A Culturally Tailored Community Health Worker Intervention Leads to Improvement in Patient-Centered Outcomes for Immigrant Patients With Type 2 Diabetes

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IN BRIEF This article reports results from a patient-centered intervention to improve management of type 2 diabetes in the New York City Bangladeshi community. The DREAM (Diabetes Research, Education, and Action for Minorities) intervention is a randomized trial among Bangladeshi immigrants with type 2 diabetes comparing those enrolled in a community health worker (CHW) intervention to those in usual care. Participants in the intervention group received five group-based educational sessions and two one-on-one visits delivered by a trained CHW, whereas those in the control group received only the first group educational session. Main outcomes include changes in A1C, systolic and diastolic blood pressure, cholesterol, triglycerides, weight, BMI, and patient-centered outcomes such as knowledge and behavior related to type 2 diabetes management.

South Asians, making up one-fifth of the world's total population (1), face a high prevalence of type 2 diabetes. More than 70 million individuals in South Asia have type 2 diabetes (2); by 2030, this number will be ~121 million (3–6). Among South Asian countries, Bangladesh has a high prevalence of type 2 diabetes, with 8.4 million Bangladeshis (10% of the total population) living with the disease; by 2030 this rate is projected to increase to 13% (7,8). Additionally, Bangladesh was among the top 10 countries with the highest numbers of people with type 2 diabetes in 2010 and is predicted to remain in this group through 2030 (9).

There are more than 3.4 million South Asians in the United States, and Bangladeshis are one of the fastest growing immigrant groups (10,11). A majority of Bangladeshis live in New York City (NYC), where the group experienced a 142% increase in growth (from 27,804 to 67,176) between 2007 to 2013 (12,13).

Although population-based estimates of type 2 diabetes prevalence in the U.S. Bangladeshi population do not exist, two studies using A1C measurements found high rates of diabetes among all South Asians; the NYC Health and Nutrition Examination Survey found an age-adjusted prevalence of diabetes of 35.4% among foreign-born South Asians, and the MASALA (Mediators of Atherosclerosis in South Asians Living in America) study in California found 29% of South Asians to have diabetes (14,15). Community-based studies of Bangladeshi immigrants in NYC have reported similarly high rates of diabetes compared to the general population, ranging from 15 to 24% (10).

The high prevalence of type 2 diabetes in the Bangladeshi population may be further influenced by their unique sociodemographic profile. For example, Bangladeshis have a high rate of limited English profi-

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ciency compared to other subgroups; about 53% of NYC Bangladeshis speak English less than "very well," as compared to the citywide limited English proficiency rate of 23%. NYC Bangladeshis are among the poorest of the Asian subgroups; ~33% of Bangladeshis in NYC live below the poverty line, compared to the citywide rate of 20%. NYC Bangladeshis also have lower rates of high school completion and annual household income compared to citywide numbers (16).

Studies have found that the impact of socioeconomic status, language, and culture plays a significant role in diabetes management disparities for the Bangladeshi population. For example, South Asians face barriers to understanding and receiving information about type 2 diabetes from health care providers and are less likely to receive care that aligns with standards of diabetes management (17). There is a paucity of culturally appropriate and in-language resources and health information on type 2 diabetes management for this population. Poor medication adherence related to language and health literacy barriers has also been identified as a major barrier to type 2 diabetes management (17,18). Additionally, systemic issues such as the difficulty in navigating complex health care systems and the concentration of the Bangladeshi populations in sedentary, low-wage workforces in urban areas such as NYC have also been identified as barriers for type 2 diabetes management for this community (18).

Given the disproportionate burden of type 2 diabetes and barriers to management faced by the Bangladeshi population, patient-centered approaches that account for the cultural, linguistic, and social context of disease are needed to mitigate the effects of type 2 diabetes. Community health workers (CHWs) play a vital role in linking diverse and underserved populations to health and social services and can facilitate patients' active involvement in their own care by providing culturally appropriate support. CHWs are indigenous to the communities they serve; they understand the values and norms of the community, making them a trusted source of information (19,20). With the advent of the patient-centered medical home model, primary care practices increasingly aim to work in an integrated, coordinated manner for patients (21). A growing evidence base suggests that CHWs provide a low-cost and cost-effective approach to improving care and adherence for patients with chronic disease (22–25). A recent review of the impact of CHWs on type 2 diabetes management found that, on average, CHW interventions produce a 0.2% reduction in A1C, with the greatest reduction (≥0.5%) among individuals at the most elevated levels (26). Our own work has demonstrated that a culturally adapted CHW-led intervention is acceptable and efficacious in improving A1C, weight loss, self-efficacy and social support, and health behaviors for Bangladeshi patients with type 2 diabetes. Outside of this pilot study, no known randomized, controlled trial has been conducted within the NYC Bangladeshi community evaluating the efficacy of a CHW intervention to improve type 2 diabetes management (27).

The purpose of this study was to test the efficacy of a CHW-led patient-centered lifestyle intervention on type 2 diabetes management among Bangladeshis in NYC. We examine the intervention effect on changes in A1C, systolic and diastolic blood pressure, cholesterol, triglycerides, weight, BMI, and patient-centered outcomes such as knowledge and behaviors related to type 2 diabetes management.

Research Design and Methods

The DREAM (Diabetes Research, Education, and Action for Minorities) Project employed a two-arm randomized, controlled trial design. Individuals were eligible to participate in the intervention if they self-identified as Bangladeshi, were between 21 and 75 years of age, resided in the NYC metropolitan area, and had a diagnosis of type 2 diabetes defined by an A1C ≥6.5%, as verified by medical record. Individuals were excluded from participation if they reported being on renal dialysis, had an acute or terminal illness or serious mental illness, had a recent history of an acute medical problem or admission to a hospital, had a poor short-term prognosis, had previously participated in a similar intervention, or had plans to move away or travel outside the United States for an extended period of time. All participants provided written informed consent before study enrollment. Human subjects approval was obtained in 2011, and the trial was registered at ClinicalTrials.gov (identifier: NCT02041598).

Participants were recruited from March 2011 through February 2016 through clinic and community settings. After providing consent and completing a screening survey, participants were stratified by sex and age (≥50 or <50 years) and randomized to either the intervention or control group using IBM SPSS Statistics for Windows, versions 21.0 and 22.0 (IBM Corp., Armonk, N.Y.) in a 1:1 ratio; spousal/familial dyads were randomized to the same study arm based on assignment of the wife or original enrollee. Multiple randomizations took place within each round of recruitment, with a total of seven recruitment and intervention rounds.

The intervention was delivered by four trained, bilingual Bangladeshi CHWs—two male and two female—who were active leaders in the community of interest. The intervention consisted of five 2-hour monthly group educational sessions and two one-on-one visits lasting ~90 min each. The intervention curriculum was culturally and linguistically adapted for Bangladeshi community members based on an existing diabetes management curriculum validated in other minority communities (27). Participants randomized to the control group were invited to attend only the first educational group session, which provided an overview of type 2 diabetes. The subsequent four sessions included group-based education on nutrition and healthy eating, the importance of and strategies for increasing physical activity, potential complications of type 2 diabetes and preventive self-care, and stress management and family support related to diabetes management. All intervention sessions and materials were delivered in Bengali and held in clinical and community settings. Two one-on-one visits were held during the 6-month intervention period at locations convenient to participants, including their home, before or after a doctor's visit, or another mutually agreed upon location. At these sessions, CHWs engaged in individualized goal-setting for health behavior change and provided culturally appropriate referrals to care as needed. Participant recruitment, CHW recruitment and training, and intervention content and delivery have been previously described in greater detail (19).

Measures

The primary study outcome was glycemic control, measured by A1C. Secondary outcomes included additional physiological measures of LDL cholesterol, HDL cholesterol, total cholesterol, triglycerides, weight, BMI, and systolic and diastolic blood pressure. A1C, LDL, HDL, total cholesterol, and triglycerides were collected from medical records. Height, weight, and blood pressure were collected by CHWs. Measures were collected at baseline and 6 months; the mean interval between baseline and follow-up A1C measures was 6.3 months (SD 2.1). Patient-centered outcomes included type 2 diabetes knowledge, self-reported measures of physical activity and diet, and self-management of diabetes. Diabetes knowledge was assessed with a question on knowledge of A1C, and the mean score of nine questions adapted from the Michigan Diabetes Knowledge Scale (28). Physical activity was assessed with a series of questions assessing self-reported weekly moderate physical activity, self-reported weekly vigorous physical activity, total weekly physical activity (moderate physical activity combined with two times vigorous physical activity, per 2008 physical activity guidelines) (29), confidence in performing physical activity (30), and barriers to performing physical activity. Self-reported diet quality was evaluated using the mean scores of three scales assessing portion control, confidence in maintaining a healthy diet, and barriers to maintaining a healthy diet that were adapted from a previous diabetes weight management study (31). Self-management of diabetes was assessed with a medication adherence scale adapted from the Morisky Medication Adherence Scale (32), a question on self-management strategies, and a scale on self-efficacy related to health care (30,33). The exact questions are included in Table S1. Further description of measures and data collection procedures are described elsewhere (19).

Statistical Methods

The study sample size was based on the main clinical outcome measure: decrease in A1C. The primary outcome measure of A1C was estimated by using previous changes observed in a pilot study, as well as in previous research (19,27,34). Control group A1C estimates were based on hospital patients receiving usual care. An absolute difference of 0.3% in A1C between the groups (6.7 vs. 6.4%) with a power of 0.8 and significance level of 0.05 could be detected with a total of 120 individuals in each group. We anticipated that 75% of study participants would be followed to completion of the study at 6 months, with ~96 individuals in each group.

We compared baseline characteristics between the intervention and control groups using Pearson χ^2 tests for categorical variables and Student's *t* test for continuous variables. To test within-group differences between baseline and 6-month follow-up, as well as the proportion with A1C under control at 6-month follow-up, we used paired *t* tests and McNemar tests for each outcome measure. To assess change across groups for each continuous outcome, we ran generalized estimated equation (GEE) models for repeated measures over time using the GENMOD procedure in SAS to fit generalized linear models, while adjusting for study arm, time point, and the interaction between study arm and time point. Adjusted models were run to also include age and sex. The interaction variable tests the intervention effect and indicates whether there are significant differences in changes in the outcome between intervention and control groups. To assess change across groups for dichotomous outcomes, we ran a GEE model using a binomial distribution, and odds ratios were produced. SAS version 9.4 (SAS Institute, Cary, N.C.) was used for all analyses.

Results

A total of 880 individuals were assessed for eligibility; of these, 11% did not meet inclusion criteria, 12% declined to participate, and 27% did not participate for other reasons. Of 336 randomized participants, 176 were allocated to the intervention and 160 were allocated to the control group (Figure 1). A larger number of individuals were enrolled to the intervention group due to multiple randomizations over seven total recruitment and intervention rounds; however, the total sample size required was exceeded for both groups. There were no statistically significant differences in sociodemographic characteristics between the groups at baseline; however, control group participants were significantly more likely than intervention group participants to report more frequent vigorous week-

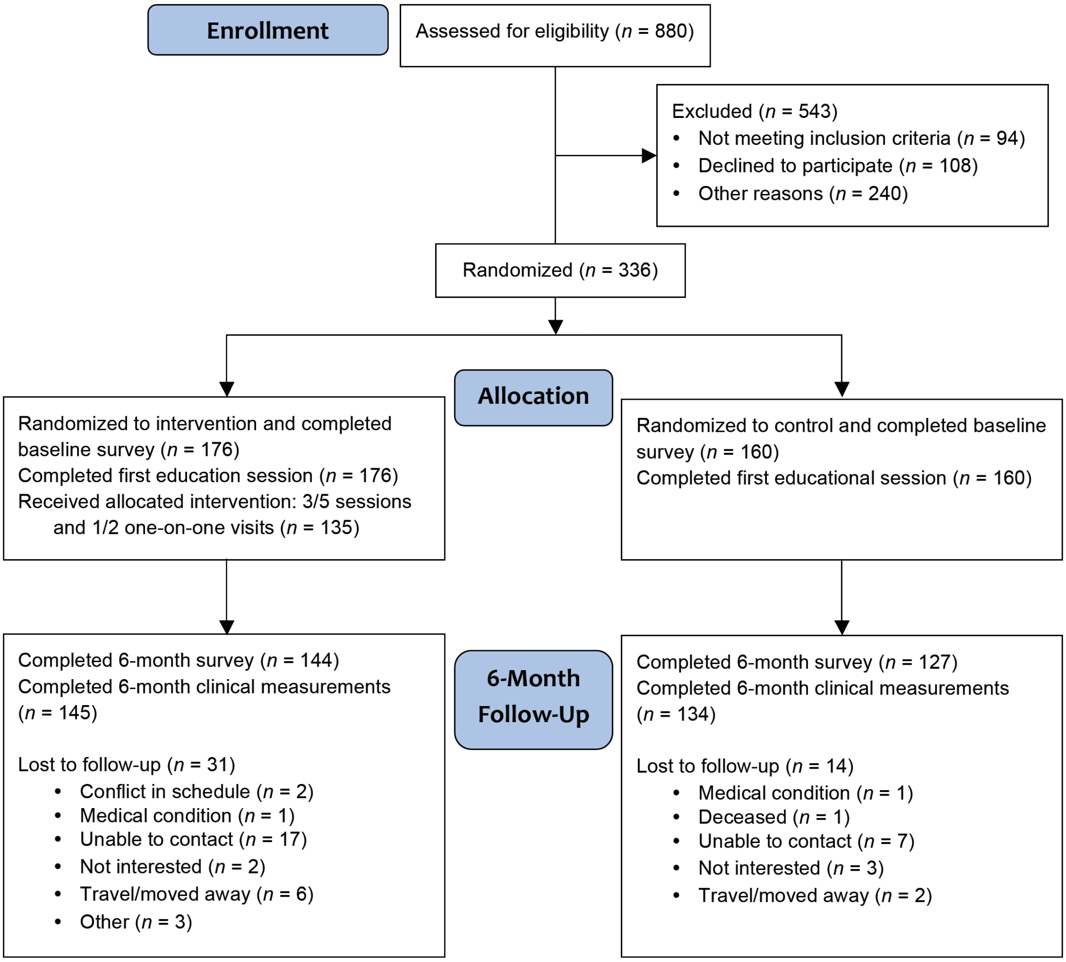

FIGURE 1. DREAM Program consort diagram.

TABLE 1. Baseline Characteristics of All Randomized DREAM Participants

	Intervention (*n* = 176)	Control (*n* = 160)	*P*
Sociodemographics			
Female (*n* [%])	71 (40.3)	64 (40.0)	0.949
Years of age (mean [95% CI])	54.2 (55.7–55.8)	55.6 (54.0–57.2)	0.221
Years lived in United States (mean [95% CI])	12.5 (11.2–13.9)	13.7 (12.2–15.2)	0.227
Marital status (*n* [%])			0.738
Married	164 (93.7)	148 (94.3)	
Widowed/divorced	9 (5.1)	7 (4.5)	
Never married	2 (1.1)	2 (1.3)	
Education level (*n* [%])			0.536
Less than high school	47 (27.3)	49 (31.2)	
High school/GED	64 (37.2)	61 (38.9)	
More than high school	61 (35.5)	47 (29.9)	
How well do you speak English? (*n* [%])			0.844
Speaks English very well or well	79 (45.4)	66 (41.5)	
Years with diabetes (mean [95% CI])	7.6 (6.7–8.5)	8.9 (7.9–10.0)	0.055

TABLE CONTINUED ON P. 104 →

TABLE 1. Baseline Characteristics of All Randomized DREAM Participants, *continued from p. 103*

Taking diabetes medication (*n* [%])	155 (89.6)	146 (91.3)	0.609
Physiological measures			
Weight (lb; mean [95% CI])	152.7 (148.8–156.6)	151.9 (148.4–155.5)	0.781
BMI (kg/m^2; mean [95% CI])	26.9 (26.3–27.5)	27.0 (26.3–27.6)	0.866
Systolic blood pressure (mmHg; mean [95% CI])	129.6 (126.9–132.3)	131.5 (128.7–134.2)	0.339
Diastolic blood pressure (mmHg; mean [95% CI])	78.3 (76.7–79.9)	78.0 (76.3–79.7)	0.793
A1C (%; mean [95% CI])	7.7 (7.6–7.9)	8.0 (7.8–8.2)	0.082
Cholesterol (mg/dL; mean [95% CI])	159.1 (150.9–167.3)	155.1 (147.0–163.1)	0.485
Triglycerides (mg/dL; mean [95% CI])	157.4 (142.0–172.7)	161.3 (147.0–175.6)	0.711
HDL cholesterol (mg/dL; mean [95% CI])	42.0 (40.4–43.5)	41.6 (39.9–43.3)	0.751
LDL cholesterol (mg/dL; mean [95% CI])	83.3 (77.9–88.7)	79.6 (73.8–85.4)	0.355
Diabetes knowledge			
Knowledge scale, 0–9, 9 = highest (mean [95% CI])	4.6 (4.3–4.9)	4.8 (4.5–5.1)	0.397
Knows what A1C is (*n* [%])	17 (9.7)	20 (12.6)	0.405
Physical activity			
Moderate weekly activity (min/week; mean [95% CI])	79.6 (60.9–98.4)	93.9 (61.5–126.3)	0.442
Vigorous weekly activity (min/week; mean [95% CI])	10.0 (2.4–17.6)	41.8 (17.3–66.3)	0.012
Total weekly activity (min/week; mean [95% CI])	99.7 (75.5–123.9)	176.9 (106.9–246.9)	0.034
Confidence, 1–4, 4 = highest (mean [95% CI])	3.4 (3.3–3.5)	3.4 (3.3–3.5)	0.821
Barriers, 0–5, 5 = most (mean [95% CI])	1.3 (1.1–1.5)	1.6 (1.4–1.8)	0.070
Diet			
Portion control, 1–4, 4 = highest (mean [95% CI])	3.2 (3.1–3.4)	3.1 (2.9–3.2)	0.095
Confidence, 1–4, 4 = highest (mean [95% CI])	3.2 (3.1–3.4)	3.1 (2.9–3.2)	0.109
Barriers, 0–7, 7 = greatest barriers (mean [95% CI])	1.6 (1.3–1.8)	1.8 (1.5–2.1)	0.298
Self-management			
Medication adherence, 0–12, 0 = highest (mean [95% CI])	2.2 (1.8–2.5)	2.4 (2.0–2.9)	0.312
Tests blood glucose ≥ 1 time/week (*n* [%])	111 (65.3)	112 (70.9)	0.278
Checks feet every day (*n* [%])	47 (27.0)	46 (28.8)	0.723
Manages diabetes with diet control (*n* [%])	135 (76.7)	116 (72.5)	0.376
Manages diabetes with physical activity/exercise (*n* [%])	84 (47.7)	81 (50.6)	0.596
Self-efficacy, 1–5, 5 = highest (mean [95% CI])	4.3 (4.2–4.5)	4.2 (4.1–4.4)	0.382

ly physical activity and total weekly physical activity (Table 1). Among intervention group participants, 31 (18%) were lost to follow-up, whereas among control group participants, 14 (9%) were lost to follow-up. Final analysis was conducted with 336 individuals; of these, 279 had complete A1C measurements.

Among individuals in the intervention group, the mean number of sessions completed was four, and the mean number of one-on-one visits completed was two. Intervention completion (defined as completing at least three of five workshops and one of two one-on-one visits) was achieved for 131 (90.3%) intervention participants.

Table 2 presents changes in clinical measurements from baseline to 6-month follow-up by study group. At 6 months, mean A1C decreased by 0.2% (P = 0.063) in the intervention group, whereas no change was seen in the control group; the adjusted intervention effect was –0.2 (P = 0.214). We also ran models stratifying by baseline A1C. Among intervention participants with baseline A1C ≥8.0%, mean A1C decreased by 0.6% (P = 0.015), whereas among control participants with a baseline A1C ≥8.0%, mean A1C decreased by 0.2% (P = 0.396); the adjusted intervention effect among individuals with baseline A1C ≥8.0% was –0.5 (P = 0.165).

In addition, we conducted secondary analyses regarding the effect of the intervention on the proportion of participants who achieved

TABLE 2. Changes in Clinical Measurements of Study Participants From Baseline to 6-Month Follow-Up

	Intervention Group				Control Group				Intervention Effect: Unadjusted	Intervention Effect: Adjusted[a]
	n	Baseline (mean [SD])	6-Month (mean [SD])	Change in Mean (95% CI)	*n*	Baseline (mean [SD])	6-Month (mean [SD])	Change in Mean (95% CI)		
A1C (%)	145	7.8 (1.3)	7.6 (1.2)	−0.2 (−0.4 to 0.0)	134	8.0 (1.5)	8.0 (1.6)	0.0 (−0.2 to 0.2)	−0.2 (−0.5 to 0.1)	−0.2 (−0.4 to 0.1)
A1C (%) where baseline A1C ≥8%	44	9.3 (1.3)	8.7 (1.5)	−0.6* (−1.2 to −0.1)	49	9.5 (1.2)	9.3 (1.8)	−0.2 (−0.7 to 0.3)	−0.5 (−1.2 to 0.1)	−0.5 (−1.1 to 0.2)
LDL cholesterol (mg/dL)	121	84.6 (35.0)	81.3 (30.0)	−3.3 (−8.7 to 2.0)	104	79.4 (34.2)	85.1 (50.2)	5.7 (−4.4 to 15.8)	−7.3 (−17.7 to 3.1)	−7.2 (−17.8 to 3.5)
HDL cholesterol (mg/dL)	124	42.5 (9.9)	42.4 (9.3)	−0.1 (−1.2 to 1.1)	109	41.7 (9.2)	41.3 (8.4)	−0.3 (−1.3 to 0.6)	0.6 (−0.9 to 2.0)	0.4 (−1.1 to 1.9)
Triglycerides (mg/dL)	122	154.6 (92.2)	148.2 (74.2)	−6.5 (−22.2 to 9.3)	109	162.7 (89.1)	162.7 (101.4)	0.0 (−17.0 to 16.9)	−7.8 (−29.9 to 14.4)	−8.2 (−30.6 to 14.2)
Cholesterol (mg/dL)	123	161.4 (52.8)	150.8 (35.2)	−10.6** (−17.8 to −3.4)	109	154.8 (47.7)	154.2 (36.4)	−0.6 (−8.0 to 6.9)	−7.7 (−17.4 to 2.0)	−8.1 (−17.8 to 1.7)
Weight (lb)	134	150.9 (24.9)	148.7 (24.9)	−2.2** (−3.2 to −1.2)	110	152.6 (23.1)	151.2 (23.5)	−1.3* (−2.5 to −0.2)	−1.0 (−2.5 to 0.5)	−1.0 (−2.5 to 0.5)
BMI (kg/m^2	134	26.8 (4.2)	26.4 (4.3)	−0.4** (−0.6 to −0.2)	109	27.3 (4.4)	27.0 (4.3)	−0.2* (−0.5 to 0.0)	−0.1 (−0.4 to 0.1)	−0.2 (−0.4 to 0.1)
Systolic blood pressure (mmHg)	129	129.8 (17.6)	124.0 (15.5)	−5.8** (−8.5 to −3.0)	101	130.5 (16.3)	127.1 (15.2)	−3.4 (−7.0 to 0.2)	−1.7 (−6.0 to 2.6)	−1.7 (−6.1 to 2.6)
Diastolic blood pressure (mmHg)	129	79.1 (11.0)	76.6 (9.2)	−2.5* (−4.4 to −0.6)	101	76.9 (10.2)	75.7 (11.4)	−1.2 (−3.2 to 8.3)	−0.6 (−3.2 to 2.0)	−0.7 (−3.3 to 1.9)

[a]*Adjusted for age and sex.* **P* <0.05. ***P* <0.01. *Intervention effect reports the beta coefficient of the interaction of time point × intervention group.*

A1C reduction and control (Figures 2 and 3). The intervention group was significantly more likely than the control group to demonstrate a decrease in A1C at the 6-month follow-up (55.2 vs. 42.5%, $P = 0.035$). When stratifying by sex, females in the intervention group were more likely to show a significant decrease in A1C at 6-month follow-up compared to the control group (59.3 vs. 37.7%, $P = 0.023$), whereas there was not significant difference between groups for males (52.3 vs. 45.7%, $P = 0.391$). Similarly, the intervention group was more likely than the control group to achieve A1C control at the 6-month follow-up (36.3 vs. 24.6%, $P = 0.034$). When stratifying by sex, males in the intervention group were more likely than their counterparts in the control group to achieve an A1C <7.0%, whereas there was no significant difference between groups for female participants.

Mean cholesterol decreased significantly by 10.6 mg/dL for the intervention group ($P = 0.004$), compared to a decrease of 0.6 mg/dL for the control group ($P = 0.878$); the adjusted intervention effect was –8.1 mg/dL ($P = 0.107$). Significant differences in mean weight and BMI were seen for both groups, with greater decreases occurring in the intervention group. The adjusted intervention effect for weight was –1.0 lb ($P = 0.212$), and the adjusted intervention effect for BMI was –0.2 kg/m^2 ($P = 0.287$). Significant differences in mean systolic and diastolic blood pressure were observed for the intervention group but not for the control group; the intervention effect for systolic blood pressure was –1.7 mmHg ($P = 0.441$), and the intervention effect for diastolic blood pressure was –0.7 mmHg ($P = 0.619$). No significant differences were shown for mean LDL cholesterol, HDL cholesterol, or triglycerides.

Table 3 presents changes in knowledge of type 2 diabetes and behavioral variables from baseline to the 6-month follow-up by study

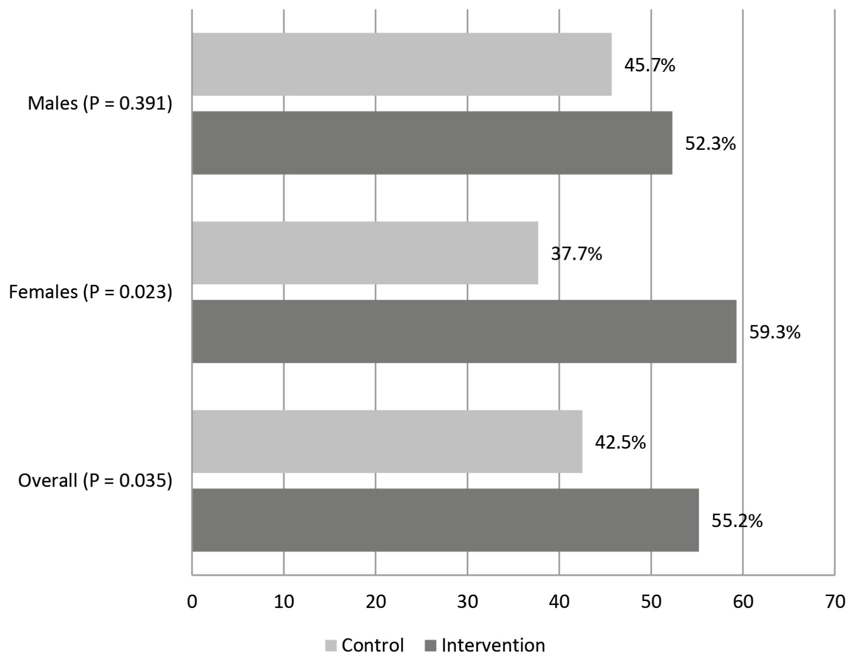

FIGURE 2. Proportion of study participants in intervention and control groups who decreased A1C at study follow-up.

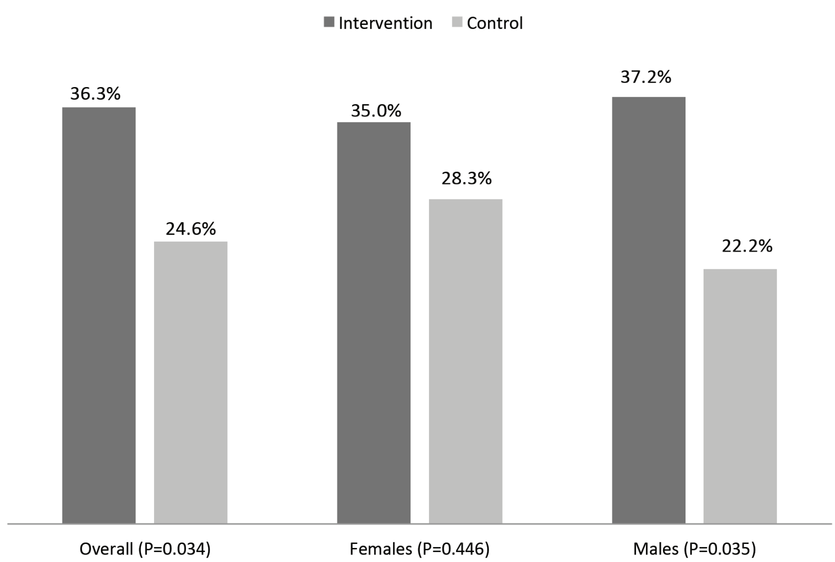

FIGURE 3. Proportion of study participants in intervention and control groups who achieved A1C control at study follow-up.

group. Significant intervention effects were shown for type 2 diabetes knowledge (knowledge scale and knowing what A1C is), time spent on weekly physical activity (moderate, vigorous, and recommended activity), confidence regarding physical activity, and type 2 diabetes self-management (e.g., testing blood glucose at least once a week, checking feet every day, managing type 2 diabetes with physical activity, and self-efficacy). Additionally, nearly all variables (excluding weekly vigorous physical activity) were significant across time for the intervention group, and the amount of vigorous weekly physical activity significantly decreased for the control group.

Discussion

In this culturally adapted CHW-led intervention of Bangladeshis with type 2 diabetes, the average decrease in A1C was 0.2% greater for the intervention group than for the control group. Although this difference between groups was not significant, there was a significantly greater percentage of individuals in the intervention group achieving A1C control (<7.0%) at 6 months (36.3 vs. 24.6%), as well as a significantly larger proportion of intervention group participants with decreased A1C at 6 months compared to individuals in the control group (55.2 vs. 42.5%). We also found that individuals in the intervention group with a baseline A1C ≥8.0% experienced a larger average decrease in A1C (mean decrease of 0.6, P <0.05) compared to those reported in previous studies among Latino individuals (26,35–38). Although the intervention effect was not significant for change in clinical measurements, changes in several patient-centered outcomes (diabetes knowledge, weekly physical activity, physical activity confidence, managing diabetes with physical activity, testing blood glucose weekly, and self-efficacy) were significant across intervention and control groups. CHW studies focused on minority groups have similarly shown significant improvement in diabetes knowledge (35,39) and physical activity (36).

The impact of the intervention on behavioral outcomes indicates that culturally adapted CHW models may be particularly important in improving patients' abilities to play a more active role in the self-management of type 2 diabetes for underserved populations that face linguistic and cultural barriers to care. This has also been demonstrated in a systematic review of the impact of CHW-led diabetes management in Latino communities (37).

TABLE 3. Changes in Knowledge of Type 2 Diabetes and Behavioral Variables of Study Participants From Baseline to 6-Month Follow-Up

	Intervention Group				Control Group				Intervention Effect: Unadjusted	Intervention Effect: Adjusted[a]
	n	Baseline	6-Month	Change in Mean or Percentage (95% CI)	*n*	Baseline	6-Month	Change in Mean or Percentage (95% CI)		
Diabetes knowledge										
Knowledge scale, 0–9, 9 = highest (mean [SD])	144	4.6 (1.9)	7.2 (1.6)	2.6** (2.2–2.9)	126	4.9 (1.9)	5.6 (1.9)	0.7** (0.4–1.1)	1.8** (1.3–2.2)	1.8** (1.3–2.2)
Knows what A1C is (*n* [%])	143	17 (11.9)	107 (74.8)	62.9** (53.0–70.7)	124	14 (11.3)	35 (28.2)	16.9** (7.1–26.5)	1.0** (0.5–1.6)	2.3** (1.5–3.1)
Physical activity										
Moderate weekly activity (min/week; mean [SD])	141	76.2 (119.8)	163.0 (130.6)	86.8** (60.4–113.1)	126	89.6 (199.58)	129.2 (158.6)	39.5 (–0.1 to 79.1)	47.1* (2.0–92.2)	50.1* (4.5–95.8)
Vigorous weekly activity (min/week; mean [SD])	141	10.7 (53.6)	34.6 (205.5)	24.0 (–11.2 to 59.1)	126	33.1 (111.6)	10.2 (45.1)	–22.9* (–44.2 to –1.7)	56.3* (13.7–98.8)	56.9* (13.4–100.4)
Total weekly activity (min/week; mean [SD])	141	97.5 (162.9)	232.2 (439.6)	134.7** (57.5–211.9)	126	155.9 (352.9)	149.5 (189.3)	–6.4 (–73.3 to 60.5)	158.8** (54.2–263.3)	163.2** (56.7–269.7)
Confidence, 1–4, 4 = highest (mean [SD])	139	3.3 (0.8)	3.7 (0.5)	0.4** (0.3–0.5)	121	3.4 (0.8)	3.5 (0.8)	0.1 (–0.1 to 0.2)	0.3** (0.1–0.5)	0.3** (0.1–0.5)
Barriers, 0–5, 5 = most (mean [SD])	132	1.4 (1.3)	0.9 (1.1)	–0.5** (–0.7 to –0.2)	117	1.5 (1.3)	1.1 (1.2)	–0.4** (–0.7 to –0.2)	0.0 (–0.3 to 0.4)	0.0 (–0.3 to 0.4)
Diet										
Portion control, 1–4, 4 = highest (mean [SD])	144	3.2 (0.8)	3.5 (0.6)	0.3** (0.1–0.4)	126	3.1 (0.9)	3.2 (0.8)	0.1 (–0.1 to 0.3)	0.1 (–0.1 to 0.4)	0.1 (–0.1 to 0.4)
Confidence, 1–4, 4 = highest (mean [SD])	120	3.3 (0.8)	3.6 (0.7)	0.3** (0.1–0.5)	103	3.0 (0.9)	3.3 (0.7)	0.2* (0.0–0.5)	0.1 (–0.1 to 0.4)	0.1 (–0.1 to 0.4)
Barriers, 0–7, 7 = greatest barriers (mean [SD])	142	1.6 (1.7)	0.7 (1.1)	–0.9** (–1.2 to –0.6)	125	1.9 (1.9)	1.4 (1.6)	–0.5* (–0.9 to –0.1)	–0.4 (–0.9 to 0.1)	–0.4 (–0.9 to 0.0)
Self-management										
Medication adherence (mean [SD])	127	2.2 (2.2)	1.2 (1.8)	–0.9** (–1.3 to –0.6)	110	2.3 (2.5)	1.7 (2.5)	–0.6* (–1.0 to –0.1)	–0.3 (–0.9 to 0.3)	–0.3 (–0.9 to 0.2)
Tests blood glucose ≥1 time/week (*n* [%])	137	93 (67.9)	107 (78.1)	10.2* (0.0–20.5)	122	88 (72.1)	81 (66.4)	5.7 (–5.8 to 17.1)	0.8** (0.2–1.3)	0.8** (0.2–1.4)

TABLE CONTINUED ON P. 108 →

TABLE 3. Changes in Knowledge of Type 2 Diabetes and Behavioral Variables of Study Participants From Baseline to 6-Month Follow-Up, ***continued from p. 107***

	Intervention Group				Control Group				Intervention Effect: Unadjusted	Intervention Effect: Adjusted[a]
	n	Baseline	6-Month	Change in Mean or Percentage (95% CI)	*n*	Baseline	6-Month	Change in Mean or Percentage (95% CI)		
Checks feet every day (*n* [%])	142	36 (25.4)	101 (71.1)	45.7** (34.7–55.2)	123	33 (26.8)	60 (48.8)	22.0** (9.9–33.2)	1.0** (0.4–1.6)	1.0 (0.4–1.7)
Manages diabetes with diet control (*n* [%])	144	114 (79.2)	134 (93.1)	13.9** (6.0–21.9)	127	91 (71.7)	107 (84.3)	12.6** (2.4–22.5)	0.6 (–0.2 to 1.5)	0.8 (–0.1 to 1.7)
Manages diabetes with physical activity (*n* [%])	144	68 (47.2)	130 (90.3)	43.1** (33.0–51.9)	127	63 (49.6)	92 (72.4)	22.8** (10.9–33.9)	1.4** (0.6–2.1)	1.5** (0.7–2.3)
Self-efficacy, 1–5, 5 = highest (mean [SD])	140	4.2 (1.0)	4.6 (0.7)	0.4 (0.2–0.5)	125	4.2 (1.1)	4.3 (1.1)	0.1 (–0.1 to 0.2)	0.3* (0.0–0.5)	0.3* (0.1–0.5)

[a]*Adjusted for age and sex. *P <0.05. **P <0.01. Intervention effect reports the beta coefficient of the interaction of time point × intervention group for linear regression models. Odds ratios are reported for logistic models.*

Ours is the first study to examine the effect of CHWs on health outcomes in the Bangladeshi American community. Importantly, the study was guided by a coalition of community stakeholders and findings from a formative evaluation that informed the cultural adaptation of the intervention content and delivery. For example, previous work has documented that Bangladeshis face unique barriers to physical activity due to cultural and religious norms (40). Additionally, Bangladeshi immigrants largely maintain their diet of traditional foods after immigration to the United States, but often may increase their consumption of rich "celebration" foods, white rice, and high-fat meats because of greater access (18). The CHW intervention was designed to address these norms related to physical activity and diet in a culturally relevant manner. For example, an at-home instructional DVD was created in Bengali and shared with treatment group participants to encourage physical activity that was both culturally accessible and low in cost. Similarly, educational sessions on dietary changes promoted traditional Bengali foods while encouraging simple substitutions (e.g., brown rice rather than white rice or traditional Bengali fish dishes rather than beef or red-meat dishes), and portion control strategies rather than replacement of favored items. The inclusion of culturally tailored strategies in the intervention likely influenced the adoption of suggested practices and the improvements in physical activity and diet reported by intervention group participants compared to control group participants.

Finally, given the high rates of limited English proficiency and predominantly first-generation immigrant status within the Bangladeshi population, previous work has noted that patients often face substantial communication barriers with clinical providers (18). For this reason, our intervention curriculum provided strategies for communicating more effectively with primary care physicians regarding the diabetes diagnosis and information about patient rights that may have led to the enhanced self-efficacy reported by intervention group participants.

Limitations

Several limitations should be noted. First, there were incomplete follow-up data for some of the clinical outcomes; although A1C was collected for most individuals through medical records, cholesterol, HDL cholesterol, LDL cholesterol, and triglyceride levels were not available for all study participants. Additionally, some follow-up surveys were collected via phone, so CHWs were not able to collect weight or blood pressure measurements for a subset of participants. Second, randomization was conducted by age and sex, but not by variables that were shown to differ between groups at baseline (e.g., A1C, physical activity, and years with diabetes). Because individuals in the control group had longer disease duration, reported higher rates of physical activity at baseline, and had higher A1C levels, some of the intervention effects may be partially attributed to regression toward the mean. However, control group participants also reported a decrease in exercise between baseline and 6 months, whereas intervention participants experienced an increase, indicating a likely intervention effect. Finally, behavioral measures were assessed through self-report, potentially overestimating results due to social desirability. However, data collection was conducted by personnel other than CHWs where possible to decrease the potential effect of this bias.

Despite these limitations, the study has several strengths of note. This is the first study using a rigorous trial design to test the efficacy of CHW-led intervention for diabetes management in the Bangladeshi population, a growing immigrant group that faces disparities in diabetes prevalence and management. Although our intervention did not demonstrate statistically significant improvements in A1C, we did show significant improvement in many patient-centered outcomes. Our findings are encouraging, especially with regard to improving behavioral outcomes related to diabetes management. The intervention offered culturally tailored diabetes management educational materials for the Bangladeshi American community; thus, behavioral strategies are relevant and likely to be sustained by study participants. Additionally, intervention toolkits and materials can be further disseminated and used in other community settings serving the Bangladeshi community and are being made publicly available as downloadable resources (41).

Practice Implications

The U.S. Community Prevention Services Taskforce has found sufficient evidence for two key strategies to improve diabetes management among patients in which CHWs may play an important role. These include employing multidisciplinary team-based care (42) and offering intensive lifestyle (diet or physical activity) interventions coupled with counseling to patients with diabetes (43). Our study contributes to the evidence base that CHWs are effective members of the health care team to deliver lifestyle interventions in immigrant communities with limited English proficiency and may play a particularly important role in these communities in fostering access to resources both inside and outside of the clinical setting that can affect behavior change (44). Furthermore, given that studies have found that patient-centered factors such as low self-efficacy and low social support (45,46) are associated with higher A1C levels, our findings suggest that CHWs may be particularly useful in influencing mediating factors that contribute to outcomes of clinical significance.

Given the demographic growth and type 2 diabetes burden in the Bangladeshi population, coupled with recent opportunities to integrate CHWs into clinical care through sustainable models, our study findings contribute to the understanding of culturally relevant models for type 2 diabetes management in diverse populations. Past studies have suggested that CHWs are a cost-effective model for diabetes management (47,48). Additionally, previous meta-analyses have shown similar or lower effect sizes for A1C reduction by interventions that may be more resource-intensive than the CHW model presented here, including telemonitoring and interventions using the Chronic Care Model (26). As demand for patient-centered approaches in clinical settings expands, CHW models will have growing clinical and public health relevance in the context of diabetes care for underserved populations.

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Duality of Interest

No potential conflicts of interest relevant to this article were reported.

Author Contributions

N.S.I. wrote the manuscript. L.C.W. wrote the manuscript and conducted analysis. M.D.T. contributed to background and reviewed the manuscript. L.R., S.D.T., M.T., B.R.M., and C.T.-S. reviewed/edited the manuscript. N.S.I. is the guarantor of this work, and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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