)	26.7 (22.6-30.8)	14.5 (13.0-16.0)
TC mg/dL, *mean (SD)*	154.0 (44.8)	173.2 (50.7)	170 (45.7)	146.8 (41.4)
TC ≥240 mg/dL, %	4.6 (3.8-5.4)	8.9 (5.9-11.9)	8.4 (5.9-11.0)	3.0 (2.3-3.7)
BMI kg/m^2, *mean (SD)*	29.4 (6.5)	29.4 (5.6)	31.2 (6.5)	29.0 (6.6)
BMI kg/m^2 categories, %				
<18.5	1.8 (1.3-2.3)	0.6 (-0.2-2.3)	2.0 (0.7-3.3)	1.9 (1.3-2.5)
18.5 - <25	24.1 (22.5-25.7)	22.5 (18.2-26.8)	13.8 (10.6-17.0)	26.6 (24.7-28.5)
25 - <30	26.7 (25.0-28.3)	31.4 (26.6-36.2)	27.6 (23.4-31.7)	25.6 (23.8-27.5)
30+	41.4 (39.6-43.2)	38.1 (33.0-43.1)	53.8 (49.2-58.4)	39.2 (37.1-41.4)
Self-reported chronic conditions, %				
Any chronic condition	22.7 (21.1-24.2)	31.1 (26.3-35.9)	26.2 (22.1-30.3)	20.4 (18.7-22.1)
Heart condition	4.1 (3.4-4.8)	4.4 (2.3-6.6)	4.2 (2.4-6.1)	4.0 (3.2-4.9)
Stroke	0.6 (0.3-0.9)	1.9 (0.5-3.4)	1.6 (0.4-2.7)	0.2 (0-0.4)
Respiratory problems	4.0 (3.2-4.7)	4.7 (2.5-6.9)	5.1 (3.1-7.2)	3.6 (2.8-4.4)
Ulcer	6.7 (5.8-7.6)	6.9 (4.3-9.6)	8.0 (5.5-10.5)	6.4 (5.3-7.4)
Gout	5.8 (4.9-6.6)	10.3 (7.1-13.4)	6.7 (4.3-9.0)	4.8 (3.8-5.7)
Chronic kidney disease	4.0 (3.3 4.8)	5.8 (3.4-8.3)	5.1 (3.1-7.2)	3.5 (2.7-4.3)
Arthritis	4.3 (3.5-5.0)	7.5 (4.8-10.2)	6.0 (3.8-8.2)	3.3 (2.5-4.1)
Cancer	0.6 (0.3-0.9)	1.4 (0.2-2.6)	0.9 (0-1.8)	0.4 (0.1-0.7)
Tuberculosis	1.0 (0.7-1.4)	2.8 (1.1-4.4)	0.7 (0-1.4)	0.8 (0.4-1.2)
Hepatitis B/C	1.1 (0.8-1.5)	1.4 (0.2-2.6)	0.2 (0-0.7)	1.3 (0.8-1.8)

Abbreviations: BP = blood pressure, BMI = body-mass index, CI = confidence interval, FBG = fasting blood glucose, RMI = Republic of the Marshall Islands, SBP = systolic blood pressure, SD = standard deviation, TC = total cholesterol

[a] Total RMI population
[b] Adults ***with*** a prior diabetes diagnosis ***or*** fasting blood glucose ≥ 126 mg/dL
[c] Adults ***without*** a prior diabetes diagnosis ***and*** fasting blood glucose ≥ 126 mg/dL
[d] Adults ***without*** a prior diabetes diagnosis and fasting blood glucose < 126 mg/dL

Table 3. Diabetes prevalence and diabetes care continuum among adults with diabetes in RMI by socio-demographic factors

			Care indicators among adults with diabetes (n=810) % (95% CI)			
Socio-demographic characteristics	**n**	**Prevalence of Diabetes, %[a] (n=2,869)**	**Aware[b]**	**Treated[c]**	**Controlled FBG[d]**	**Multiple Risk-factor Control[e]**
Total	2,869	28.2%	44.4%	8.3%	12.6%	10.2%
Age Group						
18-34	1220	11.1 (9.3-12.8)	31.1 (23.2-39.0)	2.2 (-0.3-4.7)	22.2 (15.1-29.3)	19.3 (12.5-26.0)
35-64	1499	39.4 (36.9-41.9)	45.5 (41.4-49.5)	7.6 (5.5-9.8)	10.0 (7.6-12.4)	8.0 (5.8-10.1)
65+	150	56.0 (48.0-64.0)	58.3 (47.6-69.1)	22.6 (13.5-31.8)	15.5 (7.6-23.3)	11.9 (4.8-19.0)
Sex						
Male	1359	27.4 (25.1-30.0)	48.8 (43.7-53.9)	8.8 (6.0-11.7)	16.4 (12.6-20.1)	13.9 (10.4-17.5)
Female	1510	28.9 (26.7-31.2)	40.7 (36.1-45.4)	7.8 (5.2-10.3)	9.4 (6.6-12.1)	7.1 (4.6-9.5)
Region of residence						
Urban †	1909	28.2 (26.2-30.3)	47.3 (43.1-51.5)	9.3 (6.8-11.7)	15.8 (12.7-18.9)	12.8 (10.0-15.6)
Rural ‡	960	28.2 (25.4-31.1)	38.7 (32.9-44.6)	6.3 (3.4-9.2)	6.3 (3.4-9.2)	5.2 (2.5-7.8)
Education level						
High school or less	2327	29.2 (27.3-31.1)	42.8 (39.1-46.5)	7.8 (5.8-9.8)	11.3 (8.9-13.7)	8.8 (6.7-11.0)
More than high school	542	24.0 (20.4-27.6)	53.1 (44.4-61.8)	10.8 (5.4-16.2)	19.2 (12.4-26.1)	19.2 (12.4-26.1)
Marital status						
Single/never married	800	14.6 (12.2-17.1)	34.2 (25.5-42.9)	4.3 (0.6-8.0)	18.8 (11.6-26.0)	16.2 (9.5-23.0)
Married or domestic partnership	1932	32.2 (30.2-34.4)	45.4 (41.6-49.4)	8.7 (6.4-10.9)	12.2 (9.6-14.8)	10.0 (7.7-12.5)
Widowed	111	55.9 (46.4-65.2)	51.6 (38.8-64.4)	11.3 (3.2-19.4)	6.5 (0.2-12.7)	1.6 (-1.6-4.8)
Divorced/separated	18	27.8 (4.9-50.7)	60.0 (-8.0-128.0)	20.0 (-35.5-75.5)	n/a	n/a
Employment						
Employed	1462	28.2 (25.9-30.5)	44.7 (39.8-49.5)	7.0 (4.6-9.5)	12.4 (9.2-15.6)	10.4 (7.4-13.4)
Unemployed	1121	27.7 (25.1-30.4)	40.8 (35.3-46.3)	8.1 (5.0-11.1)	11.6 (8.0-15.2)	9.0 (5.8-12.2)
Student	152	9.2 (4.6-13.9)	21.4 (-3.2-46.0)	n/a	21.4 (-3.2-46.0)	21.4 (-3.2-46.0)
Retired	112	60.7 (51.5-69.9)	64.7 (53.0-76.4)	17.6 (8.4-26.9)	16.2 (7.2-25.2)	11.8 (3.9-19.6)
Household income						
<$10,000	1063	28.9 (26.2-31.6)	47.6 (41.9-53.2)	7.5 (4.5-10.4)	13.0 (9.2-16.8)	10.4 (7.0-13.9)
$10,000 - <$20,000	318	28.9 (23.9-33.9)	40.2 (30.0-50.4)	9.8 (3.6-16.0)	12.0 (5.2-18.7)	10.9 (4.4-17.4)
≥$20,000	143	30.1 (22.5-37.7)	53.5 (38.0-69.0)	7.0 (-10.0-14.9)	11.6 (1.6-21.6)	7.0 (-10.0-14.9)
Health status						
Excellent/very good health	1936	24.6 (22.7-26.6)	42.6 (38.1-47.0)	8.0 (5.5-10.4)	13.8 (10.7-16.9)	11.3 (8.5-14.2)
Fair/poor health	933	35.7 (32.6-38.8)	47.1 (41.8-52.5)	8.8 (5.7-11.8)	10.8 (7.5-14.2)	8.7 (5.7-11.8)

Abbreviations: CI = confidence interval, RMI = Republic of the Marshall Islands
[a] Adults with a prior diabetes diagnosis ***or*** fasting blood glucose > 126 mg/dL, [b] Adults with total diabetes who reported previously diagnosed diabetes
[c] Adults with total diabetes who took oral medication and/or insulin, [d] Adults with total diabetes who had measured fasting blood glucose <126 mg/dL
[e] Adults with total diabetes who managed multiple risk-factors: fasting blood glucose <126 mg/dL, blood pressure <130/80 mm Hg, and total cholesterol <240 mg/dL, *†* Reside in Majuro or Kwajalein island, ‡ Reside in the outer atolls: Arno, Jaluit, Kili, and Wotje

Table 4. Engagement with care and self-management behaviors among adults with diabetes in RMI by diabetes awareness

Self-care variables	Mean (SD) or % (95% CI)		
	Total Diabetes[a] (n = 810)	**Previously Diagnosed Diabetes[b] (n = 360)**	**Newly Diagnosed Diabetes[c] (n = 450)**
Health care			
Annual examinations			
General exam	55.1 (51.6-58.5)	64.7 (59.8-69.7)	47.3 (42.7-52.0)
Diabetes exam	27.3 (24.1-30.1)	72.3 (66.9-77.6)	n/a
Eye exam	15.2 (12.7-17.7)	34.2 (29.2-39.1)	n/a
Foot exam	3.8 (2.3-5.3)	12.5 (7.9-17.1)	n/a
Dental exam	40.9 (37.5-44.3)	46.7 (41.5-51.8)	36.2 (31.7-40.7)
Ever had blood pressure tested	69.4 (66.2-72.6)	85.0 (81.3-88.7)	56.9 (52.3-61.5)
Ever had cholesterol tested	27.5 (24.4-30.6)	40.8 (35.7-45.9)	16.9 (13.4-20.4)
Ever had blood glucose tested	75.8 (72.8-78.8)	100	56.4 (51.8-61.0)
Daily blood glucose monitoring	63.7 (57.2-70.2)	63.7 (57.2-70.2)	n/a
Annual HbA1c check	45.0 (38.2-51.8)	45.0 (38.2-51.8)	n/a
Lifestyle behaviors			
Average servings of fruits and vegetables per day >5	4.9 (3.3-6.4)	6.1 (3.5-8.7)	3.9 (2.1-5.8)
Processed meats per day <1	78.5 (70.0-87.0)	76.7 (63.6-89.9)	80.0 (68.5-91.5)
Sugar-sweetened beverages per day <1	85.0 (77.9-92.1)	83.9 (74.5-93.3)	86.8 (75.6-98.1)
Watching sodium intake	82.2 (79.6-84.9)	82.5 (78.6-86.4)	82.0 (78.4-85.6)
Diet Type			
Majority local food	28.6 (25.5-31.8)	31.9 (27.1-36.8)	26.0 (21.9-30.1)
About half local and half imported food	38.5 (35.2-41.9)	36.1 (31.1-41.0)	40.4 (35.8-44.9)
Majority imported food	31.6 (28.4-34.8)	30.8 (26.0-35.6)	32.2 (27.9-36.6)
Drug/alcohol consumption (past 30 days)			
No tobacco use ‖	86.3 (83.9-88.7)	88.2 (84.9-91.6)	84.8 (81.4-88.1)
No betel nut use	88.1 (85.8-90.4)	90.1 (86.9-93.3)	86.4 (83.1-89.7)
No alcohol use	5.7 (4.1-7.3)	6.7 (4.1-9.3)	4.9 (2.9-6.9)
No other drug use *	98.1 (97.2-99.1)	98.1 (96.6-99.5)	98.2 (97.0-99.4)
Days of physical activity (past 30 days), *mean (SD)*	13.3 (13.6)	13.2 (13.5)	13.4 (13.6)
Time spent sitting per day (hrs), *mean (SD)*	10.1 (21.9)	9.1 (20.0)	10.9 (23.6)

Abbreviations: CI = confidence interval, SD = standard deviation, RMI = Republic of the Marshall Islands

[a] Adults ***with*** *a prior diabetes diagnosis* ***or*** *fasting blood glucose > 126 mg/dL*

[b] Adults ***with*** a prior diabetes diagnosis ***or*** fasting blood glucose ≥ 126 mg/dL

[c] Adults ***without*** a prior diabetes diagnosis ***and*** fasting blood glucose ≥ 126 mg/dL

‖ No smoking, no chewing tobacco, and/or no vapes/e-cigs

* No marijuana or inhalant use

Table 5. Multiple logistic regression analysis of multiple risk-factor control by socio-demographic factors

Socio-demographic variables	Multiple Risk-factor Control* (n=2,869)	
	Unadjusted OR (95% CI)	**Adjusted OR (95% CI)**
Age Group		
18-34	2.6 (1.5-4.3)	1.4 (0.4-5.1)
35-64	0.4 (0.3-0.7)	0.3 (0.1-1.1)
65+	Ref	Ref
Sex		
Male	2.1 (1.3-3.4)	1.6 (0.8-3.4)
Female	Ref	Ref
Region of residence		
Urban †	2.7 (1.5-4.9)	2.7 (1.2-5.9)
Rural ‡	Ref	Ref
Education level		
High school or less	0.5 (0.3-0.8)	0.6 (0.2-1.3)
More than high school	Ref	Ref
Marital status		
Single/never married	1.1 (0.7-1.9)	0.9 (0.4-2.0)
Married or domestic partnership	Ref	Ref
Divorced/separated	n/a	n/a
Employment		
Employed	1.1 (0.7-1.7)	3.7 (0.9-16.0)
Unemployed	0.8 (0.5-1.3)	1.9 (0.4-10.1)
Student	2.5 (0.7-9.0)	13.1 (0.6-273.2)
Retired	Ref	Ref
Household income		
<$10,000	1.1 (0.6-2.2)	4.5 (1.1-18.6)
$10,000 - <$20,000	1.1 (0.5-2.3)	2.3 (0.5-9.7)
≥$20,000	Ref	Ref
Health status		
Excellent/very good health	1.3 (0.8-2.2)	1.2 (0.6-2.3)
Fair/poor health	Ref	Ref

Abbreviations: CI = confidence interval, OR = odds ratio

* *Multiple Risk-factor Control* is defined as the proportion of participants with total diabetes who managed multiple risk-factors: fasting blood glucose <126 mg/dL, blood pressure <130/80 mm Hg, and total cholesterol <240 mg/dL

† Reside in Majuro or Kwajalein island

‡ Reside in the outer atolls: Arno, Jaluit, Kili, and Wotje