Health Profiles of Marshallese With and Without a Type 2 Diabetes Diagnosis in the Republic of the Marshall Islands

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ABSTRACT

BACKGROUND: The Republic of the Marshall Islands (RMI) faces a high prevalence of type 2 diabetes (T2DM).

OBJECTIVES: The aim of the study is to document the health of Marshallese with and without a T2DM diagnosis to inform future interventions.

DESIGN: Data are from screenings collected in preparation for a diabetes education intervention. Data, including HbA1c, random glucose, cholesterol, weight, and self-rated health, were collected.

METHODS: Kruskal-Wallis and Fisher's exact tests were used to identify differences in participants with and without T2DM diagnosis.

RESULTS: There were significant differences in both HbA1c level ($P \leqslant .0001$) and glucose level ($P \leqslant .0001$) between the diagnosed T2DM and non-diagnosed T2DM groups, as well as diastolic blood pressure ($P = .0179$), systolic blood pressure ($P = .0003$), and pulse pressure ($P = .0023$). There were no differences in weight, body mass index (BMI), high density lipoprotein (HDL), low density lipoprotein (LDL), total cholesterol, or self-rated health. Marshallese without a T2DM diagnosis have signs of insulin resistance, including elevated glucose and triglyceride levels.

CONCLUSION: The results indicate a need for a socioecological approach to T2DM interventions, and interventions in the RMI should consider inclusion of blood pressure and cholesterol management. There is a need for interventions to prevent prediabetes and its progression to T2DM.

KEYWORDS: Republic of the Marshall Islands, type 2 diabetes, prediabetes, intervention, health profiles

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Introduction

Type 2 diabetes (T2DM) affects approximately 463 million people worldwide, and projected estimates show the number of people with T2DM will increase to 700 million by 2045.[1] The majority of people who have been diagnosed with diabetes have T2DM resulting from the body's inability to use insulin effectively.[2] Risk factors for T2DM have been linked to lifestyle factors, including reduced physical activity, a diet high in refined carbohydrates and saturated fat, and obesity.[3] Obesity has been identified as one of the major risk factors and is most often the target of interventions aiming to prevent the development of both T2DM and its precursor, prediabetes.[4] Both prediabetes and T2DM can lead to complications, including macro- and microvascular disease leading to neuropathy and atherosclerotic changes leading to high blood pressure and cardiovascular disease.[5]

The population of the Republic of the Marshall Islands (RMI), a United States Affiliated Pacific Island nation, faces significant health challenges including a high prevalence of T2DM.[6] Many of the health challenges are a result of historical traumas endured by the inhabitants of the RMI due to the United's States' (US) testing of nuclear weapons on the atolls in the 1940s and 1950s.[7] The nuclear testing and the radioactive fallout that followed led to the loss of local fresh food sources, a higher intake of highly processed commodity foods provided by the US, and changes in physical activity related to food acquisition.[8] Subsequently, the Marshallese now experience particularly high rates of T2DM.[9] The RMI has one of the

highest prevalence rates in the world, with nearly a third of Marshallese having been diagnosed with T2DM.[1]

Conducting health research in the RMI has been constrained because of historical trauma caused when the Marshallese were subjected to medical research conducted by US scientists on the effects of nuclear fallout.[7] The research was conducted without regard to the cultural practices and language of the Marshallese and without informed consent being obtained.[7] Therefore, Marshallese in the RMI have been distrustful of outside researchers.[7]

The Compact of Free Association (COFA) with the US and the RMI was signed in 1986, permitting Marshallese to freely enter, live, work, and study in the US without a visa.[10] The largest concentration of Marshallese in the US resides in Arkansas. University of Arkansas for Medical Sciences has collaborated with the Marshallese community using a community-based participatory approach for a number of years in an effort to build trust and to address the health disparities experienced by the Marshallese community.[11] This work has resulted in a number of studies assessing community-based interventions to address T2DM among Marshallese in Arkansas.[12] At the request of the Marshallese Consulate General and the Marshallese Ministry of Health and Human Services, the community-based partnerships in Arkansas have been extended to the RMI.[13]

Most of the research that has informed interventions to prevent and treat T2DM among Pacific Islanders and Marshallese has taken place in the US, and little is known about the health of Marshallese in the RMI. Given the disparate rates of T2DM in the RMI, it is important to gather information on the health profiles of both Marshallese diagnosed with T2DM and those who have not been diagnosed with T2DM. Documenting the health profiles of Marshallese in the RMI and understanding how health profiles may differ between those with and without a T2DM diagnosis will help to inform future interventions to prevent and treat T2DM in the RMI. Therefore, this study aims to describe and compare the health profiles of a sample of Marshallese with and without a self-reported diagnosis of T2DM in the RMI.

Data and Methods

Sample design and data collection

The data used in the study come from church screening baseline data collected in preparation for a pilot study of a diabetes self-management education and support intervention which took place between May 2015 and May 2018.[13] The study protocol and materials were reviewed and approved by the University of Arkansas for Medical Sciences Institutional Review Board (#239272) and reviewed and approved by the RMI Ministry of Health and Human Services.[13] Inclusion criteria included Marshallese descent and 18 years of age or older.

Recruitment took place in 4 churches on the Majuro atoll. Informed consent and all study materials were provided to participants in both Marshallese and English, and bilingual trained research staff were available for questions. Biometric data were collected by research staff trained in the proper techniques. HbA1c was measured using the Rapid A1c test kit (Siemens DCA Vantage Analyzer). A random glucose level and lipids were collected via finger stick blood collection, and lipids were analyzed using the Cholestech LDX and a commercial lipid panel. Participants' height and weight were collected without shoes. Height was measured to the nearest inch using a portable stadiometer (0-81 inches); weight was captured to the nearest 0.1 lb (0.045 kg) using a calibrated digital scale. Body mass index (BMI) was calculated using height and weight collected by staff ((weight in pounds/[height in inches]^2) $\times$ 703). With the participant seated, systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured using an OMRON digital blood pressure monitor. Pulse pressure was calculated by subtracting the diastolic from the systolic value. Demographic questions and self-rated health questions were asked using items modified for this study from the Behavioral Risk Factor Surveillance System (BRFSS) survey's Diabetes and Healthcare Access Core Modules and the Diabetes Care Profile.[14]

Analysis

Descriptive statistics, including means and standard deviations for continuous variables and proportions for categorical variables, are presented to characterize participants with and without a self-reported diagnosis of T2DM. Kruskal-Wallis tests and Fisher's exact tests were used to identify differences between the 2 samples due to the non-normal distribution of the data. Significance was determined at the .05 level. Analysis was completed using STATA v 16 (StataCorp, College Station, TX).

Results

One-hundred and twenty-six individuals were screened for participation. One potential participant was deemed ineligible. Twenty-eight participants did not return for the data collection, resulting in a final sample of 97. The participants were asked to report if they had been diagnosed with T2DM by answering the question, "Has a health care professional diagnosed you with type 2 diabetes?" Sixty-one participants self-reported no diagnosis of T2DM, and 36 self-reported a physician diagnosis of T2DM.

Demographics

Age was the only demographic measure that differed significantly between those with a T2DM diagnosis and those without a T2DM diagnosis, with those reporting a T2DM diagnosis being older ($M = 52.3$) than those in the non-diagnosed group ($M = 45.1$, $P = .0086$). In the non-diagnosed T2DM group, 72.1% of participants were women, 80.3% were partnered/married, 59% had less than a high school level education, and

72.1% were not employed for wages. In the diagnosed T2DM group, 69.4% of participants were women, 69.4% were partnered/married, 66.7% had less than a high school education, and 69.4% were not employed for wages.

Biometric measures

There were significant differences in both HbA1c level ($P \leqslant .0001$) and glucose level ($P \leqslant .0001$) between the diagnosed T2DM and non-diagnosed T2DM groups. The non-diagnosed T2DM group had a mean HbA1c of 6.0% (±1.04%), and the mean HbA1c for the diagnosed T2DM group was 10.4% (±2.58%). Mean glucose level for the non-diagnosed T2DM was 106.5 mg/dL (±30.68 mg/dL) compared to a mean of 211.7 mg/dL (±73.33 mg/dL) for those in the diagnosed T2DM group (Table 1).

There were no differences found for weight ($P = .3205$) or BMI ($P = .2872$) between the 2 groups (Table 1).

There were significant differences in DBP ($P = .0179$), SBP ($P = .0003$), and pulse pressure ($P = .0023$) between the non-diagnosed T2DM and diagnosed T2DM groups, with elevated blood pressure and pulse pressure in the diagnosed T2DM group (Table 1). For the diagnosed T2DM group, the mean DBP was 79.3 mmHg (±11.41 mmHg), mean SBP was 134.4 mmHg (±26.43 mmHg), and the mean pulse pressure was 55.1 mmHg (±22.57 mmHg). The mean for each value was lower in the non-diagnosed T2DM group, with DBP averaging 74.2 mmHg (±11.19 mmHg), a mean SBP of 116.1 mmHg (±17.16 mmHg), and a mean pulse pressure of 41.9 mmHg (±12.31 mmHg) (Table 1).

There was no statistical difference between the 2 groups for high density lipoprotein (HDL) ($P = .1087$), low density lipoprotein (LDL) ($P = .6586$), and total cholesterol levels ($P = .0668$). Triglycerides were elevated in the group diagnosed with T2DM, with a mean of 135.5 mg/dL (±54.32 mg/dL) compared to the non-diagnosed T2DM mean of 93.9 mg/dL (±45.72 mg/dL) (Table 1).

Subjective health status

The Fisher's exact test indicates there are no significant differences between the 2 groups for self-rated current health status ($P = .0842$) or current health status compared to 12 months prior ($P = .4153$).

Discussion

We found that Marshallese with a self-reported T2DM diagnosis living in the RMI had significantly higher levels of blood glucose, blood pressure measures, and triglycerides than those without a self-reported T2DM diagnosis. However, we found no statistical difference between the 2 groups for weight, BMI, cholesterol (HDL, LDL, total cholesterol), or the 2 self-rated health status measures.

The Marshallese with a self-reported T2DM had higher HbA1c levels and glucose levels than those without an official diagnosis of T2DM. Given the mean and median HbA1c and glucose levels, more than half of those diagnosed with T2DM do not have their T2DM under control to prevent the onset or progression of microvascular complications such as retinopathy, nephropathy, and neuropathy (HbA1c of ⩽7.0%).[15]

The management of T2DM does not occur in isolation, however, and it is important to take into account the social determinants of health when considering the individual management of the disease. Prior research has revealed that among both the general T2DM community and the Marshallese community living in Arkansas and in the RMI, difficulty controlling glucose levels may be related to socioecological factors.[16,17] Marshallese in Arkansas have stated that a diagnosis of T2DM comes with a high level of social stigma and low levels of social support.[16] Moreover, Marshallese in both the RMI and Arkansas have indicated limited healthcare access, limited diabetes education, and a lack of transportation have made it more difficult to successfully manage their diabetes.[16,17] Current research in other contexts have shown the importance of taking a socioecological approach to T2DM education and self-management programs.[18–20]

The participants with a self-reported diagnosis of T2DM had elevated DBP and SBP levels, an elevated pulse pressure, and elevated triglycerides compared to the participants without a self-reported diagnosis of T2DM. These findings indicate an elevated risk for cardiac impairment and heart disease in those with T2DM, amplifying the risk of diabetic complications. Many T2DM interventions address blood pressure and cholesterol indirectly, as the conditions share similar risk factors. However, providing tools and additional education on lowering blood pressure and cholesterol may be necessary to lowering the risk of adverse events. For example, one meta-analysis indicated a more intensive approach to lowering blood pressure reduced complications including major cardiovascular events, myocardial infarction, stroke, albuminuria, and the progression of retinopathy among those with T2DM.[21] Therefore, it is important to consider incorporating the management of high blood pressure into T2DM intervention planning.[21]

We did not find differences in weight, BMI, or cholesterol (with the exception of triglycerides) between those with a self-reported diagnosis of T2DM and those without. These findings were unexpected; however, the elevated glucose levels and triglyceride levels in the non-T2DM sample are indicative of insulin resistance. Elevated weight/BMI are a factor in the development of insulin resistance and prediabetes and may explain why there were no statistical differences between the diagnosed T2DM and non-diagnosed T2DM groups on these measures. Further, these findings indicate a need for interventions addressing prediabetes and preventing its progression to T2DM in the RMI.

Table 1. Health profiles of study participants with and without a diabetes diagnosis (N = 97).

MEASURE	NO DIABETES DIAGNOSIS (N = 61)				DIAGNOSED WITH DIABETES (N = 36)				KWT OR FET
	MEAN OR N (%)	MEDIAN	SD OR SE	95% CI	MEAN OR N (%)	MEDIAN	SD OR SE	95% CI	*P*
Blood glucose									
HbA1c (%)[a]	6.0	5.8	1.04	(5.7, 6.3)	10.4	10.9	2.58	(9.5, 11.3)	<**.0001**
Random glucose (mg/dL)	106.5	99.0	30.68	(98.6, 114.3)	211.7	215.0	73.33	(186.9, 236.5)	<**.0001**
Weight									
Weight (lbs.)[a]	172.2	166.6	40.48	(161.87, 182.45)	162.7	162.6	35.08	(150.9, 174.5)	.3205
BMI[a]	31.9	30.4	6.26	(30.3, 33.5)	30.2	30.5	5.81	(28.3, 32.2)	.2872
Blood pressure									
Diastolic (mmHg)	74.2	75.0	11.19	(71.32, 77.01)	79.3	80.0	11.41	(75.53, 83.08)	**.0179**
Systolic (mmHg)	116.1	114.0	17.16	(111.7, 120.4)	134.4	124.5	26.43	(125.6, 143.1)	**.0003**
Pulse pressure (mmHg)	41.9	40.0	12.31	(38.8, 45.1)	55.1	48.0	22.57	(47.6, 62.5)	**.0023**
Cholesterol levels									
HDL (mg/dL)	32.8	31.0	7.38	(30.9, 34.7)	31.3	29.0	11.19	(27.6, 35.0)	.1087
LDL (mg/dL)[b]	107.5	108.5	21.6	(101.8, 113.2)	111.8	109.0	28.52	(102.0, 121.7)	.6586
Triglycerides (mg/dL)	93.9	89.0	45.72	(82.3, 105.0)	135.5	133.5	54.32	(117.6, 153.5)	<**.001**
Total cholesterol (mg/dL)	156.6	155.0	28.48	(149.3, 163.8)	170.1	169.5	34.41	(158.8, 181.4)	.0668
Self-rated health									
Current health status[c]	156.6	155.0	28.48	(149.3, 163.8)	170.1	169.5	34.41	(158.8, 181.4)	.0842
Excellent/Good	42 (68.9)	—	0.06	(56.6, 79.2)	18 (50.0)	—	.08	(34.2, 65.8)	
Fair/Poor	19 (31.2)	—	0.06	(20.8, 43.8)	18 (50.0)	—	.08	(34.2, 65.8)	
Current health status compared to 12 months ago									.4153
Better	17 (27.9)	—	0.06	(18.1, 40.3)	10 (27.8)	—	.07	(15.7, 44.5)	
About the same	34 (55.7)	—	0.06	(43.2, 67.6)	16 (44.4)	—	.08	(29.3, 60.7)	
Worse	10 (16.4)	—	0.05	(9.1, 27.9)	10 (27.8)	—	.07	(15.7, 44.4)	

Abbreviations: CI, confidence interval; FEt, Fisher's exact test; KWt, Kruskal-Wallis test; SD, standard deviation; SE, standard error.
Bold *P*-values indicate statistical significance. Sample sizes vary due to missing data; BMI and weight missing values are due to participant limitations.
[a]N = 96; [b]N = 89; [c]N = 95.

Finally, the results show no difference between the 2 groups on measures of self-rated health. This finding was unexpected, particularly in the context of the high HbA1c and glucose levels in the participants with a self-reported diagnosis of T2DM. As noted previously, elevated blood glucose levels lead to microvascular complications, including neuropathy. These complications are often painful and can lead to difficulties with mobility and sleeping, consequentially lowering quality of life.[22] There may be several reasons for these findings. The first may be that the self-rated health status questions may be subject to response bias, such as social desirability, leading to higher than expected ratings.[23] Second, it may be due to the severity and/or longevity of the elevated glucose levels; for those diagnosed with T2DM, the symptoms of high glucose levels may have become a normal part of everyday life, and therefore, the effects on wellbeing have diminished over time.[24] Finally, self-rated health is complicated and may be influenced by many factors including the participant's health, psychological considerations, and social context.[25] It could be that Marshallese in the RMI use different contextual clues to rate their health, and therefore, T2DM is not weighted as heavily in their evaluation of their health. Understanding how Marshallese in the RMI contextualize and rate their health is an area in need of further study and should be considered as a potential supplement for future intervention studies.

Limitations

There are some limitations to consider when interpreting the results. The sample for this study was small and recruited from 4 churches in the RMI. Further, the RMI has a unique social ecological context. Therefore, the results may not be generalizable to other geographic regions. Additionally, the sample is older and may not be representative of the younger Marshallese population living in the RMI. Finally, the sample is cross-sectional, not allowing for the analysis of when the first indicators of insulin resistance, prediabetes, and T2DM developed in the non-T2DM sample.

Conclusion

Despite these limitations, the data included a variety of health indicators which allowed for an extensive documentation and comparison of the health profiles of Marshallese with and without a self-reported diagnosis of T2DM. To our knowledge, this study is the first to compare the health profiles of Marshallese with and without a self-reported T2DM diagnosis living in the RMI. Given the high rates of T2DM among Marshallese, this new knowledge is an important foundation for interventions and research related to T2DM prevention and treatment in the RMI. Future research in this area should consider conducting longitudinal cohort studies with members of younger populations to identify specific factors leading to the development of insulin resistance, prediabetes, and T2DM. Recruiting in younger populations, especially for health screenings, may help researchers understand how and when insulin resistance and prediabetes develops in the Marshallese populations and allow for interventions to take place earlier in the disease course.

Declarations

Ethics Approval and Consent to Participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study protocol and materials were reviewed and approved by the University of Arkansas for Medical Sciences Institutional Review Board (#239272) and reviewed and approved by the RMI Ministry of Health and Human Services. Informed consent form and all study materials were provided to participants in both Marshallese and English, and bilingual trained research staff were available for questions.

Consent for Publication

Not applicable.

Author Contribution(s)

Jennifer A. Andersen: Conceptualization; Data curation; Formal analysis; Methodology; Supervision; Writing—original draft; Writing—review & editing.
Holly C. Felix: Conceptualization; Investigation; Supervision; Writing—review & editing.
Joseph R. Malhis: Writing—review & editing.
Erin Gloster: Writing—review & editing.
Pearl A. McElfish: Conceptualization; Funding acquisition; Investigation; Supervision; Writing—review & editing.

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Availability of Data and Materials

Not applicable.

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REFERENCES

1. International Diabetes Federation. *IDF Diabetes Atlas*. International Diabetes Federation; 2019. https://diabetesatlas.org/upload/resources/material/20200302_133351_IDFATLAS9e-final-web.pdf
2. WHO. *Global Report on Diabetes*. World Health Organization; 2016. https://apps.who.int/iris/bitstream/handle/10665/204871/9789241565257_eng.pdf;jsessionid=B2ADD055D7A209C90435768021400DA9?sequence=1:
3. Hu FB, van Dam RM, Liu S. Diet and risk of type II diabetes: the role of types of fat and carbohydrate. *Diabetologia*. 2001;44:805-817.
4. Tabák AG, Herder C, Rathmann W, et al. Prediabetes: a high-risk state for diabetes development. *Lancet*. 2012;379:2279-2290.

5. Wu Y, Ding Y, Tanaka Y, et al. Risk factors contributing to type 2 diabetes and recent advances in the treatment and prevention. *Int J Med Sci*. 2014;11:1185-1200.
6. International Diabetes Federation. *IDF Diabetes Atlas, Marshall Island Diabetes Report 2000–2045*. International Diabetes Federation; 2021. https://diabetesatlas.org/data/en/country/124/mh.html
7. Barker H. *Bravo for the Marshallese: Regaining Control in a Post-Nuclear, Post-Colonial World*. Cengage Learning; 2012.
8. Gittelsohn J, Haberle H, Vastine A, et al. Macro-and microlevel processes affect food choice and nutritional status in the Republic of the Marshall Islands. *J Nutr*. 2003;133:310S-313S.
9. Hawley NL, Suss R, Cash HL, et al. Diabetes prevention and care programs in the US-affiliated Pacific Islands: challenges, innovation, and recommendations for effective scale-up. *Curr Diabetes Rev*. 2019;19:24.
10. McElfish PA, Hallgren E, Yamada S. Effect of US health policies on health care access for Marshallese migrants. *Am J Public Health*. 2015;105:637-43.
11. McElfish PA, Moore R, Buron B, et al. Integrating interprofessional education and cultural competency training to address health disparities. *Teach Learn Med*. 2018;30:213-222.
12. McElfish PA, Long CR, Kohler PO, et al. Comparative effectiveness and maintenance of diabetes self-management education interventions for Marshallese patients with type 2 diabetes: a randomized controlled trial. *Diabetes Care*. 2019;42:849-858.
13. McElfish P, Boyers J, Purvis R, et al. Family model diabetes self-management education and support in faith-based organizations in the republic of the Marshall Islands study protocol. *Contemp Clin Trials Commun*. 2020;21:100710.
14. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System (BRFSS). 2020. Updated 2020. Accessed November 25, 2020. http://www.cdc.gov/brfss/
15. Davies MJ, Aroda VR, Collins BS, et al. Management of hyperglycemia in type 2 diabetes, 2022. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care*. 2022;45:2753-2786.
16. McElfish PA, Hallgren E, Henry LJ, et al. Health beliefs of Marshallese regarding type 2 diabetes. *Am J Health Behav*. 2016;40:248-257.
17. Andersen JA, Purvis RS, Scott AJ, et al. Lessons learned from the pilot family model of diabetes self-management intervention in the Republic of the Marshall Islands. *Contemp Clin Trials Commun*. 2023;32:101086.
18. Bamuya C, Correia J, Brady EM, et al. Use of the socio-ecological model to explore factors that influence the implementation of a diabetes structured education programme (EXTEND project) inLilongwe, Malawi and Maputo, Mozambique: a qualitative study. *BMC Public Health*. 2021;21:1-11.
19. Onwuchuluba E, Oyetunde O, Soremekun R. Medication adherence in type 2 diabetes mellitus: a qualitative exploration of barriers and facilitators from socio-ecological perspectives. *J Patient Exp*. 2021;8:23743735211034338.
20. Frier A, Devine S, Barnett F, et al. Improving type 2 diabetes care and self-management at the individual level by incorporating social determinants of health. *Aust N Z J Public Health*. 2022;46:865-871.
21. Xie X, Atkins E, Lv J, et al. Effects of intensive blood pressure lowering on cardiovascular and renal outcomes: updated systematic review and meta-analysis. *Lancet*. 2016;387:435-443.
22. Zelman DC, Brandenburg NA, Gore M. Sleep impairment in patients with painful diabetic peripheral neuropathy. *Clin J Pain*. 2006;22:681-685.
23. Fastame MC, Penna MP. Does social desirability confound the assessment of self-reported measures of well-being and metacognitive efficiency in young and older adults? *Clin Gerontol*. 2012;35:239-256.
24. Hörnsten Å, Sandström H, Lundman B. Personal understandings of illness among people with type 2 diabetes. *J Adv Nurs*. 2004;47:174-182.
25. Garbarski D. Research in and prospects for the measurement of health using self-rated health. *Public Opin Q*. 2016;80:977-997.