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ORIGINAL PAPER

Promoting Physical Activity Among Immigrant Asian Americans: Results from Four Community Health Worker Studies

Laura C. Wyatt[1] · Carina Katigbak[2] · Lindsey Riley[3] · Jennifer M. Zanowiak[1] · Rhodora Ursua[4] · Simona C. Kwon[1] · Chau Trinh-Shevrin[1] · Nadia S. Islam[1]

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Abstract

Racial/ethnic minorities have demonstrated lower rates of physical activity (PA) than non-Hispanic Whites. This study examined outcomes in PA measures after participation in a community health worker (CHW) intervention. We performed a secondary data analysis from four randomized controlled trials utilizing CHWs (n = 842) in New York City (Bangladeshi—diabetes management, Filipino—hypertension management, and Korean and Asian Indian—diabetes prevention). Outcomes included total weekly PA, PA self-efficacy, PA barriers, and PA social interaction. Each measure was examined at baseline and study endpoint. Generalized estimating equation models were fitted to assess the repeated measures over time, while accounting for study group and socio-demographic factors. Moderate PA, recommended PA, and self-efficacy increased significantly among treatment group participants. PA social interaction increased significantly among Filipinos and Asian Indians. In adjusted regression analysis, time x group interaction was significant for all PA outcomes except for PA barriers. Culturally-adapted lifestyle interventions may potentially improve PA-related outcomes in Asian immigrant communities. *Trial registration* at ClinicalTrials.gov includes: NCT03530579 (RICE Project), NCT02041598 (DREAM Project), and NCT03100812 (AsPIRE).

Keywords Asian Americans · Community-based participatory research · Health promotion · Physical activity · Health disparities

Introduction

The consequences of the global obesity epidemic are well-established and include contributions to the overall burden of type 2 diabetes mellitus (T2DM), cardiovascular disease (CVD), hypertension, and certain cancers. Although participation in physical activity (PA) has been demonstrated to prevent or delay the onset of obesity, just over half of individuals in the US meet the US Department of Health and Human Services 2018 PA Guideline recommendations. Recommendations include ≥ 150 min per week of moderate-intensity PA, ≥ 75 min per week of vigorous-intensity PA, or an equivalent combination of the two [1]. behavioral risk factor surveillance system (BRFSS) from 2017 to 2020 found that in the US, prevalence of overall physical inactivity was 25.3%. In New York, 25.9% of non-Hispanic Asian adults reported physical inactivity, compared to 21.5% among non-Hispanic White adults, with the highest physical inactivity among Blacks and Hispanics.

While physical inactivity and lower leisure-time physical activity (LTPA) is common among racial and ethnic minorities compared to non-Hispanic white adults [2–8], only half of studies using national and regional datasets studies included Asian Americans as a racial/ethnic group [2, 5, 6, 8], and a quarter reported findings using disaggregated Asian American subgroups [5, 8]. Online data prevalence tools have also shown differences in physical activity measures for the New York city community health survey (NYC CHS), California health interview survey (CHIS), and

✉ Laura C. Wyatt
laura.wyatt@nyulangone.org

[1] Department of Population Health, Section for Health Equity, NYU Langone Health, 180 Madison Ave, 8th Floor, New York, NY 10016, USA

[2] The University of Texas Health Science Center at Houston, Houston, TX, USA

[3] Michael J. Fox Foundation for Parkinson's Research, New York, NY, USA

[4] Alameda Health Consortium, San Leandro, CA, USA

BRFSS; only CHIS and Hawaii BRFSS included detailed Asian American subgroups [9–12]. An analysis of 2001 CHIS data found that foreign-born Asian Americans were less likely to meet recommended LTPA compared to US-born Asians, and fewer years in the US was associated with greater physical inactivity among women [13]. In NYC CHS data from 2014 to 2018 Chinese had the largest percentage of insufficient activity (34.0%), followed by Asian Indians (28.0%) and Koreans (27.0%), compared to 22.0% of overall NYC [14]. An analysis of NYC CHS data (2010, 2012) and Los Angeles County (LAC) Health Survey data also found a lower prevalence of meeting PA guidelines among Asian Americans compared to other racial/ethnic groups [8].

The deployment of community health workers (CHWs) in community- and clinic-based settings has been demonstrated as an effective strategy to promote behavior change among minority populations [15]. CHWs are frontline public health workers who are trusted members of the communities they serve and have a close understanding of the contextual factors that impact behavioral and social determinants of health [16]. The CHW model has been incorporated into diabetes prevention and management strategies in order to reach diverse, underserved populations [17, 18]. Conceptually, CHWs may help to improve PA behaviors through their roles in providing social support in its multiple domains (e.g., appraisal, emotional, informational, and tangible), while using theory and evidence-based behavior change approaches that are grounded in social cognitive theory. With underserved minority and under-represented groups in particular, CHWS leverage their cultural congruence with the populations they serve to develop trusting relationships to facilitate behavior change [19].

Interventions employing the CHW model have demonstrated effectiveness in increasing PA among many racial and ethnic groups [8, 20–25]. However, a handful of studies, most in NYC, have examined the effectiveness of CHW interventions on increasing PA among different Asian American subgroups [26], one among Bangladeshi Americans [25, 27], one among Filipino Americans, one among Asian Indian Sikhs [28, 29], one among Korean Americans [30], and one among Vietnamese Americans [31].

Additionally, interventions targeted for the general population likely will not reach ethnic minorities, or will have limited effects on their health behavior since ethnic minorities are less likely to be enrolled into the trials from which evidence guidelines are based [32]. Culturally adapting an intervention involves modifications that take into account the language, culture, and context of participants' culture and values, such as identifying health workers and staff of the same background or culture, considering culturally-appropriate concepts when translating materials, and incorporating nutrition and exercise that reflects those familiar to the particular culture [33–35]. Asian Americans are tremendously diverse, varying in nativity, migration patterns, socioeconomic status, education, language, and access to health and social service resources. Disparities among heterogeneous Asian American subgroups are often masked when data is presented in aggregated form, concealing cultural and contextual factors that impact behavior change [36–42].

This secondary analysis examines changes in performing and meeting recommended weekly PA, as well as changes in scales measuring PA self-efficacy, PA barriers, and PA social interaction among participants in four randomized controlled trials (RCTs) implemented in NYC Asian American communities. We hypothesized that treatment group participants will report greater changes in PA outcomes when compared with control group participants. In addition to examining the impact of RCT interventions utilizing CHWs on PA outcomes, this study expands on previous research [13, 43, 44] by investigating variability of PA rates and improvements among distinct Asian American subgroups, for which little information has been previously reported. Cumulatively examining data from these four interventions provides information to improve the precision and accuracy of estimates in future studies that include CHWs as a critical personnel to improve outcomes for minority ethnic groups.

Methods

Design

This secondary data analysis utilizes data collected from four CHW RCTs conducted among Bangladeshi, Filipino, Korean, and Asian Indian subgroups in NYC. Each study was culturally-adapted and employed a lifestyle intervention framework, utilizing curricula adapted from evidence-based lifestyle intervention programs [45–47]. All CHWs participated in a 60 h core competency training program prior to the intervention [48]. Main findings from these studies have been published elsewhere [22, 25, 29, 30].

Setting and Sample

The diabetes research, education, and action for minorities (DREAM) Project was designed to improve diabetes knowledge and management among Bangladeshis with T2DM [25, 27]. The 6 month study, which took place from 2011 to 2016, consisted of five monthly, 2 hour group CHW-led educational sessions, with an average of five participants per session, and two one-on-one visits which included goal-setting activities for behavior change with the CHWs. Two male and two female bilingual Bangladeshi CHWs employed by the research organization delivered the intervention. A total of 336 individuals were randomized into the treatment and control groups.

Project Asian American Partnership in Research and Empowerment (AsPIRE) was designed to improve hypertension management and CVD risk factors among Filipino Americans [22, 49]. The 4 month study, which took place from 2011 to 2014, consisted of four monthly, 90 min group or individual CHW-led educational sessions and four monthly one-on-one visits, which included goal-setting activities with the CHWs. One male and three female bilingual Filipino CHWs based at the Filipino community-based organization delivered the intervention. A total of 240 individuals were randomized into the treatment and control groups.

Project RICE (Reaching Immigrants through Community Empowerment) was designed to promote diabetes prevention in the Korean American and Sikh Asian Indian American communities [26, 28, 29]. The study was adapted from the Diabetes Prevention Program (DPP) and consisted of six 2 h CHW-led group sessions and ten follow-up phone calls including goal-setting activities from CHWs. The study was conducted in two communities: the Korean community (2011–2014) and a site-stratified study in the Sikh Asian Indian community (2012–2014). Two male and two female bilingual Korean CHWs based at the Korean community-based organization delivered the Korean intervention, while two bilingual Sikh Asian Indian CHWs and one female CHW supervisor at the Sikh Asian Indian community-based organization delivered the Sikh Asian Indian intervention. In the Korean community, a total of 302 individuals were randomized into the treatment and control groups; in the Sikh Asian Indian community, a total of 173 were randomized into the treatment and control groups, while 166 of these individuals were included in analyses.

In all studies, control group participants attended an introductory educational session only and had limited engagement with CHWs. Tailored cultural components related to PA are detailed in previous publications [26–28, 49]. Each intervention included one session specific to PA, and components included: discussion and incorporation of common sports and activities (e.g. badminton and cricket for Bangladeshi, Yoga for Koreans, Zumba for Filipinos); home-based exercises and activities (e.g., Korean seniors, Bangladeshi and Asian Indian women); information on free community exercise classes; and incorporation of culturally appropriate images and languages. CHWs led exercise demonstrations for participants, with realistic options for each community; for instance, South Asian women felt more comfortable exercising at home and not in public. Written informed consent was obtained from all participants. Each respective intervention received approval from the NYU Langone Health IRB. See Table 1 for details of each intervention.

Measures

For each study, measurements were collected at baseline and at each study endpoint (6 months for Bangladeshi, Korean, and Asian Indian, and 4 months for Filipino). Data from individuals completing both the baseline and endpoint survey were included in this analysis. Scale questions asked across all studies were shortened from the original scales for consistency across studies as necessary. Measures were identical across all interventions.

Self-Reported Weekly PA

A series of questions assessed self-reported moderate and vigorous PA. For both moderate and vigorous activities, total days per week and total minutes per day were reported; a weekly total of each type of PA was then calculated using the following equation: days x minutes. Since these variables were highly skewed, we performed log transformations using $\log(x+1)$ in SAS before running regression analyses. PA Guidelines recommend that adults perform at least 150 min a week of moderate-intensity PA or at least 75 min a week of vigorous-intensity PA. Thus, recommended weekly PA was calculated as follows: total minutes of weekly moderate PA + (total minutes of weekly vigorous PA × 2) in order for vigorous PA to account for twice the amount of moderate PA [1, 50]. Recommended weekly PA included those with ≥ 150 total minutes of combined vigorous and moderate PA.

PA Self-Efficacy

A scale assessing self-efficacy in engaging in PA was calculated using the mean of two questions adapted from Bandura's self-efficacy scale [51]. Among Bangladeshis and Filipinos, these questions were: "How much confidence do you have about knowing what exercises are healthy for you?" and "How much confidence do you have exercising at least thirty minutes five times each week in the future?" Responses included: no confidence (1), very little confidence (2), moderate confidence (3), and a lot of confidence (4). Among Koreans and Asian Indians, these questions were: "How sure are you about knowing what exercises are healthy for you?" and "How sure you are that you can exercise at least thirty minutes five times each week in the future?" Responses included: not at all sure (1), not very sure (2), somewhat sure (3), and very sure (4). Scores ranged from one to four, and four represented the greatest confidence. Our baseline data provided the following Cronbach's α: Bangladeshi: 0.66, Filipino: 0.53, Korean: 0.54, and Asian Indian: 0.90.

Table 1 Intervention details and curriculum activities related to PA across the four CHW interventions

	Bangladeshi	Filipino	Korean	Asian Indian
Eligibility criteria	Self-reported Bangladeshi; between 21 and 75 years of age; residing in NYC; and diagnosis of type 2 diabetes	Self-reported Filipino; 25–75 years of age; hypertensive based on either blood pressure measurements or on antihypertensive medication use; and residing in NYC	Self-reported Korean; 18–75 years of age; at-risk for diabetes using a diabetes assessment tool; and residing in NYC	Self-reported Sikh Asian Indian; 18–75 years of age; at-risk for diabetes using a diabetes assessment tool; and residing in NYC
Exclusion criteria	Renal dialysis; serious health problems (e.g., terminal illness or recent history of an acute problem); previous participaion in a similar intervention; or had plans to travel outside the US for an extended period of time	Renal dialysis; serious health problems (e.g., terminal illness or recent history of an acute problem); history of stroke, heart attack, or congestive heart failure; or had plans to travel outside the US for an extended period of time	Self-reported diabetes diagnosis; serious health problems (e.g., terminal illness or recent history of an acute problem); or had previously participated in a similar intervention	Self-reported diabetes diagnosis; serious health problems (e.g., terminal illness or recent history of an acute problem); or had previously participated in a similar intervention
Dates of intervention	2011–2016	2011–2014	2011–2014	2012–2014
Recruitment methods	CHWs sent mailings sent to Bengali patients with diabetes obtained from hospital databases, face-to-face recruitment took place through tabling at hospitals, advertisements were placed in Bengali ethnic media, and outreach occurred at cultural fairs and religious events	Health screening events and other community-based recruitment events were held by CHWs at faith, community, and business sites serving the Filipino community	Health fairs and cultural fairs at churches and community settings were held by CHWs	Health fairs and tabling occurred by CHWs at two neighborhood Gurdwaras (Sikh religious institutions)
CHWs	Two male and two female CHWs employed by the researcher organization	One male and three female CHWs based at the community-based organization	Two CHWs (two females or one male/one female) based at the community-based organization	Three female CHWs based at the community-based organization
Time of intervention	6 months	4 months	6 months	6 months
Sessions	Five 120 min group or individual sessions; control group attended first session	Four 90 min group or individual sessions; control group attended first session	Six 120 min group sessions	Six 120 min group sessions
Randomization	By age and gender, and CHW, spousal dyads were randomized to the same study arm; occurred after session 1	By age and gender; occurred after session 1	By age and gender; occurred before session 1	By neighborhood; neighborhood switched for Round 2
One-on-ones	In person	In person	Over phone	Over phone
PA Session Info				
Physical activity stats	X	X		
Physical activity benefits	X	X	X	X
Types of physical activity (moderate, vigorous)	X	X	X	X
How to be physically active, targets	X	X		

Table 1 (continued)

	Bangladeshi	Filipino	Korean	Asian Indian
Gradually increasing physical activity		X		
Tips for staying motivated	X	X	X	X
Stretching	X	X	X	X
Recording physical activity		X		
Discussion topics—physical activity: Motivation, Barriers & Solutions	X	X	X	X

PA Barriers

A scale assessing barriers to exercise was calculated using five questions adapted from the Exercise Benefits and Barriers Scale [52]. Questions included: "I don't have enough time to exercise," "I am not motivated to exercise," "I don't have a safe place to exercise," "Health problems prevent me from exercising," and "I need someone to exercise with but don't have one." Responses were Agree (1) or Disagree (0). Summed scores ranged from zero to five, with zero representing no barriers. Our baseline data provided the following Cronbach's α: Bangladeshi: 0.48, Filipino: 0.62, Korean: 0.45, and Asian Indian: 0.49.

PA Social Engagement

A scale assessing social engagement for PA was adapted from a previous intervention [53]. Questions included: "How often do you suggest doing something active when you get together with family members or friends?" "How often do you set aside a special time to do physical activity?" "How often do you ask a friend or relative to do some physical activity with you?" and "How often do you talk to others about the benefits of physical activity?" Responses included: Almost never (1), Sometimes (2), Often (3), and Almost always (4). The mean of the four questions was calculated for a scale of one to four, where four represents the highest social engagement. Responses were solicited from all subgroups of interest except Bangladeshis, for which this line of questioning was perceived as not culturally relevant. These scale questions were not asked on DREAM (Bangladeshi). Our baseline data provided the following Cronbach's α: Filipino: 0.88, Korean: 0.83, and Asian Indian: 0.91.

Health

Self-reported health was assessed by asking: "How would you describe your general health" Responses included Excellent, Very Good, Good, Fair, and Poor. Information on self-reported hypertension and diabetes was also collected. All Filipino individuals had a diagnosis of hypertension, all Bangladeshi individuals had a diagnosis of diabetes, and all Korean and Asian Indian individuals did not have a diagnosis of diabetes but were at-risk for diabetes as assessed by an American Diabetes Association screener. When not assessed for eligibility, hypertension and diabetes were assessed by asking: "Has a doctor, nurse, or other health professional EVER told you that you have high blood pressure/Diabetes." Responses included Yes, No (not at all), and No, BUT told borderline high or pre-hypertensive/high sugar or pre-diabetic. Responses were categorized into yes/no.

Socio-Demographics

Socio-demographic variables included gender, age, country of birth, years living in the US, marital status, employment, education, English spoken fluency, and health insurance.

Analysis

Descriptive statistics were analyzed at baseline, stratifying by study and randomization group. Baseline characteristics of randomization groups were compared using Pearson Chi-square tests for categorical variables and independent samples t-tests for continuous variables, while stratifying by study.

Change between baseline and follow-up was stratified by study group and randomization group for those completing follow-up. Change between moderate and vigorous PA over time was analyzed using Wilcoxon Signed-Rank Tests, and medians (Interquartile ranges [IQRs]) are presented; change between PA scale measures over time was analyzed using paired sample t-tests, and means (standard deviations [SDs]) are presented; and change in recommended PA was analyzed using McNemar's Tests, and n's (percentages) are presented. Differences at follow-up between treatment and control groups was analyzed using Wilcoxon rank sum tests for moderate and vigorous PA, chi-square tests for recommended weekly PA, and independent samples t-tests for PA scale measures.

Finally, generalized estimating equation (GEE) models with exchangeable correlation structure were fitted in order to assess repeated PA measures over time, both overall and stratified by study intervention, while adjusting for socio-demographic factors (age, gender, time in the US, education, employment, and health insurance) and study group. The effect of the group (treatment/control) by time (baseline/endpoint) interaction is presented. All participants are included in GEE analysis, regardless of loss to follow-up. Recommended weekly PA was modeled using logistic GEE. Significance was set at $p < 0.05$. All statistical analysis was conducted using SAS version 9.4.

Results

Table 2 presents socio-demographic variables at baseline, stratified by study group and randomization group (n = 842). Koreans reported the highest mean age and greatest mean years lived in the US. Filipinos had the highest employment rates and were least likely to be married or living with a partner. Filipinos reported the highest education levels and English spoken fluency; Bangladeshis and Asian Indians reported the lowest levels of education and Koreans reported the lowest levels of English spoken fluency. Bangladeshis were most likely to have health insurance, and the highest rates of public health insurance were seen among Bangladeshis and Asian Indians. Koreans reported the highest prevalence of fair/poor health, followed by Bangladeshis. When examining differences by randomization status within each ethnic group, a significant difference was observed for sex ($p = 0.008$) and health insurance ($p = 0.008$) among Asian Indians, a significant difference was observed for mean age among Koreans ($p = 0.022$), and a significant difference was observed for self-reported health among Koreans ($p = 0.004$) and Asian Indians ($p = 0.002$). When examining differences by ethnic group among those who completed follow-up surveys versus those who did not, Bangladeshi males and Filipinos who were married, had less than a high school education, and those with lower English spoken fluency were less likely to complete follow-up (data not presented).

Table 3 presents changes in PA outcomes between baseline and follow-up. Among treatment groups, recommended weekly PA increased from 27.7% to 56.7% among Bangladeshis ($p < 0.001$), 75.3% to 91.8% among Filipinos ($p = 0.002$), 49.1% to 63.2% among Koreans ($p = 0.011$), and 10.3% to 94.1% among Asian Indians (< 0.001). Among control groups, recommended weekly PA increased from 29.4% to 42.1% among Bangladeshis ($p = 0.030$), 79.3% to 90.6% among Filipinos ($p = 0.007$), 53.2% to 48.9% among Koreans ($p = 0.527$), and 10.1% to 36.2% among Asian Indians ($p < 0.001$). Significant differences in recommended weekly PA were seen between treatment and control participants at endpoint for Bangladeshis, Koreans, and Asian Indians.

All treatment groups demonstrated significant increases in median weekly moderate PA, while Bangladeshis, Koreans, and Asian Indians demonstrated significant increases in median weekly vigorous PA. The Bangladeshi and Asian Indian control groups demonstrated a significant increase in median weekly moderate PA, while the Bangladeshi control group demonstrated a significant decrease in median weekly vigorous PA and the Asian Indian control group demonstrated a significant increase in median weekly vigorous PA. Changes in vigorous PA, while significant, were not evident using IQRs for Bangladeshi treatment and control groups or the Asian Indian control group; full ranges for weekly vigorous PA were as follows: Bangladeshi treatment (0–420 at baseline, 0–2400 at endpoint); Bangladeshi control (0–840 at baseline, 0–420 at endpoint); Asian Indian control (0–180 at baseline, 0–240 at endpoint). Significant differences in weekly vigorous PA were seen between treatment and control participants at endpoint for all groups, and significant differences in weekly moderate PA were seen between treatment and control group participants at endpoint for Bangladeshis, Koreans, and Asian Indians.

PA self-efficacy improved significantly for all treatment groups, while no change was seen among control groups;

Table 2 Socio-Demographics and health characteristics of the four CHW interventions at baseline, n (%)

	Bangladeshi (n = 271)			Filipino (n = 196)			Korean (n = 215)			Asian Indian (n = 160)		
	Treatment (n = 144)	Control (n = 127)	p-value	Treatment (n = 86)	Control (n = 110)	p-value	Treatment (n = 115)	Control (n = 100)	p-value	Treatment (n = 71)	Control (n = 89)	p-value
Sex[2]			0.954			0.274			0.852			**0.008**
Female	64 (44.4)	56 (44.1)		33 (38.4)	34 (30.9)		67 (58.3)	57 (57.0)		57 (80.3)	54 (63.8)	
Male	80 (55.6)	71 (55.9)		53 (61.6)	76 (69.1)		48 (41.7)	43 (43.0)		14 (19.7)	35 (36.2)	
Age (years): Mean (SD)[1]	53.7 (10.6)	55.0 (10.0)	0.325	53.5 (10.4)	53.9 (10.4)	0.800	62.5 (7.6)	59.9 (8.2)	**0.022**	45.4 (10.3)	47.3 (10.0)	0.242
Years lived in the US: Mean (SD)[1]	12.1 (8.5)	13.1 (9.2)	0.376	11.2 (9.8)	9.5 (9.0)	0.214	22.3 (9.9)	22.2 (10.4)	0.926	15.3 (13.4)	13.9 (7.8)	0.470
Marital status[2]			0.416			0.624			0.373			1.000
Married/ Living with partner	135 (93.8)	119 (96.0)		48 (56.5)	63 (60.0)		95 (82.6)	87 (87.0)		68 (97.1)	83 (96.5)	
Unmarried	9 (6.2)	5 (4.0)		37 (43.5)	42 (40.0)		20 (17.4)	13 (13.0)		2 (2.9)	3 (3.5)	
Employment[2]			0.121			0.792			0.339			0.407
Employed	62 (43.1)	43 (33.9)		70 (85.4)	89 (84.0)		52 (46.4)	53 (53.0)		18 (26.1)	28 (32.2)	
Unemployed	82 (56.9)	84 (66.1)		12 (14.6)	17 (16.0)		60 (53.6)	47 (47.0)		51 (73.9)	59 (67.8)	
Education[2]			0.685			0.367			0.848			0.641
Less than high school	40 (28.4)	41 (33.1)		1 (1.3)	3 (2.8)		10 (9.0)	8 (8.6)		11 (15.7)	10 (11.8)	
High school/ Some college	54 (38.3)	46 (37.1)		18 (22.2)	16 (15.1)		60 (54.1)	47 (50.5)		48 (68.6)	64 (75.3)	
College graduate	47 (33.3)	37 (29.8)		62 (76.5)	87 (82.1)		41 (36.9)	38 (40.9)		11 (15.7)	11 (12.9)	
English spoken fluency[2]			0.805			0.718			0.933			0.777
Very well/ well	60 (42.0)	51 (40.5)		84 (98.8)	108 (98.2)		32 (28.1)	27 (27.6)		38 (55.1)	47 (52.8)	
Not well/Not at all	83 (58.0)	75 (59.5)		1 (1.2)	2 (1.8)		82 (71.9)	71 (72.4)		31 (44.9)	42 (47.2)	
Health insurance[2]			0.291			0.495			0.217			**0.008**
Public	114 (79.7)	102 (83.6)		12 (13.9)	14 (12.7)		50 (43.9)	32 (32.3)		29 (44.6)	60 (69.8)	
Private/Other	3 (2.1)	5 (4.1)		11 (12.8)	21 (19.1)		14 (12.2)	16 (16.2)		4 (6.2)	3 (3.5)	
None	25 (18.2)	15 (12.3)		63 (73.3)	75 (68.2)		50 (43.9)	51 (51.5)		32 (49.2)	23 (26.7)	
Self-reported health[2]			0.227			0.229			**0.004**			**0.002**

Table 2 (continued)

	Bangladeshi (n = 271)			Filipino (n = 196)			Korean (n = 215)			Asian Indian (n = 160)		
	Treatment (n = 144)	Control (n = 127)	p-value	Treatment (n = 86)	Control (n = 110)	p-value	Treatment (n = 115)	Control (n = 100)	p-value	Treatment (n = 71)	Control (n = 89)	p-value
Excellent/ Very good	16 (11.1)	8 (6.3)		16 (18.8)	26 (23.6)		7 (6.1)	15 (15.0)		4 (5.8)	0 (0.0)	
Good	77 (53.5)	64 (50.4)		44 (51.8)	63 (57.3)		55 (47.8)	27 (27.0)		54 (78.3)	56 (65.1)	
Fair/Poor	51 (35.4)	55 (43.3)		25 (29.4)	21 (19.1)		53 (46.1)	58 (58.0)		11 (15.9)	30 (34.9)	
Diabetes diagnosis[2]	144 (100.0)	127 (100.0)	1.000	23 (26.7)	25 (22.5)	0.494	0 (0.0)	0 (0.0)	1.000	0 (0.0)	0 (0.0)	1.000
Hypertension diagnosis[2]	80 (58.8)	78 (62.9)	0.501	86 (100.0)	110 (100.0)	1.000	47 (41.2)	49 (49.5)	0.227	29 (40.8)	36 (40.4)	0.960

Bold values are statiscally significant ($p < 0.05$)

[1]Independent samples t-test

[2]Pearson Chi-square

significant differences were seen between treatment and control at endpoint. Mean barriers to PA decreased significantly for all treatment groups except for Koreans, as well as for Bangladeshi and Asian Indian control groups; significant differences were seen between treatment and control groups at endpoint for Asian Indians. Mean PA social interaction increased significantly among Filipino and Asian Indian treatment groups; significant differences were seen between these treatment and control groups at endpoint.

Regression Analysis

Results of GEE models are shown in Table 4. After controlling for age, gender, time in the US, education, employment, health insurance, study, and the effect of group (treatment/control) by time (baseline/endpoint), significantly greater improvements (shown by the interaction between group and time) were seen in weekly moderate PA ($\beta = 0.97$, 95% CI 0.56–1.38), weekly vigorous PA ($\beta = 1.18$, 95% CI 0.82, 1.54), and recommended weekly PA (OR = 2.80, 95% CI 1.81–4.32), as well as PA confidence ($\beta = 0.36$, 95% CI 0.25, 0.46) and social interaction ($\beta = 0.45$, 95% CI 0.27–0.63) for the treatment group relative to the control group.

GEE models stratified by study found similarities and differences in outcomes. Significance in moderate and vigorous PA was seen among all groups, while significance for recommended weekly PA was seen among Asian Indians only. A significantly greater improvement in PA self-efficacy was seen among all groups; a significantly greater improvement in PA barriers was seen among Filipinos; and a significantly greater improvement in PA social interaction was seen among Filipinos and Asian Indians (these questions were not asked among Bangladeshis).

Discussion

The results from our study suggest that culturally-adapted lifestyle interventions for Asian American communities have the potential to improve PA and PA-related outcomes across diverse Asian subgroups. We found that across the four studies, mean weekly moderate PA, meeting weekly PA recommendations, and mean PA self-efficacy increased significantly among treatment group participants. In addition, mean weekly vigorous PA increased significantly among Bangladeshi, Korean, and Asian Indian treatment groups, mean PA barriers decreased significantly for Bangladeshi, Filipino, and Asian Indian treatment groups, and mean PA social interaction increased significantly among Filipino and Asian Indian treatment groups. All PA outcomes except for PA barriers were significant in final adjusted regression analyses, when examining the interaction between study group (treatment/control) and time (baseline/endpoint).

Table 3 Change in PA outcomes between baseline and follow-up, by study and randomization group)

	Bangladeshi		Filipino		Korean		Asian Indian	
	Treatment (n = 141)	Control (n = 126)	Treatment (n = 85)	Control (n = 109)	Treatment (n = 114)	Control (n = 94)	Treatment (n = 68)	Control (n = 69)
Weekly moderate PA, minutes, median (IQR)								
Baseline	0 (0–140)	0 (0–105)	180 (0–420)	210 (85–510)	60 (0–180)	90 (0–180)	0 (0–0)	0 (0–0)
Endpoint	140 (70–210)	90 (0–210)	290 (150–1200)	180 (120–720)	116 (0–240)	90 (0–180)	180 (150–210)	90 (60–150)
P-value BL to Endpoint[1]	**< 0.001**	**< 0.001**	**< 0.001**	0.243	**0.020**	0.234	**< 0.001**	**< 0.001**
P-value T vs. C at Endpoint[5]	**0.002**		0.054		**0.027**		**< 0.001**	
Weekly vigorous PA, minutes, median (IQR)								
Baseline	0 (0–0)	0 (0–0)	60.0 (0–240)	90.0 (0–210)	0 (0–80)	0 (0–120)	0 (0–0)	0 (0–0)
Endpoint	0 (0–0)	0 (0–0)	150.0 (30–360)	90 (0–210)	90 (0–180)	0 (0–120)	30 (0–60)	0 (0–0)
P-value BL to Endpoint[1]	**0.011**	**0.026**	0.056	0.508	**< 0.001**	0.148	**< 0.001**	**0.039**
P-value T vs. C at Endpoint[5]	**0.009**		**0.048**		**0.005**		**< 0.001**	
≥ Recommended weekly PA, n (%)								
Baseline	39 (27.7)	37 (29.4)	64 (75.3)	84 (79.3)	56 (49.1)	50 (53.2)	7 (10.3)	7 (10.1)
Endpoint	80 (56.7)	53 (42.1)	78 (91.8)	96 (90.6)	72 (63.2)	46 (48.9)	64 (94.1)	25 (36.2)
P-value BL to Endpoint[2]	**< 0.001**	**0.030**	**0.002**	**0.007**	**0.011**	0.527	**< 0.001**	**< 0.001**
P-value T vs. C at Endpoint[4]	**0.017**		0.773		**0.039**		**< 0.001**	
PA Self-Efficacy (1–4, 4 = highest), mean (SD)								
Baseline	3.3 (0.8)	3.3 (0.7)	3.2 (0.8)	3.3 (0.7)	3.0 (0.7)	3.0 (0.7)	3.2 (0.6)	3.2 (0.7)
Endpoint	3.7 (0.5)	3.4 (0.6)	3.7 (0.5)	3.4 (0.6)	3.2 (0.4)	2.9 (0.5)	3.9 (0.3)	3.3 (0.5)
P-value BL to Endpoint[3]	**< 0.001**	0.386	**< 0.001**	0.311	**0.006**	0.436	**< 0.001**	0.939
P-value T vs. C at Endpoint[6]	**< 0.001**		**< 0.001**		**< 0.001**		**< 0.001**	

Table 3 (continued)

	Bangladeshi		Filipino		Korean		Asian Indian	
	Treatment (n = 141)	Control (n = 126)	Treatment (n = 85)	Control (n = 109)	Treatment (n = 114)	Control (n = 94)	Treatment (n = 68)	Control (n = 69)
PA Barriers (1–5, 5 = most), mean (SD)								
Baseline	1.4 (1.3)	1.5 (1.2)	0.7 (1.0)	0.8 (1.1)	0.9 (1.1)	1.0 (1.0)	2.4 (1.4)	2.5 (1.4)
Endpoint	0.9 (1.1)	1.1 (1.2)	0.4 (0.9)	0.7 (1.0)	0.8 (1.1)	1.0 (1.2)	1.1 (1.0)	1.8 (1.2)
P-value BL to Endpoint[3]	**< 0.001**	**0.004**	**0.021**	0.282	0.304	0.843	**< 0.001**	**< 0.001**
P-value T vs. C at Endpoint[6]	0.178		0.070		0.132		**< 0.001**	
PA Social Interaction (1–4, 4 = highest), mean (SD)								
Baseline	n/a	n/a	2.5 (1.0)	2.4 (0.9)	2.1 (0.7)	2.1 (0.8)	1.5 (0.6)	1.5 (0.6)
Endpoint	n/a	n/a	2.9 (0.7)	2.4 (0.8)	2.2 (0.8)	2.0 (0.8)	3.2 (0.7)	2.0 (0.6)
P-value BL to Endpoint[3]	n/a	n/a	**< 0.001**	0.965	0.253	0.223	**< 0.001**	**< 0.001**
P-value T vs. C at Endpoint[6]			**< 0.001**		0.155		**< 0.001**	

Bold values are statiscally significant ($P < 0.05$)

PA physical activity, *T* treatment, *C* control, *BL* baseline, *IQR* interquartile range

[1]Wilcoxon signed rank Test

[2]McNemar's test

[3]Paired- samples t-test

[4]Chi-square test

[5]Wilcoxon rank sum test

[6]Independent samples t-test

When stratified by study, moderate PA, vigorous PA, and PA self-efficacy remained significant in all studies, while recommended weekly PA was significant only among Asian Indians and PA social interaction was significant only among Filipinos and Asian Indians.

Age differences may explain some of the findings in the Korean group, as this study consisted of older individuals when compared to the other studies. Older age is associated with greater presence of comorbidities and variations in physical function [54, 55]. It may be that lower physical function among the Korean sample drives PA barriers in this group. While the items assessing PA barriers addressed individual, environmental, and social factors, it is difficult to determine the role of physical function since objective performance measures were not included in the parent studies.

We also found a significant association for social interaction in regression, aligning with recent work demonstrating the relationship between PA and social engagement [56, 57]. For Asian immigrants, the availability of culturally and linguistically adapted programming and materials is identified as a significant barrier to engaging in PA [58]. It may be that participation in these studies allowed study participants to access structured programming that specifically met their needs for information, coaching, or social network support in improving one's activity level. While it is difficult to discern whether improved social engagement is a direct result of a CHW's efforts or arises from the natural process of group dynamics in a structured intervention, these results nonetheless highlight the importance of examining how social engagement may be used to promote physical activity in future studies.

Table 4 GEE Regression analysis of PA outcomes overall and stratified by CHW intervention

Outcome	GEE Models		
Overall	Coefficient[1]	95% Confidence Interval	p-value
Moderate PA[2]	0.97	(0.56, 1.38)	**< 0.001**
Vigorous PA[2]	1.18	(0.82, 1.54)	**< 0.001**
Recommended weekly PA[3]	2.80	(1.81, 4.32)	**< 0.001**
Self-efficacy scale	0.36	(0.25, 0.46)	**< 0.001**
Barriers scale	− 0.17	(− 0.37, 0.03)	0.103
Social Interaction scale	0.45	(0.27, 0.63)	**< 0.001**
Bangladeshi			
Moderate PA[2]	0.98	(0.68, 1.80)	**< 0.001**
Vigorous PA[2]	1.03	(0.52, 1.54)	**< 0.001**
Recommended weekly PA[3]	2.32	(1.14, 4.72)	0.192
Self-efficacy scale	0.34	(0.12, 0.56)	**0.002**
Barriers scale	0.00	(− 0.36, 0.35)	0.982
Filipino			
Moderate PA[2]	0.86	(0.14, 1.58)	**0.019**
Vigorous PA[2]	0.85	(0.01, 1.68)	**0.048**
Recommended weekly PA[3]	1.83	(0.53, 6.26)	0.338
Self-efficacy scale	0.36	(0.17, 0.55)	**< 0.001**
Barriers scale	− 0.31	(− 0.66, 0.03)	0.077
Social Interaction scale	0.40	(0.12, 0.68)	**0.005**
Korean			
Moderate PA[2]	1.22	(0.30, 1.95)	**0.008**
Vigorous PA[2]	1.46	(0.69, 2.22)	**< 0.001**
Recommended weekly PA[3]	2.04	(0.93–4.45)	0.074
Self-efficacy scale	0.24	(0.05, 0.44)	**0.015**
Barriers scale	− 0.13	(− 0.51, 0.25)	0.504
Social Interaction scale	0.18	(− 0.07, 0.43)	0.165
Asian Indian			
Moderate PA[2]	1.26	(0.54, 1.99)	**< 0.001**
Vigorous PA[2]	1.78	(1.06, 2.49)	**< 0.001**
Recommended weekly PA[3]	41.4	(6.46, 265.26)	**< 0.001**
Self-efficacy scale	0.65	(0.38, 0.92)	**< 0.001**
Barriers scale	− 0.51	(− 1.06, 0.04)	0.070
Social Interaction scale	1.07	(0.72, 1.42)	**< 0.001**

Bold values are statiscally significant ($p < 0.05$)

[1]Effect of group (treatment/control) by time (baseline/endpoint) interaction, adjusted for age, gender, time in the US, education, employment, health insurance, and study

[2]Log transformed

[3]Logistic model, odds ratio presented

The recently released Physical Activity Guidelines for Americans, 2nd Edition notes that engaging in PA may produce both immediate and cumulative benefits, and establishing habitual activity is critical to optimizing the myriad effects of sustained PA [1]. Thus, from a behavior change standpoint, our findings suggest that targeting precursors to engaging in PA, such as PA barriers and PA self-efficacy, may help individuals to meet recommended PA levels. This further supports the notion that multi-component lifestyle interventions targeting psychosocial variables and clinical outcomes have the potential to effect positive behavior changes. Lifestyle approaches are known to produce beneficial changes in outcomes related to diabetes prevention [59, 60] and CVD risk factors [61], and our study adds to the literature that these changes can also occur among Asian American subgroups.

All studies employed an approach that integrated CHWs as program interventionists. This innovation may have bolstered the curriculum, strengthening improvements in clinical outcomes, PA, and PA related outcomes.

The significant improvements in PA self-efficacy and PA barriers for most subgroups suggest that important mechanisms may have been affected, such as activating participant engagement in PA. In fact, our previous work demonstrates that participants who were engaged with CHWs reported that CHWs helped them to change their behaviors and considered this a significant attribute of the CHWs' role [62]. Culturally-tailored approaches that employ CHWs also address health needs of diverse groups. CHWs leverage their distinct community knowledge and experience to establish a therapeutic rapport and provide supportive culturally salient care to build one's knowledge and self-efficacy for behavior change [19]. Although data specific to the roles of CHWs on PA behaviors and outcomes was not collected, future work should examine this aspect of study delivery in order to better understand the pathways of program effectiveness. This data may inform further refinement and tailoring of education and counseling efforts towards individual PA prescriptions and recommendations.

This study has several limitations. First, PA data was collected by self-report and therefore is subject to recall bias or interviewer bias. It is also possible that PA may be subject to social desirability bias, and thus over-reported by some participants. Future work should include objective PA measures. Second, PA outcomes have been reported in previous publications, but our scales were tailored for consistency across studies for data harmonization. Our final analysis aggregated all of the studies. Third, while recommended PA increased for all ethnic groups, we do not know whether this effect is the result of a comprehensive approach to improving a set of lifestyle behaviors. Additionally, although significant changes in vigorous PA were observed in the Bangladeshi and Asian Indian groups, this occurred among a smaller subset and should thus be interpreted with caution; greater changes were seen in moderate PA, which aligns with the focus of the intervention materials. Fourth, we do not examine the impact of the individual CHWs within each group. Notable limitations include variable presence of diabetes and hypertension across ethnic groups that may have confounded the results. Similarly, differences across studies in the interval between pre- and post-test measurements, along with varied intervention approaches by ethnic group may have influenced the results. Lastly, while our Filipino sample was highly educated and had high English fluency, this sample was also highly uninsured, which we are unable to explain using our data. Possible reasons for high rates of uninsurance in this group can include having undocumented immigration status or being concentrated in service sector professions where employer-sponsored insurance in unavailable, but we did not collect this information from participants. Filipinos who immigrate to the US tend to have high college education rates and stronger English skills, and the Philippines ranks 3rd for sending highly educated migrants to other countries [63, 64].

Conclusion

Despite these limitations, our study contributes to the growing evidence that culturally and linguistically appropriate interventions can improve lifestyle outcomes for Asian Americans. In particular, novel approaches to promoting PA through the use of CHWs may hold promise in future interventions aimed at lifestyle improvement and chronic disease management. Subsequent work in this area should include objective measures of PA and questionnaires with established validity and reliability. Furthermore, our study results are consistent with the previously well-established work on the importance of goal setting in behavior change [61, 65–67]. Additional examination of curricular variations that influence significant outcomes may be warranted. Similarly, future work should aim to identify the mechanisms through which multi-component interventions exert their effect. The success of CHW studies across various Asian subgroups in improving PA and related outcomes demonstrates the potential for widely disseminating this approach to improve Asian American health.

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Declarations

Conflict of interest The Authors declare that there is no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helinski Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all participants included in the studies.

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