Supporting South Asian Taxi Drivers to Exercise through Pedometers (SSTEP) to Decrease Cardiovascular Disease Risk

Francesca Gany, Pavan Gill, Raymond Baser, and
Jennifer Leng

ABSTRACT *There is considerable evidence demonstrating the positive impact of pedometers and walking programs for increasing physical activity and reducing risk for cardiovascular disease among diverse populations. However, no interventions have been targeted towards South Asian taxi drivers, a population that may be at high risk for developing cardiovascular disease. Supporting South Asian Taxi Drivers to Exercise through Pedometers (SSTEP) was a 12-week pilot study among South Asian taxi drivers to increase their daily step counts. SSTEP assessed the feasibility, acceptability, and potential impact of an exercise intervention employing pedometers, a step diary, written materials, and telephone follow-up to initiate or increase physical activity in this at-risk occupational group. Seventy-four drivers were recruited to participate at sites frequented by South Asian taxi drivers. Participant inclusion criteria were: (1) age 18 or over; (2) birthplace in India, Pakistan, or Bangladesh; (3) fluent in English, Hindi, Urdu, Punjabi, or Bengali; and (4) intention to remain in New York City for the 3-month study period. Comprehensive intake and exit questionnaires were administered to participants in their preferred languages. Intake and exit health screenings, including blood pressure, cholesterol, and glucose were completed. Daily step counts were obtained 4 days after recruitment, and at the 4-, 8-, and 12-week mark via phone calls. To measure the impact of the intervention, step counts, blood pressure, cholesterol, and body mass index were compared at intake and exit. Participants in SSTEP were sedentary at baseline. The SSTEP intervention resulted in a small increase in step counts among participants overall, and in a significant increase (>2,000 steps) among a subset ("Bigsteppers"). Drivers with higher baseline glucose values had significantly greater improvements in their step counts. Focused lifestyle interventions for drivers at high risk for cardiovascular disease may be particularly impactful.*

KEYWORDS *Cardiovascular disease, Prevention, Pedometer, South Asian, Taxi drivers*

Gany and Leng are with the Immigrant Health and Cancer Disparities Service, Department of Psychiatry and Behavioral Sciences, Department of Medicine, Memorial Sloan-Kettering Cancer Center, 300 E. 66th St., 15th Floor, New York, NY 10065, USA; Gany and Leng are with the Department of Public Health, Weill Cornell Medical College, 300 E. 66th St., 15th Floor, New York, NY 10065, USA; Gill is with the Immigrant Health and Cancer Disparities Service, Department of Psychiatry and Behavioral Sciences, Memorial Sloan-Kettering Cancer Center, 300 E. 66th St., 15th Floor, New York, NY 10065, USA; Baser is with the Department of Epidemiology and Biostatistics, Memorial Sloan-Kettering Cancer Center, 307 E. 63rd St, New York, NY 10065, USA.

Correspondence: Jennifer Leng, Immigrant Health and Cancer Disparities Service, Department of Psychiatry and Behavioral Sciences, Department of Medicine, Memorial Sloan-Kettering Cancer Center, 300 E. 66th St., 15th Floor, New York, NY 10065, USA. (E-mail: lengj@mskcc.org)

BACKGROUND

Six percent of cardiovascular disease-related deaths are attributed to physical inactivity.¹ Substantial evidence suggests that daily moderate-intensity physical activity, including walking, is highly beneficial.^{2–6} Elderly men who walked over 1.5 miles daily had significantly lower cardiovascular disease risk than men who walked 0.25 to 1.5 miles.⁷ Pedometer-based walking programs are effective in increasing exercise.⁸ In a systematic review, pedometer use was associated with statistically significant increases in physical activity, by about 2,000 steps/day, and with significant decreases in body mass index and blood pressure.⁹ Pedometer programs with the greatest step count increase included a 10,000 step per day goal and a step diary.⁹

There is considerable evidence demonstrating the success of pedometers and walking programs among sedentary workers,^{10,11} underserved African-Americans^{12–14} and the elderly.⁶ However, no interventions have been targeted towards South Asian taxi drivers, a population that may be at high cardiovascular risk, due to their occupation and ethnicity. Studies in Japan show an increased prevalence of myocardial infarction, multivessel disease, and cardiovascular risk among taxi drivers.^{15,16} High levels of particulate matter exposure among taxi drivers in Beijing is associated with low heart rate variability, a strong predictor for cardiovascular disease.¹⁷ Reports from Los Angeles and New York City (NYC) highlight the poor health status of taxi drivers, high stress, and sedentary lifestyle,^{18,19} which may exacerbate risk.

South Asian cardiovascular disease risk is well established. Coronary artery disease rates in overseas Asian Indians worldwide are 50 to 400 % higher than in other ethnic groups.²⁰ There is a higher prevalence and younger age of onset of cardiovascular disease in South Asian immigrants, compared with Caucasians,^{21–23} and a 33 % higher risk than in non-Hispanic whites.²⁴ In a study of US immigrant Indian physicians and their families, the age-adjusted prevalence of myocardial infarction or angina among Asian Indian men was 7.2 %, compared with 2.5 % in the Framingham Offspring Study.²² Asian Indians have an almost 300 % higher risk of metabolic syndrome, a key cardiovascular disease risk, than non-Hispanic whites.²⁵ Additional risk factors include low high density lipoprotein (HDL) and abnormal apolipoprotein A1 levels.²⁶ In Canada, South Asian immigrants had the lowest prevalence of physical activity compared with White, Black, Latin American, West Asian/Arab, East/Southeast Asian, and other groups, especially among recent immigrants.²⁷ Several studies have reported that Indians, Pakistanis, and Bangladeshis in the UK have lower physical activity levels compared to the general population.²⁸ Culturally linked priorities may deter exercise, including a belief that South Asian men should devote their time to financially support their families, rather than exercising.²⁹

Supporting South Asian Taxi Drivers to Exercise through Pedometers (SSTEP) was a 12-week pilot pedometer study among South Asian taxi drivers to increase their physical activity. SSTEP assessed the feasibility, acceptability and potential impact of an exercise intervention employing pedometers, a step diary, written materials, and telephone follow-up.

METHODS

Study approval was obtained by the New York University Institutional Review Board (authors' affiliation at the time of the study).

Recruitment was conducted at break sites, including a gurdwara (Sikh place of worship), and four popular restaurants. Inclusion criteria were: (1) taxi driver; (2) age 18 or over; (3) Indian, Pakistani, or Bangladeshi birthplace; (4) English, Hindi, Urdu, Punjabi, or Bengali fluency; and (4) intention to remain in NYC for the 3-month study period. Drivers with mobility impairments or exercise restrictions were excluded. Multilingual (English and one or more South Asian languages) research assistants consented the participants.

An intake questionnaire was administered in the driver's preferred language. Items included sociodemographic, medical history, health care access and utilization, and National Health and Nutrition Examination Survey physical activity questions.³⁰ Items on the intake questionnaire asked participants specifically if they had a history of cardiovascular disease, including heart attack, heart failure, angina, and/or stroke. Additional items asked participants whether they had a history of hypertension, diabetes, and/or elevated cholesterol.

Participants then completed intake health screenings: blood pressure using a 9002 E-Sphyg 2 Digital LCD Desk Unit Sphygmomanometer; nonfasting lipid (total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), total cholesterol/HDL) and glucose values using Cholestech LDX point of care testing;³¹ height using a measuring tape affixed to a wall; and weight using a Taylor 7009 Lithium Electronic Scale. Individuals who declined participation or were ineligible were also offered the free health screening and were provided cardiovascular risk reduction educational materials. Reasons for refusal were documented.

Following the intake, participants were provided with a HJ-303 OMRON pedometer, a step count diary, a pedometer instruction guide, and an illustrated speaking book on lowering cardiovascular disease risk,³² both written at a third-grade reading level. A "teach back" method was used to ensure participants knew how to use the pedometer. Participants were asked to wear the pedometer daily and were informed that research staff would call them in 4 days to obtain baseline step counts. Calls were scripted to ensure uniformity of the intervention; baseline step count values were obtained, and participants were educated about how to reach the daily 10,000 step count goal.⁹

Participants were then contacted at weeks 4, 8, and 12 to obtain step counts for the 7 days prior to the call, and the total step count since recruitment. Comments shared by the participants were noted. At the 12-week mark, exit interviews and health screenings were conducted, and a final step count obtained, either at the recruitment sites or at the Immigrant Health and Cancer Disparities Service, located next to a taxi stand. A \$25 incentive was provided.

To assess the potential impact of weather on step counts, temperature, precipitation, and snowfall were documented.

Data Analysis

SPSS version 19.0 was used to conduct descriptive analyses to describe demographic variables, medical history, health care access and utilization, and health screening results. Chi-square tests were conducted to test for associations between these variables and changes in step counts from baseline to participants' last follow-up. Changes in glucose, blood pressure, cholesterol, and body mass index from intake to exit were tabulated and tested for significant changes using the McNemar-Bowker test of symmetry for paired data. For continuous variables, the Wilcoxon signed-rank test was used to evaluate significant changes.

Linear mixed models (LMMs) were used to evaluate the associations of various predictors with change in steps per day from baseline. These models incorporated all available follow-up step data from each driver, which ranged from 1 to all 4 follow-up measurement periods, and accounted for the multiple observations per driver by including a random-effect intercept. First, a basic “control” model was fit that included only average baseline steps per day and average follow-up temperature (in degrees Fahrenheit). Both of these variables were centered at their means to facilitate interpretation of the estimated fixed-effect intercept term. Next, a series of models was fit in which each model evaluated the effect of a single additional predictor added to the “control” model. More complex models were not fit due to sample size limitations. Continuous predictors were centered at their means before model entry.

RESULTS

One hundred and three male South Asian taxi drivers were approached to participate. Seventy-four were recruited, 24 refused, and 5 were ineligible. Reasons for refusal (in decreasing frequency order) included no time ($n=15$), already exercising/not seeing it as beneficial ($n=5$), and no interest ($n=4$). Forty-seven drivers completed the study, which required completing the intake questionnaire, providing baseline step counts, and providing at least one follow-up step count (Fig. 1).

FIGURE 1. Study Flow Diagram.

Intake Sociodemographic Characteristics and Health History

The intake demographic data are reported for only the 47 drivers who completed the study. There were no differences between the drivers who completed the study versus those who dropped out except in mean number of days worked/week (6.29 days among completers, 5.98 among dropouts, $p=0.027$), years residing in the USA (70 % of completers versus 42 % of dropouts had been living in the USA for >15 years, $p=0.037$), and English proficiency (62 % of dropouts versus 32 % of completers spoke English very well, $p=0.027$).

Among study completers, mean age was 47.9 years. Eighty-one percent were yellow cab drivers. The mean number of years driving a taxi was 10.6. The participants worked a mean of 6.3 days/week and 10.1 h/day. Eighty-five percent of participants were married. Twenty-two (47 %) participants were born in India, 18 (38 %) in Pakistan, and 7 (15 %) in Bangladesh. Seventy percent of participants had resided in the USA for more than 15 years; only 2 % had been living in the USA for 2 years or fewer. Nearly all participants (98 %) preferred a language other than English for healthcare (Table 1).

Fifty-one percent of participants had health insurance. Sixty-six percent had a primary care provider (PCP); 67 % had visited their PCP in the last 6 months. Twenty percent had been to the emergency room at least once in the 6 months prior to recruitment. Eighty-three percent of participants had not been physically active for a total of at least 60 min in the 7 days prior to recruitment. Seventeen percent reported currently using tobacco.

Eleven percent of participants reported a previous history of cardiovascular disease, 38 % hypertension, 24 % diabetes, and 36 % hypercholesterolemia. Seventy-five percent of those with hypertension were taking medications, all those diagnosed with diabetes were taking medication, and 54 % of those with hypercholesterolemia were taking related medications.

Intake and Exit Health Screening

Thirty-one drivers completed both intake and exit glucose and blood pressure screening, 32 total cholesterol screening, 24 LDL, 30 HDL and total cholesterol/HDL ratio, and 27 completed body mass index. Reasons for noncompletion included inability for the Cholestech machine to calculate lipid breakdown when triglyceride readings were high, and participant inaccessibility because of travel outside of the country, phone numbers out of service or lack of time to complete the exit screening. Nearly all drivers had random glucose below 200 mg/dL (94 % at intake and 97 % at exit). Sixty-five percent had elevated blood pressure (mmHg) (≥ 140 systolic and/or ≥ 90 diastolic) at intake and 55 % had elevated values at exit. Fifty percent had elevated total cholesterol values (≥ 200 mg/dL) at intake and 41 % had elevated values at exit. Eighty-one percent were overweight or obese ($\text{BMI} \geq 25$) at both intake and exit. There were no significant differences in health screening values between intake and exit for participating drivers (Table 2).

In comparing self-report to intake screening values, a larger percentage of drivers who self-reported a history of hypertension had elevated blood pressure values at intake compared to drivers who did not self-report a history of hypertension (76 vs. 60 %), but this difference was not statistically significant ($p=0.529$). A significantly larger percentage of drivers who self-reported a history of diabetes had intake glucose levels greater than 200 mg/dL compared to drivers who did not report a diabetes diagnosis (45 vs. 3 %, $p=0.0002$). A significantly larger percentage of

TABLE 1 Participant sociodemographics

	<i>n</i>	%
Type of taxi		
Yellow cab	38	81
Car service	9	19
Age		
30–39	5	11
40–49	21	45
50–59	16	34
60–69	3	6
70–79	2	4
Country of birth		
India	22	47
Pakistan	18	38
Bangladesh	7	15
Years in USA		
1–2 years	1	2
6–9 years	3	6
10–15 years	10	21
>15 years	33	70
Visited country of birth after immigrating to USA		
Yes	40	85
No	7	15
No. of visits to country of birth		
1–5	21	53
6–10	11	28
>10	8	20
Missing	7	
Visited country of birth during study		
Yes	6	13
No	41	87
Missing	3	
No. of years driving taxi		
<1	1	2
1–5	10	22
6–10	13	28
11–15	14	30
16–20	7	15
>20	1	2
Missing	1	
No. of days working per week		
5	4	9
6	22	49
7	19	42
Missing	2	
No. of hours worked per day		
6–7	2	4
8–9	16	35
10–11	17	37
12–13	9	20
14–15	2	4
Missing	1	

TABLE 1 (continued)

	<i>n</i>	%
No. of children under age 18 in household		
0	20	44
1	5	11
2	10	22
3	7	15
4	4	9
Missing	1	
Marital status		
Married	39	85
Partnered	1	2
Divorced	2	4
Widowed	1	2
Single	3	7
Missing	1	
Highest level of education completed		
3rd–4th grade	1	2
5–6th grade	1	2
7–8th grade	2	4
9–11th grade	5	11
12th grade/HS graduate	9	19
Some college	7	15
College graduate/	9	19
Post college/graduate school	13	28
Preferred language for healthcare ^a		
English	1	2
Bengali	8	14
Punjabi	27	46
Hindi	11	19
Urdu	12	20
Spoken English proficiency		
Very well	15	32
Well, not well, not at all	32	68
Reading English proficiency		
Very well	17	36
Well, not well, not at all	30	64
Writing English proficiency		
Very well	15	32
Well, not well, not at all	32	68

^a*n*=59 for this variable as several participants reported multiple languages preferred

drivers who self-reported a history of elevated cholesterol had high total cholesterol at intake (200 mg/dL or higher) than drivers who did not report having a history of elevated cholesterol (79 vs. 26 %, $p<0.001$).

Step Counts

Research staff contacted drivers to obtain baseline and follow-up step counts. During these telephone calls, staff would ask drivers to describe how they were obtaining the step counts from the pedometer, i.e., which buttons they were pressing on the pedometer, which was a strong indication that drivers were indeed using the

TABLE 2 Blood pressure, glucose, cholesterol, and BMI

	Intake		Exit		
	<i>n</i>	%	<i>n</i>	%	<i>p</i> value
Glucose screening results (mg/dL)					
<200	29	93.5	30	96.8	0.317
200–399	1	3.2	1	3.2	
≥400	1	3.2	0	0	
Total	31	100.0	31	100.0	
Blood pressure screening results (mmHg)					
S (<120) and D (<80)	0	0	1	3.2	0.515
S (120–139) and/or D (80–89)	11	35.5	13	41.9	
S (140–159) and/or D (90–99)	15	48.4	9	29.0	
S (160–179) and/or D (100–110)	5	16.1	8	25.8	
S (>180) and/or D (>110)	0	0.0	0	0.0	
Total	31	96.9	31	100.0	
Total cholesterol screening results (mm/dL)					
<200	16	50.0	19	59.4	0.362
200–239	11	34.4	11	34.4	
240 and above	5	15.6	2	6.3	
Total	32	100.0	32	100.0	
LDL screening results (mg/dL)					
<100	7	29.2	11	45.8	0.199
100–129	9	37.5	6	25	
130–159	6	25.0	6	25	
160–189	2	8.3	1	4.2	
≥190	0	0.0	0	0	
Total	24	100.0	24	100	
HDL screening results (mg/dL)					
<40	17	56.7	22	73.8	0.180
≥40	13	43.3	8	26.7	
Total	30	100.0	30	100.0	
TC/HDL ratio					
≤3.5	2	6.7	1	3.3	0.607
>3.5–4.5	6	20.0	6	20	
>4.5	22	73.3	23	76.7	
Total	30	100.0	30	100	
BMI					
<18.5	0	0	0	0	0.407
18.5–24.9	5	18.5	5	18.5	
25–29.9	15	55.6	12	44.4	
≥30	7	25.9	10	37	
Total	27	100	27	100	

pedometers. At baseline, the overall mean (standard deviation, SD) number of steps/day was 3,731.9 (SD=1,685.4) and the median was 3,241.4. Those who dropped out of the study had lower baseline mean steps/day (3,064.1, SD=1,502.2) and a lower median (2,686.8), though this difference was not statistically significant. The mean steps/day during the drivers' last follow-up was 3,948.9 (SD=2,154.7); the median was 3,443.7. There was a mean increase in steps/day of 217 (SD=1,964.96) and a median of 42.2 steps for study completers. Overall, 24 drivers (51.1 %) had a

TABLE 3 Linear mixed models predicting average change in follow-up steps/day, controlling for average baseline steps/day and average follow-up temperature

	Regression coefficient (beta)	Standard error of beta	t value	DF	p value
(Intercept)	290.005	230.427	1.260	89	0.211
Ave baseline steps/day	−0.515	0.140	−3.670	44	0.001
Average follow-up temperature	68.609	24.093	2.850	44	0.007
(Intercept)	−94.951	324.770	−0.292	89	0.771
Ave baseline steps/day	−0.501	0.138	−3.627	43	0.001
Average follow-up temperature	68.252	23.665	2.884	43	0.006
Insured	747.202	452.263	1.652	43	0.106
(REF: not insured)	(REF)				
(Intercept)	518.013	856.354	0.605	89	0.547
Ave baseline steps/day	−0.537	0.146	−3.686	41	0.001
Average follow-up temperature	63.094	27.933	2.259	41	0.029
Age, 39 to <49 years	−321.746	944.916	−0.341	41	0.735
Age, 49 to <59 years	−374.590	942.516	−0.397	41	0.693
Age, 59 years or older (76 oldest)	337.516	1,080.978	0.312	41	0.756
(REF: Age, <39 years (31 youngest)	(REF)				
(Intercept)	−633.568	836.685	−0.757	89	0.451
Ave baseline steps/day	−0.499	0.146	−3.418	42	0.001
Average follow-up temperature	67.328	24.275	2.774	42	0.008
Years in USA, 10–15 years	840.277	988.744	0.850	42	0.400
Years in USA, 16 or more years	1,051.390	877.286	1.198	42	0.237
(REF: years in USA, 1–9 years)	(REF)				
(Intercept)	−3.289	288.740	−0.011	87	0.991
Ave baseline steps/day	−0.545	0.145	−3.774	41	0.001
Average follow-up temperature	56.621	25.698	2.203	41	0.033
Marital status, separated	1,206.537	614.441	1.964	41	0.056
Marital status, divorced/widowed/single	306.273	729.641	0.420	41	0.677
(REF: Marital status, cohabitating)	(REF)				
(Intercept)	308.896	401.874	0.769	89	0.444
Ave baseline steps/day	−0.506	0.147	−3.446	42	0.001
Average follow-up temperature	73.165	28.402	2.576	42	0.014
Education, some college/college grad	−134.217	629.260	−0.213	42	0.832
Education, post-college	112.557	587.758	0.192	42	0.849
(REF: education, high school grad or less)	(REF)				
(Intercept)	−962.082	648.799	−1.483	89	0.142
Ave baseline steps/day	−0.465	0.135	−3.433	42	0.001
Average follow-up temperature	124.214	29.427	4.221	42	0.000
Birth country, India	2,081.603	819.193	2.541	42	0.000
Birth country, Pakistan	744.507	714.472	1.042	42	0.303
(REF: birth country, Bangladesh)	(REF)				
(Intercept)	−629.412	364.658	−1.726	89	0.088
Ave baseline steps/day	−0.498	0.129	−3.867	43	0.000
Average follow-up temperature	63.324	22.112	2.864	43	0.006
PCP, has a PCP	1,378.967	446.651	3.087	43	0.004
(REF: PCP, does not have a PCP)	(REF)				
(Intercept)	181.435	233.416	0.777	77	0.439
Ave baseline steps/day	−0.493	0.141	−3.499	38	0.001
Average follow-up temperature	78.208	26.149	2.991	38	0.005
TC/HDL ratio	−230.145	144.507	−1.593	38	0.12

TABLE 3 (continued)

	Regression coefficient (beta)	Standard error of beta	<i>t</i> value	DF	<i>p</i> value
(Intercept)	279.136	217.296	1.285	89	0.202
Ave baseline steps/day	-0.477	0.133	-3.582	43	0.001
Average follow-up temperature	62.435	22.865	2.731	43	0.009
Glucose	7.026	2.930	2.398	43	0.021
(REF: baseline glucose, below 150)	(REF)				
(Intercept)	-637.902	445.295	-1.433	89	0.155
Ave baseline steps/day	-0.389	0.142	-2.732	41	0.009
Average follow-up temperature	67.894	23.068	2.943	41	0.005
Baseline glucose, 25th to <50th percentile (98.5 to <113.0)	824.617	651.408	1.266	41	0.213
Baseline glucose, 50th to <75th percentile (113.0 to <148.5)	1,228.009	628.692	1.953	41	0.058
Baseline glucose, 75th percentile or higher (148.5 or higher)	1,666.701	638.661	2.610	41	0.013
(REF: Baseline glucose, <25th percentile (<98.5))	(REF)				
(Intercept)	98.592	244.889	0.403	89	0.688
Ave baseline steps/day	-0.546	0.138	-3.967	43	0.001
Average follow-up temperature	56.770	24.259	2.340	43	0.024
Using tobacco products	1,320.754	674.653	1.958	43	0.057
(REF: was not using tobacco products)	(REF)				

All continuous variables were centered at their means

net increase in their number of steps/day at their last follow-up compared to baseline.

Both baseline steps/day and follow-up temperature (follow-up temperature=mean temperature of the days a given driver recorded follow-up steps) were significantly associated with changes in average steps/day in the LMM that included only those two variables. Specifically, at the mean baseline steps/day and mean follow-up temperature, the drivers increased a mean of 290 steps/day from their baseline values. For each additional step/day taken at baseline, the drivers decreased their steps/day by 0.515 steps. For each 1° Fahrenheit increase in the average follow-up temperature, the drivers tended to increase their steps/day by 68.6 steps.

Several additional variables were evaluated by adding them to this basic model, each separately and one at a time to avoid overfitting. Age, years in the USA, years driving a taxi, type of taxi, visits to home country, having children, education, average driving hours/day, average driving days/week, insurance, history of cardiovascular disease, hypertension, diabetes or hypercholesterolemia (each evaluated separately), weight, BMI, total cholesterol, LDL, HDL, blood pressure, and triglycerides were not associated with change in average steps/day, controlling for average baseline steps/day and average follow-up temperature.

Drivers born in India compared to Bangladesh had a significantly greater increase in steps/day. Drivers with a PCP also significantly improved their average steps/day, as did drivers with relatively higher glucose levels at baseline. Baseline total cholesterol/HDL ratio was not a significant predictor of change in steps/day. Drivers

who were separated had increases in their steps/day compared to married/co-habiting drivers, though this was not statistically significant ($p=0.056$). Finally, tobacco users had increases in their steps/day compared to drivers who were not using tobacco products; this was also not statistically significant ($p=0.057$; Table 3).

“Bigsteppers”

Seven out of 47 (14.9 %) of the drivers improved 2,000 or more steps. The temperature was significantly higher (Wilcoxon rank sums test p value=0.049) at the last step timepoint for these 7 drivers (median=68.3, IQR=63.2–68.7) than for the other 40 drivers (median=52, IQR=45.5–88.9). These improvers tended to be in either the youngest (<39 years, $n=4$) or the oldest age group (59 years or older, $n=6$); half of the drivers in these two age groups improved by 2,000+ steps, compared to only 5.5 % of the 37 drivers between 39 and 59 (Fisher’s exact test $p=0.005$). The majority of the improvers (71 %) were either separated, divorced, widowed, or single, compared to only 29 % who were married or co-habiting (Fisher’s exact test $p=0.029$).

The improvers had significantly higher (Wilcoxon rank sums test $p=0.033$) intake systolic blood pressure (median=146, IQR=140–154) than the other drivers (median=130, IQR=127–142). There were differences between the improvers and other drivers in both weight and body mass index at intake, though these were not statistically significant (Wilcoxon rank sums test $p<0.100$). The median intake weight of improvers was 179 lbs compared to 191 lbs for the other drivers ($p=0.074$). The intake BMI of improvers also tended to be lower (median=27.6) than that of the other drivers (median=28.9), $p=0.057$. Despite lower weight and BMI at intake, drivers with step improvements of >2,000 steps also had reductions in BMI from intake to exit (though not statistically significant). Specifically, improvers saw a median BMI decrease of 0.62, while the other drivers’ BMI increased a median of 0.27 ($p=0.088$).

CONCLUSIONS

This study describes the results of a pedometer-based exercise intervention among an at-risk, hard-to-reach group, South Asian taxi drivers. The majority of SSTEP participants were yellow cab drivers and sedentary at baseline. Previous work by the authors³³ suggests that these drivers (compared to livery drivers) may find it especially challenging to increase their physical activity due to high stress, time constraints, and little flexibility/opportunity for walking breaks. The SSTEP intervention resulted in a small increase in step counts among participants overall, and in a significant increase (>2,000 steps)⁹ among a subset (“Bigsteppers”). Drivers were at risk for cardiovascular disease; an alarming proportion had abnormal blood pressure and cholesterol, and over 80 % were overweight or obese. Focused interventions for these high-risk drivers may be particularly impactful. Drivers with higher baseline glucose values had significantly higher improvements in their step counts; this is important for programs directed towards diabetic and/or prediabetic drivers, who may be especially amenable to lifestyle interventions.

Study staff experienced several barriers in contacting participants. This resulted in significant study dropout, a study limitation. Three barriers were most common: (1) no response to phone calls, despite multiple attempts at various times throughout the day and evening, during the week and on weekends; (2) phone numbers no longer in service as the study progressed; (3) inability of participants to speak at the

time of the calls (busy driving or just unable to talk at the time). In such cases, it took several attempts to obtain complete study data. Pedometer loss represented an additional issue. Several participants who lost their pedometers did not promptly obtain their replacement. Wrist pedometers are now available; these may help address this issue. The greatest dropout took place between the baseline and month 1 Follow-up calls. Future interventions should focus on incentivizing participation through this drop-out point (i.e., free cell phones/minutes, staff presence at occupational sites to facilitate data collection and pedometer replacement). Retention efforts should also be directed towards drivers who are more recent immigrants. We also did not collect data regarding shift hours (day vs. night drivers), which could have impacted drivers' ability to walk. Questions related to occupational stress, which would contribute to drivers' cardiovascular disease risk profile, were also not asked. Future studies should include these factors.

Despite the aforementioned barriers, most participant comments were positive. They stated that the intervention served as a reminder to exercise, encouraged the drivers to stay healthy, and increased their levels of physical activity. Comments included, "it makes a difference because it reminds us to exercise, makes a routine, sometimes you forget to wear it but otherwise it is really beneficial, it tells you how much you need to exercise and you can use that as a reason to exercise." Many participants also noted an improvement in health behaviors, physical health, or overall relaxation and mood: "because of walking I have less pain in my arms and legs, I am going to buy a blood pressure machine to monitor my blood pressure, I am motivated to take care of my health." Another stated, "it feels really good for the heart when I walk; it feels fresh and my blood pressure stays good too." Another participant described motivating peers to exercise, "I have a lot of friends who joined the gym and they are educating each other about taking care of their health (what fat means, etc.), I am more serious about my health and am exercising since I got the pedometer."

Forty-seven percent of drivers in this study completed college or beyond, somewhat higher than the figure for the larger NYC taxi driver community at 37 %.³⁴ Future interventions should be inclusive of drivers from diverse educational backgrounds, as it has been described that individuals with lower educational levels are more likely to have a higher burden of cardiovascular disease and related risk factors.³⁵ Consistent with previous literature, married men in this study exercised less than their single counterparts.³⁶ With greater family demands, married men may benefit from exercise interventions that engage families and communities. Temperature was an important factor; colder weather resulted in lower step counts. Future interventions should address the impact of weather on exercise, i.e., be inclusive of information on how to achieve step goals indoors during winter weather conditions. Interventions should also incorporate multilevel strategies to address cardiovascular disease risk among taxi drivers, including strategies at the individual, environmental, organizational, and policy levels.³⁷

ACKNOWLEDGMENTS

Contributors. Thank you to S. Acharya, A. Aymed, and M. Khera from the South Asian Council for Social Services for assisting with the recruitment of taxi drivers. Thank you to J. Silberstein, A. Singh, and M. Mittal for assisting with conducting the health screenings and completing follow-up calls with the taxi drivers. Lastly, thank you to the South Asian Health Initiative for its insight throughout the study.

Funding. Funding for this study was provided by the New York State Department of Health Empire Clinical Research Investigator Program (ECRIP).

REFERENCES

1. World Health Organization. *Global health risks: mortality and burden of disease attributable to selected major risks*. Geneva: WHO; 2009.
2. Lau DC, Douketis JD, Morrison KM, Hramiak IM, Sharma AM, Ur E. 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children [summary]. *CMAJ*. 2007; 176(8): S1–13.
3. Centers for Disease Control and Prevention. *Phys Act Health*. 2011; <http://www.cdc.gov/physicalactivity/everyone/health/index.html>. Accessed 7 Sept 2011.
4. Tanasescu M, Leitzmann MF, Rimm EB, Hu FB. Physical activity in relation to cardiovascular disease and total mortality among men with type 2 diabetes. *Circulation*. 2003; 107(19): 2435–9.
5. Rothenbacher D, Hoffmeister A, Brenner H, Koenig W. Physical activity, coronary heart disease, and inflammatory response. *Arch Intern Med*. 2003; 163(10): 1200–5.
6. Tully MA, Cupples ME, Chan WS, McGlade K, Young IS. Brisk walking, fitness, and cardiovascular risk: a randomized controlled trial in primary care. *Prev Med*. 2005; 41(2): 622–8.
7. Hakim AA, Curb JD, Petrovitch H, et al. Effects of walking on coronary heart disease in elderly men: the Honolulu Heart Program. *Circulation*. 1999; 100(1): 9–13.
8. Baker G, Gray SR, Wright A, et al. The effect of a pedometer-based community walking intervention “Walking for Wellbeing in the West” on physical activity levels and health outcomes: a 12-week randomized controlled trial. *Int J Behav Nutr Phys Act*. 2010; 7(1): 51.
9. Bravata DM, Smith-Spangler C, Sundaram V, et al. Using pedometers to increase physical activity and improve health: a systematic review. *JAMA*. 2007; 298(19): 8.
10. Chan CB, Ryan DA, Tudor-Locke C. Health benefits of a pedometer-based physical activity intervention in sedentary workers. *Prev Med*. 2004; 39(6): 1215–22.
11. Freak-Poli R, Wolfe R, Backholer K, de Courten M, Peeters A. Impact of a pedometer-based workplace health program on cardiovascular and diabetes risk profile. *Prev Med*. 2011; 53(3): 162–71.
12. Zoellner J, Connell C, Powers A, Avis-Williams A, Yadrack K, Bogle ML. Does a six-month pedometer intervention improve physical activity and health among vulnerable African Americans? A feasibility study. *J Phys Act Health*. 2010; 7(2): 224–31.
13. Duru OK, Sarkisian CA, Leng M, Mangione CM. Sisters in motion: a randomized controlled trial of a faith-based physical activity intervention. *J Am Geriatr Soc*. 2010; 58(10): 1863–9.
14. Panton LB, Kushnick MR, Kingsley JD, Moffatt RJ, Haymes EM, Toole T. Pedometer measurement of physical activity and chronic disease risk factors of obese lower socioeconomic status African American women. *J Phys Act Health*. 2007; 4(4): 447–58.
15. Kobayashi F, Watanabe T, Watanabe M, et al. Blood pressure and heart rate variability in taxi drivers on long duty schedules. *J Occup Health*. 2002; 44: 214–20.
16. Kurosaka K, Daida H, Muto T, Watanabe Y, Kawai S, Yamaguchi H. Characteristics of coronary heart disease in Japanese taxi drivers as determined by coronary angiographic analyses. *Ind Health*. 2000; 38(1): 15–23.
17. Wu S, Deng F, Niu J, Huang Q, Liu Y, Guo X. Association of heart rate variability in taxi drivers with marked changes in particulate air pollution in Beijing in 2008. *Environ Health Perspect*. 2010; 118(1): 87–91.
18. Blasi G, Leavitt J. *Driving poor: taxi drivers and the regulation of the taxi industry in Los Angeles*. Los Angeles: UCLA Institute of Industrial Relations; 2006.
19. Urban Justice Center. UNFARE: taxi drivers and the cost of moving the city. New York: Urban Justice Center; 2003.

20. Enas E SA. Coronary artery disease in Asian Indians: an update and review. *Int J Cardiol.* 2002;1(2).
21. Anand SS, Yusuf S, Vuksan V, et al. Differences in risk factors, atherosclerosis, and cardiovascular disease between ethnic groups in Canada: the Study of Health Assessment and Risk in Ethnic groups (SHARE). *Lancet.* 2000; 356(9226): 279–84.
22. Enas EA, Garg A, Davidson MA, Nair VM, Huet BA, Yusuf S. Coronary heart disease and its risk factors in first-generation immigrant Asian Indians to the United States of America. *Indian Heart J.* 1996; 48(4): 343–53.
23. Cappuccio FP. Ethnicity and cardiovascular risk: variations in people of African ancestry and South Asian origin. *J Hum Hypertens.* 1997; 11(9): 571–6.
24. Holland AT, Wong EC, Lauderdale DS, Palaniappan LP. Spectrum of cardiovascular diseases in Asian-American racial/ethnic subgroups. *Ann Epidemiol.* 2011; 21(8): 608–14.
25. Palaniappan LP, Wong EC, Shin JJ, Fortmann SP, Lauderdale DS. Asian Americans have greater prevalence of metabolic syndrome despite lower body mass index. *Int J Obes (Lond).* 2011; 35(3): 393–400.
26. Dodani S, Butler M, Vacek J. Metabolic syndrome in South Asian immigrants: more than low Hdl requiring aggressive management. *J Epidemiol Community Health.* 2011; 65: A381–2.
27. Tremblay MS, Bryan SN, Perez CE, Ardern CI, Katzmarzyk PT. Physical activity and immigrant status—evidence from the Canadian Community Health Survey. *Can J Public Health.* 2006; 97(4): 277–82.
28. Fischbacher CM, Hunt S, Alexander L. How physically active are South Asians in the United Kingdom? A literature review. *J Public Health (Oxford).* 2004; 26(3): 250–8.
29. Patel M, Phillips EP, Boutin-Foster C. Barriers to lifestyle behavioral change in migrant South Asian populations. *J Immigr Minor Health.* 2012; 14(5): 774–85.
30. National Health and Nutrition Examination Survey Questionnaire—physical activity and physical fitness—PAQ. Hyattsville, MD: US Department of Health and Human Services, Centers for Disease Control and Prevention. 1 Oct 2010.
31. Inverness Medical. Cholestech LDX System. NJ: Princeton.
32. Pfizer. *High blood pressure and staying healthy.* Florida: Books of Hope LLC; 2010.
33. Gany FM, Gill PP, Ahmed A, Acharya S, Leng J. “Every disease...man can get can start in this cab”: focus groups to identify South Asian taxi drivers’ knowledge, attitudes and beliefs about cardiovascular disease and its risks. *J Immigr Minor Health.* 2013; 15(5): 986–92.
34. Schaller B, Gilbert G. Factors of production in a regulated industry: New York taxi drivers and the price for better service. *Trans Q;* 1995; 49(4): 81–90.
35. Winkleby MA, Jatulis DE, Frank E, Fortmann SP. Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. *AJPH.* 1992; 82(6): 816–20.
36. Nomaguchi KM, Bianchi SM. Exercise time: gender differences in the effects of marriage, parenthood, and employment. *J Marriage Fam.* 2004; 66(2): 413–30.
37. Karwalajtys T, Kaczorowski J. An integrated approach to preventing cardiovascular disease: community-based approaches, health system initiatives, and public health policy. *Risk Manag Healthc Policy.* 2010; 3: 39–48.