Feasibility and efficacy of a pilot family model of diabetes self-management intervention in the Republic of the Marshall Islands

Jennifer A. Andersen a, Holly Felix b, James Selig b, Brett Rowland c, Wana Bing c, Jonell Hudson d, Jack Niedenthal d, Henry Otuafi a, Ainrik George e, Sheldon Riklon e, Edlen Azures e, Pearl A. McElfish a, * 

ABSTRACT

Background: The Republic of the Marshall Islands (RMI) faces numerous health disparities, including one of the highest prevalence of type 2 diabetes mellitus (T2DM) in the world. Diabetes self-management education and support (DSMES) has shown efficacy in improving glycemic control and through increases in knowledge and self-management activities; however, there is limited research on DSMES in the RMI. This study evaluated the feasibility and efficacy of a culturally adapted family model of DSMES (F-DSMES) in the RMI. The F-DSMES included 8 h of group educational classes delivered in churches by a community health worker.

Methods: This pilot study assessed retention and dosage rates (e.g., class attendance) among the participants with T2DM (n = 41). Efficacy was evaluated by examining pre- and post-intervention differences in HbA1c, knowledge, family support, and self-management activities among those who completed the post-intervention data collection (n = 23).

Results: The results indicate completion of post-intervention data collection and attendance were associated; 70% of participants who completed the post-intervention data collection received at least 6 h of intervention compared to 3 h for those who did not. Although the reduction in HbA1c was not statistically significant, participants demonstrated statically significant increases in knowledge, family support, and an increase in self-management including in checking of blood glucose and feet.

Conclusions: This study provides important information to help address T2DM disparities in the RMI, including the feasibility and efficacy of F-DSMES. Additional research will help in understanding how to translate improvements in knowledge, family support, and self-management activities into improvements in HbA1c. This may include addressing social ecological factors that affect glycemic control.

Background

The Republic of the Marshall Islands (RMI), an independent United States (US) Affiliated Pacific Island nation, faces significant health disparities [1,2]. Nuclear testing conducted in the RMI by the US Military in the 1940s and 1950s intensified these health disparities in two important ways [1,3–5]. The first stems from research conducted by American scientists of the effects of nuclear fallout on the Marshallese population, without consideration of language differences or informed consent, thus creating distrust in outside researchers [3]. The second stems from the nuclear fallout that led to the contamination of local fresh food sources, creating a reliance on highly processed commodity foods (e.g., rice, canned meat) [3–7]. The dependence on commodity foods has increased the intake of simple carbohydrates and fats while simultaneously reducing the intake of fresh fruits and vegetables [5,6]. Given the transition from the traditional diet of natural, whole foods to a diet high in processed foods, health disparities now experienced by the Marshallese population in the RMI include a higher than average rate of type 2 diabetes mellitus (T2DM) [5,6].
diabetes mellitus (T2DM) [8–11]. Over 30% of Marshallese adults in the RMI have T2DM, a rate much higher than experienced by the general population in the US (13.3%) and globally (9.3%) [8,12].

Diabetes self-management education and support (DSMES), an evidence-based intervention, has shown to improve risk factors for diabetes as well as assist people diagnosed with diabetes and effectively manage the condition [13–16]. Although DSMES has resulted in improvement of diabetes self-management, the results are not universal across racial/ethnic groups, leading to the need to adapt DSMES interventions to improve efficacy in marginalized communities [17–19]. Culturally appropriate family models of DSMES (F-DSMES) have shown improvements in diabetes management for marginalized communities, including African American, Latinx, and Native American communities [16–22]. There is limited research on the effectiveness of F-DSMES in the RMI. The one currently published study of DSMES in the RMI did not document an effect on diabetes related outcomes, including glycemic control, and did not include family members [23]. Given the historical trauma and resulting health disparities, including the high rate of diabetes in the RMI, it is crucial to address the disparate rate of diabetes in ways that are sensitive to the culture and experiences of the Marshallese population of the RMI.

F-DSMES in the RMI

Social Cognitive Theory (SCT) is the basis for F-DSMES interventions. SCT recognizes interactions between individuals, their environment, and their behaviors that are active and reciprocal [24,25]. Moreover, SCT recognizes that human health is a social matter, an important aspect of the successful implementation of F-DSMES interventions. Social and environmental context is particularly important in understanding self-management behaviors. Individual attribution ignores the influence of the social, cultural, and environmental context on the ability to adhere to diabetes treatment and self-management plans [22,26–38]. Family members, through interactions with the person with T2DM, may sway choices to follow recommended treatment and self-care regimens.

The goal of the F-DSMES curriculum is to engage family members as active participants in diabetes care and to include them in the setting of goals and planning strategies to manage T2DM, with the intention of increasing social support for self-management behaviors and ultimately improving health outcomes for the person with T2DM and potentially for the family member [39,40].

The authors developed an F-DSMES intervention in conjunction with the Marshallese community in Arkansas. The Arkansas F-DSMES curriculum is asset-based, identifying and leveraging culturally specific facilitators of healthy behavioral change to overcome barriers to effective self-management. Multiple articles have described the F-DSME intervention [41–43]. When the Arkansas F-DSMES intervention was compared to a standard DSMES intervention in a randomized controlled trial (RCT), the Arkansas F-DSMES demonstrated a 1.15% reduction in mean HbA1c (p < .001) immediately post intervention and 0.87% reduction at 12 months (p < .001) [41].

Given the success of the RCT in Arkansas, the curriculum was pilot tested in the RMI in cooperation with the local community leaders and the Ministry of Health and Human Services. This article presents the initial evaluation of the pilot F-DSMES in RMI and its effect on glycated hemoglobin levels (HbA1c), diabetes knowledge, and family support for diabetes care for the Marshallese participants. The article also describes the feasibility of conducting a trial in the RMI [43].

Methods

Study setting

In Arkansas, the F-DSMES intervention was delivered to a participant with T2DM and at least one family member. F-DSMES sessions held in the home were facilitated by a bilingual community health worker (CHW) and a certified diabetes educator (CDE) over the course of eight weeks. Although the F-DSMES using these methods demonstrated efficacy in the Marshallese community in Arkansas, the RMI lacks resources including CDEs and homes large enough to facilitate family education sessions [41,42,44]. Therefore, the F-DSMES offered in the RMI used trained CHWs without a CDE present and group-based education sessions delivered in local faith-based organizations (FBOs) [45]. CHWs received 40 h of general CHW training, plus 40 h of F-DSMES curriculum and study specific training. All the CHWs were local Marshallese living in the RMI. The eight weeks of F-DSMES provided 10 h of diabetes education to participants and their family members, with an additional two-week window for make-up classes, as needed.

Recruitment

Faith and FBOs are an important part of Marshallese culture, and prior reports indicate 96.5% of the Marshallese population report regular church attendance [45]. Recruitment took place during informational sessions at four FBOs where the group educational classes for participants and family members were later held [45].

Inclusion criteria

The inclusion criteria for participants included: (1) Marshallese descent; (2) at least 18 years of age; (3) a diagnosis of T2DM (defined as having an HbA1c ≥ 6.5); (4) a family member willing to participate in the program; and (5) a commitment to attend and participate in all educational sessions and data collection events. Exclusion criteria included: (1) having participated in a DSMES in the past five years; (2) plans to leave the area during the study; or (3) reporting a condition which would make it unlikely for the participant to complete the program [43].

Informed consent

Bilingual research staff completed a written informed consenting process with all interested and eligible participants.

Data collection

The study protocol and materials were reviewed and approved by the University of Arkansas for Medical Sciences Institutional Review Board (#239272), adapted from the instruments and protocol developed as part of the Adapted Family Model of DSME RCT (UAMS IRB#203482) (Clinical Trial #NCT02407132) [41,46]. The RMI Ministry of Health and Human Services reviewed and approved the study for conduct in the RMI. Each of the eight 75-min sessions recorded class attendance. Data collection took place pre-intervention and immediately post-intervention. At each time point, the researchers collected biometric data, including HbA1c, and survey data.

Researchers only collected data from those who consented to participate in the study. Participants could refuse any aspect of the data collection and continue in the F-DSMES program. Researchers provided the participants with a copy of their biometric screening results and provided participants with confidential health counseling and referral information to a local healthcare provider as needed. Additionally, participants were given a glucometer and were provided a supply of tests strips during the study.

Measures. Researchers utilized a finger stick, blood collection process with a Rapid A1c test kit (Siemens DCA Vantage Analyzer) to measure HbA1c, the primary outcome. HbA1c is a continuous measure of glycated hemoglobin, representing an average level of blood glucose over the previous three-month period. Pre- and post-intervention body mass index (BMI) was calculated using the participant’s height and weight collected in normal street clothes without shoes ([weight in pounds]/[height in inches] 2 ) *703. Researchers also used an OMRON digital blood pressure monitor to measure systolic and diastolic blood
pressure while the participant was seated with arm elevated.

In addition, participants completed a survey instrument previously piloted in the Arkansas F-DSMES program, utilizing questions from the Behavioral Risk Factor Surveillance System (BRFSS) and Healthcare Access Modules and the Diabetes Care Profile. The survey questions included basic demographic questions (e.g., age, sex, education) and additional questions regarding diabetes knowledge, family support, and diabetes self-care behaviors. The diabetes knowledge and family support questions used a three point Likert scale (0 = none, 2 = a lot). Self-care behaviors are a categorical variable of the reported number of self-checks of blood sugar and feet done daily, weekly, monthly, yearly, or never.

Analysis

The current study reports retention and dosage information. Descriptive statistics, including means and standard deviations for continuous variables and proportions for categorical variables, are presented to characterize all participants with T2DM (n = 41) who enrolled in the study and assess differences between those who completed the post-intervention data collection (n = 23) and those who did not (n = 18). The researchers used a Wilcoxon signed-rank test to evaluate the differences in HbA1c, diabetes knowledge, and family support, and an exact McNemar test was used to evaluate differences in self-checks pre-intervention and immediately post-intervention due to the non-normal distribution of the data.

The purpose of the pilot study was to assess the preliminary effectiveness of the intervention; thus, the size, direction of the effect sizes, and the clinical meaningfulness (e.g., 0.5-1% reduction of HbA1c level) were included in interpreting the results [47–49]. The analyses were conducted using STATA version 15.1, and p-values less than 0.05 were considered statistically significant.

Fig. 1. Enrollment and retention of study participants.
Results

Recruitment

One-hundred and twenty-six participants from four FBOs were screened for inclusion in the RMI F-DSMES intervention, (Fig. 1). One person was deemed ineligible due to a preexisting health condition, and ten required waivers from the intervention team’s physician. One-hundred and twenty-five agreed to be enrolled in the study. Twenty-eight participants did not return for the primary data collection, with a final intervention sample of 97, including 41 participants with diabetes and 56 family members. This article focuses on the 41 participants with diabetes. The final analysis includes 23 participants with T2DM who returned for the post-intervention data collection (Fig. 1).

Demographics, retention, and dosage

Table 1 reports the characteristics of the sample. The mean age of participants was 51.5 years (±12.4) and the majority (78.3%) were female. Over half of participants had not graduated high school (60.9%), and less than 9% had attended at least some college. Fifty-seven percent of the participants were married or cohabitating. Overall, the 41 participants was 51.5 years (±12.4) for the pre- and post-intervention HbA1c. Results did not show a significant difference in median HbA1c pre- and post-intervention (p = .78). Eight of the participants showed a decrease in their HbA1c; however, fourteen showed an increase in HbA1c. One participant had a pre- and post-intervention HbA1c that remained unchanged.

Table 2 reports the results of the Wilcoxon Signed Rank Test for pre- and post-intervention HbA1c. Results did not show a significant difference in median HbA1c pre and post-intervention (p = .78). Eight of the participants showed a decrease in their HbA1c; however, fourteen showed an increase in HbA1c. One participant had a pre- and post-intervention HbA1c that remained unchanged.

Changes in HbA1c

Table 2 reports the results of the Wilcoxon Signed Rank Test for pre- and post-intervention HbA1c. Results did not show a significant difference in median HbA1c pre and post-intervention (p = .78). Eight of the participants showed a decrease in their HbA1c; however, fourteen showed an increase in HbA1c. One participant had a pre- and post-intervention HbA1c that remained unchanged.

Changes in diabetes knowledge

Post-intervention scores show an improvement in all categories of family support. Table 4 details the results of the Wilcoxon Ranked Sign Test for each of the questions regarding the participant’s level of support from their family members. Prior to the F-DSMES intervention, the participants reported little support from their family in following their diabetes care plans. Post intervention, there were significant improvements in family support reported, including (1) following a meal plan (p = .007); (2) remembering medications (p = .006); (3) foot care (p = .004); (4) blood sugar testing (p < .001); and (5) dealing with feelings about diabetes (p < .001).

Changes in self-care behavior

Participants who indicated they had been previously told they had diabetes (N = 18) were asked pre- and post-intervention how often they were performing self-care behaviors, including self-checks of blood

Table 1

Comparison of demographics and biometrics for participants with complete and incomplete HbA1c data.

| Measures                        | Complete Cases (n=23) | Incomplete Cases (n=18) | Fisher Exact/Two Sample Wilcoxon Ranked Sum Test |
|--------------------------------|----------------------|------------------------|-------------------------------------------------|
|                                | Mean (±SD) / n (%)   | Mean (±SD) / n (%)     | p                                                |
| Age                            | 51.5 (±12.4) / 18     | 52.2 (±12.0) / 12      | .87                                              |
| Sex                            |                       |                        | .49                                              |
| Male                           | 5 (21.7)              | 6 (33.3)               |                                                  |
| Female                         | 18 (78.3)             | 12 (66.7)              |                                                  |
| Marital Status                 |                       |                        | .51                                              |
| Married or Cohabitating        | 13 (56.5)             | 11 (61.1)              |                                                  |
| Single                         | 10 (43.5)             | 7 (38.9)               | .49                                              |
| Education                      |                       |                        | .73                                              |
| Less than a HS Diploma         | 14 (60.9)             | 14 (77.8)              |                                                  |
| HS Diploma                     | 7 (30.4)              | 4 (22.2)               |                                                  |
| Beyond HS Diploma              | 2 (8.7)               | 0 (0.0)                |                                                  |
| Work Status                    |                       |                        | .13                                              |
| Employed                       | 7 (30.4)              | 4 (22.2)               |                                                  |
| Unemployed                     | 16 (69.6)             | 14 (77.8)              | <.001                                            |
| Number Of Hours Attended       | 7.1 (±3.1)            | 3.2 (±3.0)             |                                                  |
| Pre-Intervention HbA1c         | 9.9 (±2.6)            | 10.3 (±2.4)            | .51                                              |
| Pre-Intervention BMI           | 31.7 (±5.7)           | 29.1 (±6.4)            | .13                                              |
| Has a doctor told you that you have Diabetes? | 5 (21.7) | 6 (33.3) | .49                                              |
| No                             | 18 (78.3)             | 12 (66.7)              |                                                  |

Notes: Totals may not add to 100% due to rounding. SD: Standard Deviation.
there was not a statistically significant difference in the proportion of participants asked were not performing these self-care behaviors.

Changes in family support from pre-to post-intervention.

|                          | Measure | Pre-Intervention (n = 18) | Post-Intervention (n = 17) | Wilcoxon Ranked Sign Test | P |
|--------------------------|---------|--------------------------|---------------------------|---------------------------|---|
| Does your family help you... |         |                          |                           |                           |   |
| Follow your meal plan?   | Mean (±SD) | 1.33 (±.69)            | 1.94 (±.24)               | .007                      |   |
| Remember your medications? |         | 1.11 (±.76)            | 1.88 (±.49)               | .006                      |   |
| Remember to check your feet? |         | .89 (±.83)             | 1.71 (±.69)               | .004                      |   |
| Remember to check your blood sugar? |   | 1.22 (±.73)           | 2.00 (±.00)               | <.001                     |   |
| Deal with your feelings about diabetes? | | 1.28 (±.67)        | 2.00 (±.00)               | <.001                     |   |

Notes: d = Cohen’s d effect size.

Changes in diabetes knowledge from pre-to post-intervention.

| Measures of Diabetes Knowledge | Pre-Intervention (n = 18) | Post-Intervention (n = 17) | Wilcoxon Ranked Sign Test | P |
|--------------------------------|--------------------------|---------------------------|---------------------------|---|
| Do you understand how...      | Mean (±SD)               | Mean (±SD)                | p                         |   |
| To manage your diabetes?      | .89 (±.47)               | 1.71 (±.47)               | <.001                     |   |
| To cope with stress?          | .94 (±.58)               | 1.71 (±.59)               | .006                      |   |
| Food affects your blood sugar?| .89 (±.47)               | 1.71 (±.47)               | .002                      |   |
| Exercise affects your blood sugar? | .89 (±.47)         | 1.76 (±.44)               | <.001                     |   |
| To take your diabetes medications? | 1.11 (±.83)       | 1.76 (±.56)               | .030                      |   |
| To use your blood sugar results? | 1.11 (±.83)        | 1.88 (±.33)               | .005                      |   |
| Diet, exercise, and medicines affect blood sugar levels? | .89 (±.47) | 1.88 (±.33) | <.001 | |
| To prevent high blood sugar? | .67 (±.59)               | 1.94 (±.24)               | <.001                     |   |
| To prevent low blood sugar?   | .78 (±.65)               | 1.76 (±.56)               | <.001                     |   |
| To prevent complications from diabetes? | .78 (±.55)     | 1.82 (±.39)               | <.001                     |   |
| To care for your feet?        | .89 (±.68)               | 1.94 (±.24)               | <.001                     |   |
| The benefits of managing your diabetes? | .89 (±.58)     | 1.94 (±.24)               | <.001                     |   |

Table 4 Changes in family support from pre-to post-intervention.

|                          | Pre-Intervention (n = 18) | Post-Intervention (n = 17) | Wilcoxon Ranked Sign Test | P |
|--------------------------|--------------------------|---------------------------|---------------------------|---|
| Does your family help you... |         |                          |                           |   |
| Follow your meal plan?   | Mean (±SD)               | 1.33 (±.69)            | 1.94 (±.24)               | .007                      |   |
| Remember your medications? |         | 1.11 (±.76)            | 1.88 (±.49)               | .006                      |   |
| Remember to check your feet? |         | .89 (±.83)             | 1.71 (±.69)               | .004                      |   |
| Remember to check your blood sugar? |   | 1.22 (±.73)           | 2.00 (±.00)               | <.001                     |   |
| Deal with your feelings about diabetes? | | 1.28 (±.67)        | 2.00 (±.00)               | <.001                     |   |

* Note: Responses limited to participants who stated a physician or other HCW said they have diabetes (Pre-Intervention n = 18, Post-Intervention n = 17).

Table 5 Changes in self-care behaviors from pre-to post-intervention.

|                          | Measure | Pre-Intervention (n = 18) | Post-Intervention (n = 17) | Exact McNemar’s Test | P |
|--------------------------|---------|--------------------------|---------------------------|----------------------|---|
| Self-Check Feet          | n(%)    | n(%)                     |                           |                      |   |
| Never or No              | 10 (55.5) | 5 (29.4)               |                           |                      | .22 |
| Daily                    | 4 (22.2)  | 10 (58.8)              |                           |                      |   |
| Weekly                   | –       | 1 (5.9)                 |                           |                      |   |
| Monthly                  | 2 (11.1)  | 1 (5.9)                |                           |                      |   |
| Yearly                   | 2 (11.1)  | –                      |                           |                      |   |
| Self-Check Glucose       | n(%)    | n(%)                     |                           |                      | .001 |
| Never                    | 4 (22.2)  | –                      |                           |                      |   |
| Daily                    | 3 (16.7)  | 17 (100)               |                           |                      |   |
| Weekly                   | 5 (27.8)  | –                      |                           |                      |   |
| Monthly                  | 2 (11.1)  | –                      |                           |                      |   |
| Yearly                   | 4 (22.2)  | –                      |                           |                      |   |

* Responses limited to participants who stated a physician or other HCW said they have diabetes (Pre-Intervention n = 18, Post-Intervention n = 17).

Overall retention in the RMI F-DSMES was low with only 56% completing post-intervention data collection. Although overall intervention dosage was moderate, with a mean of 5.4 (±3.6) hours of diabetes education per participant, those who provided post-intervention data completed a mean of 7.1 (±3.1) hours of diabetes education per participant. These results are compared to a retention rate of 97% in post-intervention data collection for the F-DSME in Arkansas and a mean dosage rate of 8 h of diabetes education. These results demonstrate promise but also show that improvement in retention methods is needed.

Discussion

in participants checking their feet. Self-checks of blood glucose levels improved post-intervention, with all participants reporting checking their blood glucose daily compared to 16.7% reporting daily checks at pre-intervention (p = .001) (Table 5).
HbA1c tests are influenced by the overall physical health of the person. Prior research has shown that a majority of Marshallese in the RMI demonstrated hemoglobin cells survive for 115 days, with a range of 70–140 days [60]. With this in mind, HbA1c may not be reflective of the overall change in glucose levels even at the 12-week mark. Moreover, HbA1c tests are influenced by the overall physical health of the person from whom the sample is drawn. It may be, given the history of nuclear fallout exposure in the RMI, inhabitants of the RMI may have undetected health conditions (e.g. anemia) limiting the accuracy of HbA1c tests [61].

Despite the limitations, this article adds important and significant information to the literature. This is the first Family DSMES study to be implemented in the RMI and the first DSMEs to be implemented in the RMI with CHW. Although the F-DSMES did not yield results similar to those achieved in Arkansas, the pilot does provide important information as the authors, other researchers, and policy makers address the significant diabetes health disparities evident in the RMI. Future research should consider multi-level interventions that address social ecological factors, consider further adaptation, and consider additional training for CHWs for implementation of DSME in the RMI and other areas where health care workers are limited.

**Funding**

UAMS Translational Research Institute funding awarded through the National Center for Research Resources and National Center for Advancing Translational Sciences of the National Institutes of Health (NIH) (number 1U54TR001629-01A1) supported the community engagement efforts. An award from the Sturgis Foundation supported the DSME pilot study.

**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 IRB Protocol Number is #239272.

** Consent for publication**

Not applicable.

**Availability of data and material**

Not applicable.

**Declaration of competing interest**

The authors have no potential conflicts of interest.

**Acknowledgements**

This study was made possible because of a community-based participatory research partnership with local Marshallese faith-based leaders, the RMI Ministry of Health & Human Services, Kora In Jiban Lolorjake Ejmour (KIJLE), and the Marshallese Consulate General in Springdale, Arkansas.

**References**

[1] Central intelligence agency. The world factbook: Australia-oceania: Marshall Islands. Available from: https://www.cia.gov/library/publications/the-world-factbook/geos/rr.html, June 2, 2020.

[2] H.M. Ichiro, et al., An assessment of non-communicable diseases, diabetes, and related risk factors in the republic of the Marshall Islands, majuro atoll: a systems perspective, Hawai`i J. Med. Public Health 72 (5 Suppl 1) (2013) 87–97.

[3] H. Barker, Bravo for the Marshallese: Regaining Control in a Post-Nuclear, Post-Colonial World, Cengage Learning, Belmont, CA, 2012.

[4] R. Guyer, Radioactivity and rights: clashes at bikini atoll, Am J Public Health 91 (9) (2001) 1371–1376.

[5] N. Pollock, Health transitions, fast and nasty: exposure to nuclear radiation, Pac. Health Dialog 9 (2) (2002) 275–282.

[6] J. Gittelsohn, et al., Macro- and microlevel processes affect food choice and nutritional status in the Republic of the Marshall Islands, J. Nutr. 133 (1) (2003) 3105–3135.
