Effectiveness of a Community-Based Intervention Program to Reduce Hypertension Prevalence Among Adults

Results of a Quasiexperimental Study With Control Group in the Region of Sousse, Tunisia

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ABSTRACT

Background: High blood pressure is preventable and is directly related to lifestyle habits such as an unbalanced diet, low levels of physical activity, and tobacco use.

Objectives: This quasiexperimental study aimed to assess the effectiveness of a 3-year community intervention targeting healthy lifestyle promotion in reducing hypertension prevalence among adults.

Methods: A quasiexperimental design was used to evaluate the effectiveness of a 3-year intervention for healthy lifestyle that was implemented between 2010 and 2013 in a community of adults in the region of Sousse in Tunisia. The population study was randomly selected in both intervention and control groups at pre-assessment and post-assessment. After considering a type 1 error α of 5%, a type 2 error β of 20%, and a change in the prevalence of various risk factors of 6% between pre-intervention and post-intervention, the sample size was fixed to 2,000 adults in intervention and control areas.

Results: The intervention group was composed of 940 and 1,001 adults, and the control group was composed of 940 and 976, respectively, at pre-assessment and post-assessment. The prevalence of hypertension decreased in the intervention group globally from 37.3% to 33.7% but not significantly ($p = 0.1$). In the control group, this proportion increased from 31.1% to 33.4% without significant difference ($p = 0.28$). In the intervention group, after stratification for age, a significant decrease ($p = 0.007$) in the prevalence of hypertension was observed for participants younger than 40 years old: it decreased from 22.8% to 16.2%. In the control group, it increased from 14% to 15.4% ($p = 0.52$). In intervention group, a significant decrease of the hypertension from 31.4% to 26% ($p = 0.03$) was observed among nonobese participants after stratification for weight status. No significant change was observed in the control group.

Conclusions: This study showed the feasibility and effectiveness of a community-based intervention to reduce the prevalence of hypertension in the context of a developing country.

According to the World Health Organization (WHO), cardiovascular disease is responsible for one-third of global deaths and is a major contributor to the global burden of disease [1]. One of the major factors for cardiovascular disease is hypertension, which has reached pandemic levels worldwide. In 2008, approximately 40% of adults 25 years old and older were diagnosed with hypertension [2]. In 2009, 13% of all deaths were attributed globally to high blood pressure, thus making it a major public health issue in both developing and developed nations [3]. High blood pressure is preventable and is directly related to lifestyle habits such as poor diet, low levels of physical activity, tobacco use, and obesity [3]. Lifestyle modification is a leading component of population-based strategies to prevent high blood pressure. These prevention efforts are receiving growing attention to offset the increasing burden of disease and to stem rising health care costs [4]. Many examples show that developed nations have been successful in improving public health and reducing blood pressure by implementing interventions targeting lifestyle habits [3]. Despite the success of addressing these risk factors in high-income countries, the prevalence of these risk factors has increased or remained unchanged in many low-income and middle-income countries [5]. For developing countries, the evidence of the effectiveness of lifestyle intervention is less clear, and intervention studies have been scarce [6].

Tunisia, a North African developing country of 11 million inhabitants, after accelerated socioeconomic and

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health development, has experienced a supported demographic transition [7]. As a corollary, Tunisia has entered a phase of epidemiological transition characterized by the decrease in the share of communicable diseases and the increase in noncommunicable diseases. This increase is largely the result of marked changes in lifestyles [7].

Aware of this new epidemic, the Tunisian Ministry of Health set up a national program to improve the management and the control of hypertension and diabetes since 1993. The national program strategy is based on 4 components: 1) the health education of the patient himself and members of his family; 2) the training of doctors and paramedics; 3) frontline public health requirements for hypertension; and, finally, 4) national and regional supervision to identify inadequacy and propose solutions [8]. In Tunisia, many observational studies were made to evaluate determinants of hypertension [9–14], as well as its prevalence, which is approximately 30% [14]. However, community-based trials were rare [8].

Considering this context, this study was conducted to assess the effectiveness of a 3-year community intervention targeting the promotion of healthy lifestyle in the prevention of hypertension in adults in the region of Sousse, Tunisia.

METHODS

Study design

This quasiexperimental study was conducted between 2009 and 2014 in a community of adults in the region of Sousse. The intervention group was located in the delegation of Sousse Jawhra-Riadh, and the control group was located in the delegation of M'saken (Figure 1). In term of demographics, environment, culture, and socioeconomic status, these two regions are comparable. According to data from the last population census of the National Institute of Statistics in 2004, the delegation of Sousse Riadh-Jawhara had 127,996 inhabitants and 30,635 households. The delegation of M'saken had 85,380 inhabitants and 19,423 households. Jawhra-Riadh was chosen as the intervention group for reasons of proximity. A distance of approximately 20 km separates Sousse Riadh-Jawhra from M'saken. This distance was considered to avoid the contamination bias of the intervention.

Sample size

After considering a type 1 error (α) of 5%, a type 2 error (β) of 20%, and a change in the prevalence of various factors risk (smoking, poor diet, lack of physical activity) of 6% between pre-intervention and post-intervention, the sample size needed for the purpose of our study was 1,000 adults in each group.

The region of Sousse, divided into 15 delegations, is composed of 544,413 inhabitants and 124,519 households. To have the minimum size needed of 1,000 adults in each group, the National Institute of Statistics, according to the data of the last decennial population census of 2004, randomly selected districts from each delegation, and all adults 18 to 65 years old in the households of the selected districts were invited to participate in the study.

Data collection and variable definitions

A questionnaire prepared in collaboration with the Community Intervention for Health Project was translated into Arabic and was pre-tested and used for the purpose of this study to assess the effects of the intervention.

The questionnaires were administrated through personal interviews by trained investigators to collect the following: sociodemographic data (age, sex, study levels, employment status); medical history; attitudes and beliefs

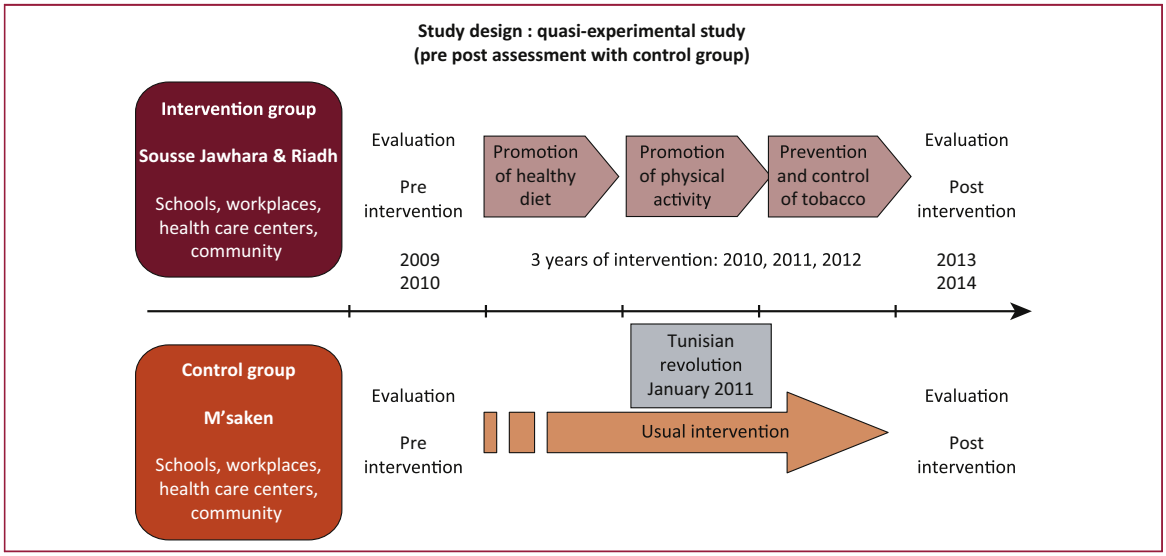

FIGURE 1. The study design of the quasiexperimental study: pre-assessment and post-assessment with a control group in the region of Sousse Tunisia, 2009 to 2014.

toward risk factors for chronic disease (unhealthy diet, physical inactivity, and tobacco use); anthropometrics (weight, height, and waist circumference); and blood pressure.

Blood pressure was measured by medical doctors twice with a digital monitor at rest. The mean value of 2 measurements was used to define high blood pressure the day of the measurement. Adults were considered to have hypertension if they had systolic blood pressure of 140 mm Hg or more, diastolic blood pressure of 90 mm Hg, or a medical history of hypertension.

Hypertension is defined as systolic blood pressure) of 140 mm Hg or more, diastolic blood pressure of 90 mm Hg, or the use of antihypertensive medication [15].

To define overweight and obesity, we used international body mass index (BMI) cutoff values according to the WHO [16].

Intervention program

The intervention, which lasted 3 years, from September 2010 to September 2013, consisted of community education about the importance of chronic disease prevention that targeted the major three modifiable lifestyle risk factors: tobacco use, unhealthy diet, and sedentary lifestyle.

This study reported the results of the intervention in neighborhoods. It is part of a comprehensive integrated community-based intervention program for chronic disease risk factor prevention that targets different settings: neighborhoods, workplaces, schools, and primary care centers.

In addition to the intervention in neighborhoods, adults could be targeted through interventions in the other settings. Besides the specific effect of the intervention in neighborhoods, a global effect results from interventions in the other settings because an adult can be targeted in a neighborhood and also through the workplace as a worker, through the school as a parent, and through a primary care center as a potential patient.

The project team was composed of a variety of health care professionals: physicians, paramedics, a nutritionist, and a psychologist. They were trained to standardize the educational messages.

The educational materials were designed specifically for the purposes of this study by a team of professionals in communication and health care. The materials included flyers, posters, videos, and radio spots containing various chronic disease preventive messages. These educational materials were used in the different settings.

In the different settings, the intervention program consisted mainly of education sessions and open sensitization days on 3 different topics: smoking, physical activity, and diet.

Concerning tobacco use, in addition to oral and written warning messages, smokers benefited from measurement of carbon monoxide in expired air. The Fagerstrôm score was used to evaluate the degree of addiction. People desiring to quit were referred to antismoking consultations.

To promote physical activity, messages provided by educators aimed to help participants integrate it into everyday life: "take the stairs instead of the lift," "plant a flower garden," "wash the car or clean the house," "drive less and walk more."…

"Eat more fruits and vegetables and less fat, sugar, and salt," "drink more water," and "do not snack between meals" were the main oral and written messages to promote healthy eating among participants.

In neighborhoods, the intervention program consisted mainly of open sensitization days, which took place monthly on a Sunday, in front of the supermarkets of the intervention districts. During these open sensitization days, the program provided risk factor screenings (obesity, hypertension) and education for persons at risk.

Flyers containing various chronic disease preventive messages were distributed to the participants in the open sensitization days and to the households belonging to the intervention group district at the beginning and at the end of the intervention.

Mass media intervention to promote healthy diet and physical activity and to control tobacco use included radio programs provided by local stations and narrated by a variety of specialists (endocrinologist, pulmonologist, nutritionist, and psychologist). Various radio spots were broadcast 3 times daily during a period of 6 months.

In the workplace, the intervention program consisted mainly of the following: open sensitization days; education sessions; workshops; showings of educational films followed by interactive discussions; free physical activity sessions for employees; and free smoking cessation consultations. Education sessions on healthy diet, physical activity, and tobacco cessation were led by occupational physicians who were trained to provide a standardized educational message.

In primary care centers, all the doctors and paramedics in the intervention area were trained to manage hypertension and diabetes and to evaluate cardiovascular risk. Education sessions on these risk factors and the promotion of healthy lifestyle behaviors were delivered to the consultant. The intervention program involved 19 primary care centers.

In schools, after creation of leaders groups among teachers and schoolchildren, education sessions on physical activity, healthy diet promotion, and tobacco use prevention were led by teachers. Workshops on these three topics were organized by the project team and by schoolchildren leaders in each school in the presence of parents. The participants in intervention group benefited from open days with sensitization sessions and work groups to adopt healthy behaviors. Topics related to healthy lifestyle such as balanced diet, sodium reduction, recommended physical activity, and tobacco cessation were developed in these sessions.

Data analyses

Statistical analysis was performed using SPSS 10.0 software (IBM, Armonk, NY, USA). Data are presented with frequencies, means, and standard deviations. The chi square test was used to compare categorical variables. The Student *t* test was used to compare means for independent samples. A 2-tailed p value of <0.05 was considered the threshold for statistical significance.

To identify the determinants of hypertension in the study, a binary logistic regression model was used because the presence of hypertension was coded as yes or no. The effect of intervention (which was coded as pre-intervention or post-intervention), age, sex, marital status, employment, weight status, tobacco use, consumption of 5 fruits and vegetables daily, and practice of 30 minutes of physical activity daily at least 5 days a week were the variables used in the model.

Ethical considerations

This study was undertaken with respect for the rights and integrity of the participants. Ethical clearance was obtained from the Ethical Committee of Farhat Hached University Hospital in Sousse, Tunisia. Participation was voluntary, and all participants gave informed consent. At the end of the study period, a delayed intervention was offered to the control group.

RESULTS

Characteristics of population study

The baseline questionnaire completion rates were 73.5% and 73.1% in intervention and control groups, respectively; and 74.3% and 72.5%, respectively, at post-intervention.

At pre-assessment, our study population was composed of 940 adults in the intervention group and 940 in the control group. At post-assessment, the population was composed of 1,001 and 976 participants, respectively. The intervention group was composed of 56.8% women at pre-assessment versus 55.8% at post-assessment. The control group was composed of 71.2% women at pre-assessment versus 65.7% at the end of the study. Table 1 illustrates the mean characteristics of the population study.

In the intervention group the means of both systolic and diastolic blood pressure had significantly decreased from 132.40 ± 19.20 mm Hg to 130.60 ± 17.70 mm Hg ($p < 0.001$) and from 78.70 ± 11.70 mm Hg to 76.90 ± 11.10 mm Hg ($p = 0.035$), respectively. In the control group, nonsignificant increases in the mean of systolic blood pressure were observed (Table 2).

The prevalence of hypertension decreased not significantly in the intervention group from 37.3% to 33.7% ($p = 0.10$). It decreased from 42.1% to 38.5% ($p = 0.29$) among men and from 33.8 % to 29.9% ($p = 0.17$) among women. In the control group, this proportion increased from 31.1% to 33.4% without significant difference ($p = 0.28$).

After stratification for age, for participants younger than 40 years old, a significant decrease in the prevalence of hypertension from 22.8% to 16.2% ($p = 0.007$) was observed in the intervention group; in the control group, it increased from 14% to 15.4% ($p = 0.52$) (Table 3).

After stratification for weight status, a significant decrease of the prevalence of hypertension from 31.4% to 26% ($p = 0.03$) was observed only among nonobese participants in the intervention group; no significant change was observed in the control group (Table 3).

The stratification for sex and smoking status did not show any significant differences in the improvement of

TABLE 1. Characteristics of population study at pre-assessment and post-assessment of the 3-year community intervention, in Sousse Tunisia, 2009 to 2014

	Intervention Group			Control group		
	Pre-Assessment	Post-Assessment	p	Pre-Assessment	Post-Assessment	p
Age, yrs	37.20 ± 13.22	39.25 ± 13.61	0.001	38.61 ± 13.73	40.43 ± 13.96	0.004
Response rate	940 (73.5)	1001 (74.3)	0.61	940 (73.1)	976 (72.5)	0.56
Sex			0.66			0.01
Male	406 (43.2)	442 (44.2)		271 (28.8)	335 (34.3)	
Female	534 (56.8)	559 (55.8)		669 (71.2)	641 (65.7)	
Marital status			0.01			
Single	331(35.3)	296 (29.6)		270 (28.8)	212 (21.9)	0.004
Married	582 (62.1)	662 (66.1)		622 (66.2)	689 (71.3)	
Divorced	8 (0.9)	18 (1.8)		12 (1.3)	17 (1.8)	
Widowed	16 (1.7)	25 (2.5)		35 (3.7)	49 (5.1)	
Employment status			<0.001			0.001
Student	157 (16.7)	100 (10.0)		123 (13.1)	77 (7.9)	
Worker	338 (36.1)	369 (36.9)		214 (22.8)	256 (26.2)	
Not working	442 (47.2)	530 (53.1)		602 (64.1)	643 (65.9)	

Values are mean ± SD or n (%).

TABLE 2. Blood pressure in the intervention and control groups after a community intervention to prevent hypertension in the region of Sousse Tunisia, 2009 to 2014

	Intervention Group			Control Group		
	Pre-Assessment	Post-Assessment	p	Pre-Assessment	Post-Assessment	p
SBP, mm Hg	132.4 ± 19.2	130.6 ± 17.7	<0.001	129.7 ± 17.8	130.4 ± 17.9	0.380
<40 yrs	125.6 ± 14.1	123.7 ± 13.8	0.030	123.1 ± 13.1	123.7 ± 13.9	0.501
>40 yrs	141.9 ± 21.1	138.6 ± 18.4	0.010	138.1 ± 19.3	137.3 ± 19.0	0.530
DBP, mm Hg	78.7 ± 11.7	76.9 ± 11.1	0.035	78.1 ± 10.8	76.7 ± 11.0	0.007
<40 yrs	76.1 ± 10.9	74.1 ± 10.7	0.003	75.7 ± 10.0	7.41 ± 10.4	0.008
>40 yrs	82.4 ± 12.0	80.1 ± 10.7	0.003	81.2 ± 11.0	79.5 ± 10.9	0.021

Values are mean ± SD.
DBP, diastolic blood pressure; SBP, systolic blood pressure.

hypertension between men and women or between smokers and nonsmokers (Table 3).

After binary logistic regression, in the final model, factors associated with hypertension were age >40 years, male sex, and obesity. The intervention effect was negatively associated with hypertension (adjusted odds ratio: 0.73; 95% confidence interval: 0.59 to 0.91; p = 0.006) (Table 4).

DISCUSSION

Our study showed that a 3-year community-integrated lifestyle intervention program for hypertension control was feasible, and an improvement in the proportion of hypertension among adults in the intervention group was seen. Lifestyle modifications to adopt healthy behavior are needed in the primary prevention of high blood pressure and are obligatory components of the management of the patient with established hypertension. The integrated lifestyle interventions including regular physical exercise, dietary modification and consequent weight loss, and smoking cessation have been shown to attenuate blood pressure, reduce cardiac risk, and intensify the effects of antihypertensive medications [17,18]. It is increasingly recognized that interventions that target more than 1 risk behavior may be effective and efficient ways of improving people's lifestyles [19].

The improvement of hypertension in our study involved nonobese participants. The relationship between obesity and hypertension was well established [20], and weight-loss can lower blood pressure [21]. Booth et al. [22] found that the control of hypertension was negatively associated with BMI category and that morbidly obese patients were less likely to have controlled blood pressure than were patients of normal weight. The attainment and maintenance of a healthy body weight can prevent hypertension and can be used as the primary treatment for mild hypertension or combined with pharmacological therapy. Knowing that a modest weight loss (4.5 kg) can generate an improvement in blood pressure and other metabolic abnormalities should emphasize the potential important role of weight reduction in blood pressure

TABLE 3. Hypertension in the intervention and control groups by age, sex, smoking, and weight status after community intervention to prevent hypertension in the region of Sousse Tunisia, 2009 to 2014

	Intervention Group			Control Group		
HBP	Pre	Post	p	Pre	Post	p
Age <40 yrs	120 (22.8)	86 (16.2)	0.007	74 (14.0)	76 (15.1)	0.52
Age >40 yrs	217 (57.4)	248 (53.8)	0.29	213 (53.1)	248 (51.8)	0.89
Male	162 (42.1)	169 (38.5)	0.29	84 (31.3)	119 (35.5)	0.28
Female	177 (33.8)	165 (29.9)	0.17	207 (31.0)	207 (32.3)	0.62
Nonsmoker	245 (36.8)	246 (32.3)	0.07	257 (32.1)	270 (33.9)	0.45
Smoker	89 (38.9)	88 (38.4)	0.99	33 (24.8)	55 (30.9)	0.25
Obese	129 (54.2)	150 (51.0)	0.46	145 (53.7)	162 (56.0)	0.36
Nonobese	206 (31.4)	181 (26.2)	0.03	143 (21.9)	161 (25.1)	0.17
Known hypertension diagnosis	56 (80.0)	64 (73.6)	0.34	80 (82.5)	79 (72.5)	0.08
Unknown hypertension diagnosis	269 (32.1)	247 (27.3)	0.03	194 (23.2)	217 (25.0)	0.36
Treated hypertension	44 (81.5)	54 (73.0)	0.26	67 (83.8)	63 (71.6)	0.06
Untreated hypertension	12 (85.7)	9 (75.0)	0.49	13 (76.5)	13 (76.5)	1.00

Values are n (%).
HBP, high blood pressure.

TABLE 4. Odds of hypertension in intervention and control group after community intervention to reduce the prevalence of hypertension in the region of Sousse Tunisia, 2009 to 2014

	Intervention Group			Control Group		
	OR_a	95% CI	p	OR_a	95% CI	p
Intervention effect	0.73	0.59–0.91	0.006	0.96	0.76–1.20	0.71
Male	1.96	1.50–2.55	<0.001	1.62	1.20–2.19	0.002
Age >40 yrs	4.48	3.46–5.79	<0.001	4.45	3.47–5.71	<0.001
Obesity	2.35	1.85–2.99	<0.001	2.32	1.83–2.93	<0.001

CI, confidence interval; OR_a, odds ratios adjusted for tobacco use, consumption of 5 fruits and vegetables daily, practice of 30 minutes of physical activity daily at least 5 days per week, employment, and marital status.

control. However, the results of lifestyle modification to reduce obesity are poor and can disappoint both the patient and the health care provider [23]. Preventing and managing obesity-related hypertension require multiple, parallel efforts with involvement of government, industry, health professionals, and individual self-care [24]. More research is needed to understand why hypertension is more difficult to control in obese subjects and to find the most effective ways of helping obese hypertensive patients to sustain lifestyle changes and to reduce the risk of cardiovascular and obesity-related metabolic diseases [22,24].

In our study, the reduction of hypertension was not significant among both men and women; however, male sex was associated with hypertension at post-assessment in the intervention and control groups. Kent et al. [25] found that their lifestyle intervention program (CHIP: Complete Health Improvement Program) reduced chronic disease risk factors more effectively in men than in women. Possible physiological or behavioral factors including food preferences, making commitments, and differential support modes were suggested. These investigators recommended that developers of lifestyle intervention programs should consider sex differences in physiological and behavioral factors when planning interventions [25].

In our study a nonsignificant improvement of hypertension was seen only among nonsmokers, possibly because of a lack of power in this group of participants. Evidence suggests that cigarette smoking is a powerful cardiovascular risk factor, and smoking cessation is the single most effective lifestyle measure for the prevention of a large number of cardiovascular diseases such as hypertension [26].

Our study had limitations, the most important being that a nonrandomized trial does not provide the certitude that the improvement of the hypertension is the result of the effect of the intervention. We compared independent groups at pre-assessment and post-assessment, and some sociodemographic characteristics were different. Therefore, there could have been individual-level changes in blood pressure that were missed by our approach. We considered this limitation in multivariate analyses by adjustment by marital status and employment. On the other side, a risk of contamination bias existed. Its origin could probably be the mass media that broadcast radio sessions containing intervention messages.

The basis of our intervention was educating people at risk. Despite its importance as a component of an effective health promotion, education alone may be insufficient to modify health risk behaviors [27]. Programs and interventions should attempt to modify social environmental conditions directly to have a positive influence on human behaviors and, consequently, disability and disease [28]. The social, economic, and cultural contexts must be taken into account for the policies to be established as effective [29]. Strengthening multisectorial efforts to improve diets, promote physical activity, and reduce tobacco use, is a priority [30]. Thus, the most successful health interventions have always been public health interventions [31,32].

There are many examples of government action leading to increases in healthy behavior. Taxes and public smoking bans have had the greatest impact on smoking rates [33]. The systematic review of Powell et al. [34] showed that higher prices on fast food, together with lower prices on fruits and vegetables, were associated with lower weight and lower BMI. Parker et al. [35] found that building new bicycle lanes in New Orleans led to a tripling of the number of cyclists on those streets. Fernandez and Sturm [36] found that 20 minutes of recess a day, as recommended by the National Association for Sport and Physical Education of the United States (NASPE), led to lower BMI in elementary school students.

In our study, we tried to develop compelling communication to motivate executives and other stakeholders to be involved in creating an environment that promotes and encourages healthy lifestyles. However, with the occurrence of the revolution in Tunisia in 2011, this issue was not a priority for these stakeholders.

CONCLUSIONS

Despite obstacles related mainly to the Tunisian revolution, our intervention was achieved, and we obtained proof of the feasibility of lifestyle intervention in the context of a developing country. Conversely, in the increasingly sedentary and aging population worldwide, the implementation of multisectorial policy to prevent and manage cardiovascular diseases must be a national public health issue.

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