Effectiveness of a Singaporean community-based physical activity and nutrition intervention: a cluster randomised controlled trial

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Abstract

This study examined the effectiveness of a 6-month intervention to improve the health behaviours and outcomes among women aged 50 and over. A sample of 580 (intervention n = 295; control n = 285) women was recruited from 26 recreational centres. Only the intervention group participated in the Singapore physical activity (PA) and nutrition study (SPANS), received health resources (calendar, recipe and booklets) and motivational support from program ambassadors. The intervention group showed significant improvements in moderate-intensity PA, vigorous-intensity PA and total PA ($p<0.001$), increased intake frequency of fruit and vegetables ($p=0.049$) and reduction in salt and sugary beverages ($p\leq0.042$) and reductions in systolic blood pressure (BP) (-3.68 mmHg), diastolic BP (-3.54 mm Hg) and percentage body fat (-2.13%) ($p\leq0.020$) when compared to the control group. The SPANS appeared to be efficacious in improving PA and dietary behaviours, reducing BP and percentage body fat among Singaporean women.

Keywords: Ageing, anthropometry, blood tests, dietary habits, health promotion, non-communicable diseases, physical activity, program ambassadors.

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What We Already Know

- Singaporean women aged over 50 years report high levels of leisure-time physical inactivity and less than half meet the recommended intake for fruit and vegetables.
- There is a scarcity of culturally appropriate evidence-based physical activity (PA) and nutrition interventions for Asian countries.
- Innovative strategies are needed to support Singaporean women (>50 years) to adopt health-enhancing nutrition and physical activity behaviours.

What This Article Adds

- To our knowledge, this was the first randomised controlled trial to determine the impact of a 6-month community-based PA and nutrition intervention for Singaporean women aged over 50 years.
- There were significant increases in PA levels (moderate, vigorous, total) and improvements in frequency of intake for fruit, vegetables, salty sauce and sugary beverages.
- Recreational centres located below high rise government housing provide an accessible local space to recruit older women and conduct physical activity and nutrition interventions.
- This successful intervention appears to be culturally appropriate for older Singaporean women.

Introduction

In Singapore, women aged over 50 years self-reported high levels of leisure-time physical inactivity (72%) and had a high intake of saturated fat (67%), sugary beverages (41%) in 2010.[1,2] Moreover, less than half of these women met the recommended serving guidelines for vegetables (26%) and fruit (34%). Due to these poor lifestyle practices, metabolic risk factors such as high blood pressure (BP), fasting blood glucose (BG) levels and waist-hip ratio (WHR) are highly prevalent among these women.[2]

Evidence-based physical activity (PA) and nutrition interventions are well-established for Western populations but there is a scarcity of culturally relevant interventions for non-communicable diseases (NCD) prevention programs in Asian countries.[3-6] Considering Singapore's ageing population and the associated increase in NCDs, innovative strategies to support women to adopt healthy lifestyles are required. Despite the Singapore government being committed to improving community health and addressing the risk factors for NCDs, targeted programs for women's health remain limited.[7]

Recreational centres (RCs) are public facilities located below high-rise government housing, where 80% of Singaporeans live.[8] Building healthier communities through facilities, such as the RCs can create viable and convenient environments to initiate health-promoting opportunities for these women. Therefore, this study examined the effectiveness of a 6-month community-based intervention to improve the health behaviours (PA and diet), BP, anthropometric and blood parameter outcomes among Singaporean women aged 50 years and over in RCs.

Methods

Study design

Ethics approval was obtained for the 6-month community-based PA and nutrition cluster randomised controlled trial (RCT) from the Curtin University Human Research Ethics Committee. The Singapore Physical Activity and Nutrition Study (SPANS) protocol and design have been described in detail previously.[9] The screening, recruitment and intervention period were staggered over 18 months from October 2016 to March 2018, and post-test evaluation was completed in April 2018. The intervention was reported in accordance with the Consolidated Standards of Reporting Trials (CONSORT) Statement; see Supplementary file 1 (CONSORT flow diagram) and Supplementary file 2 (CONSORT checklists).[10]

Participants

Following the research protocol, 61 RCs (intervention N=31; control N=30) located in five Singaporean geographical districts were randomly selected using computer-generated random numbers by the principal investigator (PI).[9] There was a minimum separation distance of four kilometres to avoid the possibility of contamination between the two groups. Out of the 61 RC managers who were invited to the study, only 26 [intervention (N=14) or control (N=12)] of them agreed to be involved in the study. For the intervention sites, the trained program ambassadors (final-year nutrition, sports and wellness students, qualified nutritionists and a certified fitness instructor) carried out the pre- and post-test assessment and the SPANS intervention. While at the control sites, the program ambassadors conducted only the pre- and post-assessment.

Of those who were invited, 682 (intervention, n=351; control, n=331) agreed to participate and met the selection criteria: a) female, aged 50 years and over; b) did not meet the recommended PA guidelines (less than 150 minutes of self-reported moderate-intensity PA per week); c) absence of a medical condition or poor mobility that prohibited their involvement in a PA program and d) not currently enrolled in other nutrition and PA research studies. All eligible participants (n=682) who met the above criteria completed the baseline assessment that included the Global PA Questionnaire-Short Form (GPAQ-SF).[11] Participants on medications (e.g., glucose-lowering drugs) were eligible to participate in the intervention.

Procedure

Program ambassadors frequently liaised with the 26 RC managers to distribute the recruitment flyers and intervention resources and answered any enquiries related to the intervention. The flyers were promoted by the respective RC managers during the centres' activities and given to female patrons that meet the selection criteria. Recruitment of participants was conducted through program flyers placed on the RCs' bulletin boards. Contact details of interested participants were recorded by the RC managers and provided to the program ambassadors. Participants were then contacted to assess their eligibility and informed of the study's purpose, confidentiality issues and that they were free to withdraw at any stage. All participants were blinded to their intervention status. Only the program ambassadors and PI were aware of the group allocation.

Intervention

Social Cognitive Theory[12] complemented by Motivational Interviewing (MI) guided the development of SPANS and delivery of the program's educational and skill sessions, along with telephone support. Provision of feedback, reinforcement, skill-building, practice and

goal setting were program strategies to support positive behaviour change. The SPANS program was developed by examining previously successful PA and nutrition strategies used in targeting older adults,[3-6] pilot-testing resources and conducting formative evaluation with the target group. Program ambassadors introduced the program, distributed and explained printed resources (health calendar, PA and nutrition booklets and recipe booklet) based on the Singaporean PA and dietary guidelines[13,14] to the intervention participants at the RCs. Participants were encouraged to engage in 150 minutes of moderate-intensity PA weekly and record their PA frequency and duration in the health calendar. They also attended nutrition workshops, telephone dietary counselling sessions and low-intensity bi-weekly PA classes and received text messages, telephone follow-up and feedback from the program ambassadors. The components of the intervention were designed to motivate participants to stay physically active and maintain a healthy diet as a means of reducing risk factors of chronic diseases. Positive behavioural reinforcements through regular encouragement and feedback were facilitated by RC managers and program ambassadors. Furthermore, the interventions were conducted in RCs within the participants' neighbourhood to minimise participant burden. In contrast, the control group participants only received a falls prevention booklet. Intervention strategies and resources have been explained in details previously.[9]

Measurement instruments

A structured bilingual (English and Chinese) questionnaire was administrated face-to-face by the program ambassadors at baseline and post-intervention to gather information on demographic and health characteristics. Details of the measurement instruments and outcome variables have been described elsewhere.[9]

Primary outcome variables

The *GPAQ-SF,* developed by the World Health Organization (WHO), has been validated for Singaporean adults.[11] It was used to measure self-reported PA (moderate-vigorous PA, walk and cycle PA and total PA) and sitting time.

Accelerometers [*ActiGraph GT3X* (ActiGraph, Pensacola, Florida, USA)] objectively measured the duration (minutes daily) and intensity (moderate-vigorous) of PA including sedentary behaviour (sitting time).[15] Acceleration was accumulated from three axes (vertical, mediolateral, anteroposterior) and combined into a vector magnitude score.[16] Participants with ≤4 days of 10 hours daily wear-time (excluding water-based activities) were included in the analysis. Non-wear-time was filtered from the raw data using Troiano algorithm, based on ≥60 consecutive minutes of zero counts, with an allowance of up to 2 minutes of counts from 1 to 100.[16,17] Interested participants were given an information sheet on the accelerometer and the device was fitted to their right hip. Accelerometry data were collected and downloaded using 10-second epochs. Using the ActiLife 6 software (ActiGraph, Pensacola, Florida, USA), the Freedson cut-off points for adults estimated sedentary behaviour [<100 counts per minute (cpm)], moderate-intensity PA (1952-5724 cpm) and vigorous-intensity PA (5725-9498 cpm).[16,17]

A modified STEPwise approach to Surveillance *dietary behaviour questionnaire,* developed by the WHO, was used to assess the frequent intake of fat, salt, sugary beverages, fruit and vegetables.[18]

Fasting *blood samples* were collected to determine fasting BG, total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), non-

HDL-C, cholesterol ratio and triglyceride (TG) levels. They were measured, calculated and compiled into reports at approved laboratories under the Singaporean Ministry of Health guidelines.[19,20]

Secondary outcome variables

Trained program ambassadors followed standard protocols to measure: a) weight using a calibrated electronic scale and recorded to the nearest 0.01 kg; b) height measured barefoot with a portable stadiometer to the nearest 0.1 cm and Body Mass Index (BMI) calculated by dividing weight by the square of height (kg/m^2);[21] c) percentage body fat taken without shoes and socks by an Endo Body Fat Composition Analyser E-DBS908;[22] d) waist circumference (WC) using a non-stretch tape, standing up at the midway level between the lowest rib margin and the iliac crest and recorded to the nearest 0.1 cm; e) hip circumference (HC) at the widest circumference at the level of the symphysis pubis and gluteus maximus;[5] and f) WHR calculated by dividing WC by HC. Systolic and diastolic BP were measured three times using an Omron electronic sphygmomanometer on the participant's upper arm at one-minute intervals while seated and the mean of the readings was recorded.[3]

Statistical Analysis

Descriptive statistics contrasted the baseline characteristics of the intervention and control groups. Comparisons between the groups were made across the baseline and post-test time points using Chi-square tests for dichotomous and categorical outcomes, and independent t-tests and paired t-tests for continuous outcomes. For variables with skewed distributions [(moderate, total, walk and cycle) PA, sitting time, BG and TG], Mann-Whitney U test and Wilcoxon signed-rank test were applied instead.

To confirm any apparent association from the univariate analysis and to accommodate the inherent correlation of observations due to participants being nested within RCs, generalised estimating equations (GEE) models with exchangeable correlation structure were fitted to compare the outcome variables between the two groups from baseline to post-intervention. The GEEs provided robust standard errors for the regression coefficients to adjust for the intra-cluster correlation, while accounting for the baseline magnitude of the measures and the effects of potential confounders (age, ethnicity, educational level, marital status, housing type, health conditions, medication usage and clustering effect). These covariates were specified in the study protocol and based upon comparable PA and nutrition interventions for older adults. All statistical analyses were performed at an individual level using Statistical Package for the Social Science version 25.[23] The sample size requirement of 240 participants per group[9] was met in this study, enabling an 80% statistical power to detect a medium effect size of 10% improvement in PA prevalence by intervention participants relative to the control at a significance level of 5%.

Accelerometry data were obtained from the intervention group only. As most participants did not engage in vigorous PA, this variable was recoded into binary form to specify participation status (yes, no). Moderate PA, total PA, walk and cycle PA and sitting time remained as continuous variables. For dietary behaviour outcomes, fruits and vegetables consumption were classified as 'frequent intake' if at least two servings were eaten daily, whereas salt and salty sauce consumption were classified as 'frequent intake' if taken at least once per week. Sugary beverage and fatty food intake were classified as 'frequent intake' if taken more than three times per week. Binary outcomes such as vigorous PA, frequent intakes of fruits, vegetables, salt and salty sauce, sugary beverage and fatty food intake, were analysed using logistic GEE models, while normal GEE models with identify link and gamma GEE models

with log link were applied to continuous outcomes exhibiting symmetric/normal and skewed empirical distributions, respectively.

Results

The final sample included 295/351 intervention (84%) and 285/331 control (86%) participants. The number of participants lost was n=56 for the intervention group and n=46 for the control group (see Supplementary file 1-CONSORT figure for more details). In addition, there were no missing data for all outcomes and covariates. There were no significant differences in the baseline characteristics between the intervention and control groups, except for age (p=0.005). The intervention participants (mean age 64.5 years, standard deviation (SD)=7.9) were slightly older than the control group (mean age 61.6 years, SD=6.9). Majority of participants were of Chinese descent (95.3%), completed secondary school education (54.3%), were married (76.3%) and had existing health conditions (61.2%), see Table 1.

"INSERT TABLE 1 HERE"

There were no significant differences in self-reported PA behaviours at baseline between the intervention and control groups. However, from baseline to post-test, significant increases were observed in the intervention group for moderate PA (65.2 metabolic equivalent of task (MET) mins per week, p<0.001), total PA (1123.5 MET mins per week, p<0.001), walk and cycle PA (187.5 MET mins per week, p=0.002), vigorous PA (p<0.001), but sitting time did not change significantly (p=0.872). No significant changes in self-reported PA behaviours were observed in the control group from baseline to post-test. At post-test, significant differences were observed between intervention and control groups for moderate PA

(p<0.001), vigorous PA (p<0.001) and total PA (p=0.004), but not for walk and cycle PA (p=0.558) or sitting time (p=0.574); see Table 2. Accelerometry data for the self-selected intervention participants (n=65) from 10 RCs supported the findings of the aforementioned PA measures, with significant increases in moderate (p<0.001), total PA (p=0.003), but not for vigorous PA and sitting time between the two-time points; see Supplementary file 3.

There were no significant differences in measures of dietary behaviour between the control and intervention groups at baseline. At post-test significant improvements were observed in the intervention group for the frequent intake of fruit (p<0.001), vegetables (p=0.018), salt and salty sauce (p=0.031), and sugary beverages (p<0.001). But no differences were observed in the control group from baseline to post-test apart from a reduction in frequent intake of sugary beverages (p<0.001). At six-month post-test, statistically significant differences between the two groups were observed for frequent intake of fruit (p<0.001), vegetables (p=0.027), salt and salty sauce (p=0.026) and sugary beverages (p=0.04); see Table 2.

"INSERT TABLE 2 HERE"

The diastolic and systolic BP in the intervention participants were found to be significantly improved post-intervention with a decrease of 3.54 and 3.68 mm Hg respectively (p<0.001). Conversely, the BPs of participants in the control group slightly increased (i.e., diastolic by 1.18 mm Hg, p=0.034 and systolic by 1.26 mm Hg, p=0.184); see Table 3.

The intervention group also exhibited small but statistically significant reductions in weight (0.57 kg), BMI (0.24 kg/m^2), and percentage body fat (2.13%) (p<0.001), whereas these parameters were unaltered in the control group. Significant improvements were also observed

in the intervention group for measures of central adiposity (WC, HC, WHR). However, similar improvements were also observed in the control group for WC and HC; see Table 3. Fasting BG concentration significantly decreased during the study in both intervention (0.11 mM, p =0.027) and control (0.19 mM, p <0.001) groups, whereas their lipid profiles remained essentially unchanged except for a marginal increase in TC concentration in the control group (by 0.1 mM, p=0.041); see Table 3.

"INSERT TABLE 3 HERE"

After controlling for confounders and the inherent clustering, GEE analyses confirmed significant increases for moderate PA (p<0.001), vigorous PA (p<0.001), total PA (p<0.001) but not for walk and cycle PA (p=0.454) and sitting time (p=0.190) by the intervention group relative to the control group; see Supplementary file 4. As for BP, anthropometry and blood parameter outcomes, significant reductions (baseline to post-intervention) in the intervention group relative to the control group were only observed with systolic BP (p=0.020), diastolic BP (p=0.001) and percentage body fat (p<0.001).

Logistic GEE analyses demonstrated significant improvements in the frequent intake of fruit (p=0.001), vegetables (p=0.049), salt and salty sauce (p=0.042) and sugary beverages (p=0.019) by the intervention group relative to the control group (see Supplementary file 5). Moreover, the magnitudes of the estimated intra-cluster correlations for the various continuous and binary outcomes were all small (<0.07), indicating minimal effect due to the RC clusters.

Discussion

The SPANS intervention had a low attrition rate (15%) which may have been due to its acceptability and accessibility for the Singaporean women aged above 50 years.[24] This compared favourably with similar PA and nutrition RCTs for older adults (19-22%).[3-6] The GEE analyses confirmed significant improvements in behavioural and health outcomes between the intervention and control groups. Such improvements were displayed in moderate to vigorous PA and total PA compared to the control group. These findings were supported by objectively measured accelerometry measurements (except for vigorous PA) taken from a sub-sample of the intervention participants (n=65). Moreover, there were improvements in dietary behaviour (increased frequent intake of fruit and vegetables, reduced frequent intake of salt and salty sauce and sugary beverages). Furthermore, systolic BP, diastolic BP and percentage body fat significantly reduced over the 6-month period. These findings are similar to those reported in a limited number of primary prevention initiatives conducted in other areas of Asia, showing that culturally appropriate PA and nutrition interventions can effectively improve behaviour and metabolic risk factors in older populations.[6,25,26]

Other anthropometric measures and the lipid profiles were not significantly altered relative to the control group. However, within-group improvements for the intervention group were observed for WC, HC, WHR, weight and BMI. These improvements are consistent with those observed in other PA and nutrition intervention studies of similar duration.[3-6] However, no statistically significant within- or between-group changes in the fasting lipid profile were found. This may be related to the dose of PA performed in the SPANS intervention with a short PA intervention period (<60 minutes) and insufficient PA volume and frequency,[26] perhaps indicating a need for higher intensity and longer duration interventions. A systematic review of

behavioural lifestyle RCTs also reported higher-intensity behavioural PA and dietary counselling exhibited greater improvements in anthropometric and metabolic risk factors.[27]

Self-reported walk and cycle PA were not significantly different between groups at post-test; possibly due to a high percentage of intervention and control participants (89%) already walking or cycling at baseline. A similar non-significant result was observed in a study, where 78% of the Japanese participants were already walking or doing other PA at baseline.[28] Further increases in these modes of transport might not be feasible due to the densely built environment, hot-rainy weather, and a lack of cycling infrastructure, as reflected in a qualitative Singaporean study.[29] Moreover, there was no reduction in sitting time which has also been reported in similar studies.[3,5] This issue is deserving of attention through the trialling of future strategies to encourage less sitting time.

Self-selection bias was unavoidable but was minimised through allocation concealment throughout the trial. Although in hindsight, to ensure a more homogenous study group, the recruitment age could be restricted to less than 70. Self-reported PA and dietary practices might have introduced recall and response bias. However, participants were blinded to their group allocation, which reduced any differential in reporting of health behaviours, with the expectation that inaccuracies would be similar across both groups. Additionally, the program ambassadors and the PI in charge of data collection were not blinded which may have introduced some bias. Nevertheless, the positive PA and dietary behaviours and improvements in BP and percentage body fat offer a potential model for implementing PA and dietary intervention program with this Singaporean population. Since NCDs are largely preventable, there is an urgency to prioritise and investigate the applicability of such long-

term primary interventions to address chronic diseases at a national level in this Asian population.

Limitations

The study was restricted to women aged 50 years and above. However, future research could be extended to Singaporean men to increase the study's generalisability. Due to resource constraints, the study was conducted only for six months. A longer follow-up assessment period could be considered to examine program sustainability and the effectiveness of behavioural changes over time. Furthermore, the sub-sample of the self-selected intervention participants who wore the accelerometers might have been more committed to PA, which could bias the PA outcomes. Although these devices were limited in number due to budgetary constraints, they provided objective measurements of the PA outcomes.

Conclusions

The SPANS program was associated with improvements in PA and dietary behaviours, as well as reductions in percentage body fat, systolic and diastolic BP in the intervention participants when compared to the control participants over the 6-month intervention period. Given the high prevalence of NCD risk factors among Singaporean older women, adoption of desirable health behaviours through culturally appropriate lifestyle interventions, such as SPANS within supportive environments, could be an effective strategy to reduce the risk of NCDs and optimise the health status of the 'at risk' insufficiently active ageing populations.

Supplementary files

Supplementary file 1- CONSORT figure

Supplementary file 2- CONSORT checklist

Supplementary file 3- Accelerometry data for a sub-sample of the self-selected intervention participants (n=65) from 10 RCs

Supplementary file 4- Generalised estimating equations analyses of continuous outcomes between the two groups from baseline to post-intervention (n=580)

Supplementary file 5- Generalised estimating equations analyses of binary outcomes between the two groups from baseline to post-intervention (n=580)

Abbreviations

BG: Blood glucose, BMI: Body Mass Index, BP: Blood pressure, CONSORT: Consolidated Standards of Reporting Trials, CPM: Counts per minute, GEE: Generalised estimating equations, GPAQ-SF: Global Physical Activity Questionnaire-Short Form, HDL-C: High-density lipoprotein cholesterol, HC: Hip circumference, LDL-C: Low-density lipoprotein cholesterol, MET: Metabolic Equivalent of Task, MI: Motivational interviewing, NCDs: Non-communicable diseases, PA: Physical activity, PI: Principal Investigator, RC: Recreational centre, RCT: Randomised controlled trial, SD: Standard deviation, SPANS: Singapore Physical Activity and Nutrition Study, TC: Total cholesterol, TG: Triglyceride, WC: Waist circumference, WHO: World Health Organization, WHR: Waist-hip ratio.

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Table 1

Baseline characteristics of intervention and control group participants (n=580)

Variables	Intervention group ($n = 295$)	Control group ($n = 285$)	p value[a]
Age: mean (SD)	64.5 (7.9)	61.6 (6.9)	0.005
50-55	50 (16.9%)	59 (20.7%)	
56-62	74 (25.1%)	99 (34.7%)	
≥63	171 (58.0%)	127 (44.6%)	
Ethnicity			0.495
Chinese	283 (95.9%)	270 (94.7%)	
Malay, Indian and others	12 (4.1%)	15 (5.3%)	
Education Level			0.283
Primary school / no education	66 (22.4%)	80 (28.1%)	
High / secondary school	167 (56.6%)	148 (51.9%)	
Diploma, university and above	62 (21%)	57 (20.0%)	
Marital Status			0.184
Married	218 (73.9%)	224 (78.6%)	
Widowed, divorced or single	77 (26.1%)	61 (21.4%)	
Housing type			0.522
1-3 rooms	82 (27.8%)	68 (23.9%)	
4 rooms	89 (30.2%)	87 (30.5%)	
5 rooms and others[b]	124 (42.0%)	130 (45.6%)	
Health condition			0.051
No	103 (34.9%)	122 (42.8%)	
Yes[c]	192 (65.1%)	163 (57.2%)	
Medication usage			0.126
No	155 (52.5%)	166 (58.2%)	
Blood pressure	49 (16.6%)	44 (15.4%)	
Cholesterol	76 (25.8%)	70 (24.6%)	
Others[d]	15 (5.1%)	5 (1.8%)	

[a] Chi-square test or independent t-test between intervention and control groups.

[b] Executive flat (public housing at 130 sqm[2]), Housing and Urban Development Corporation flats (hybrids of public and private properties), condominium (private housing with recreational facilities), and landed properties (e.g. a semi-detached house, terraced home, townhouse, shophouse or bungalow.

[c] Heart disease, stroke, high blood pressure, high cholesterol, diabetes, cancer, osteoporosis, arthritis, and others.

[d] Medication for cardiovascular disease, blood clotting disorder, asthma, thyroid, osteoporosis, diabetes, cancer, and Parkinson's disease.

SD: standard deviation.

Table 2

Comparison of self-reported PA and dietary behaviour outcomes between intervention and control groups (n=580)

Outcomes	Intervention group ($n = 295$)		*p* value[a]	Control group ($n = 285$)		*p* value[b]	*p* value[c]	*p* value[d]
	Baseline Mean (SD) / n (%)	Post-test Mean (SD) / n (%)		Baseline Mean (SD) / n (%)	Post-test Mean (SD) / n (%)			
Moderate PA (MET mins/week) [e]	64.71 (54.46)	129.86 (150.07)	<0.001	62.78 (54.62)	54.40 (64.08)	0.064	0.522	<0.001
Vigorous PA n (%)	18 (6.1%)	69 (23.4%)	<0.001	9 (3.2%)	10 (3.5%)	0.815	0.093	<0.001
Total PA (MET mins /week) [e]	2767.43 (3254.51)	3890.93 (3671.38)	<0.001	3134.62 (3230.52)	3290.13 (3361.10)	0.528	0.057	0.004
Walk and Cycle PA (MET mins/week) [e]	911.33 (1588.98)	1098.86 (1934.26)	0.002	821.52 (1154.30)	842.44 (1137.39)	0.428	0.470	0.558
Sitting time (mins/week) [e]	1290.85 (978.18)	1243.04 (783.63)	0.872	1279.16 (938.54)	1334.053 (904.33)	0.071	0.871	0.574
Frequent fruits intake [f]	123 (41.7%)	171 (58%)	<0.001	128 (44.9%)	122 (42.8%)	0.613	0.434	<0.001
Frequent vegetables intake [f]	169 (57.3%)	197 (66.8%)	0.018	149 (52.3%)	165 (57.9%)	0.178	0.226	0.027
Frequent salt and salty sauce intake [g]	230 (78%)	207 (70.2%)	0.031	214 (75.1%)	223 (78.2%)	0.323	0.413	0.026
Frequent sugary beverages intake [h]	55 (18.6%)	28 (9.5%)	<0.001	53 (18.6%)	43 (15.1%)	<0.001	0.988	0.040
Frequent fat Intake [h]	90 (30.5%)	80 (27.1%)	0.375	88 (30.9%)	80 (28.1%)	0.383	0.923	0.798

[a] Wilcoxon Signed-Rank test or Chi-square test between baseline and post-test for the intervention group.

[b] Wilcoxon Signed-Rank test or Chi-square test between baseline and post-test for the control group.

[c] Mann-Whitney *U* test or Chi-square test between intervention and control group at baseline.

[d] Mann-Whitney *U* test or Chi-square test between intervention and control group at post-test.

[e] Non-parametric tests applied.

[f] At least two servings per day.

[g] At least once per week.

[h] More than three times per week.

MET: Metabolic Equivalent of Task, PA: Physical Activity, SD: Standard Deviation.

Table 3

Comparison of blood pressure, anthropometry and blood parameter outcomes between intervention and control groups (n=580)

Outcomes	Intervention group ($n = 295$)		p value[a]	Control group ($n = 285$)		p value[b]	p value[c]	p value[d]
	Baseline Mean (SD)	Post-test Mean (SD)		Baseline Mean (SD)	Post-test Mean (SD)			
Systolic blood pressure (mmHg)	132.25 (18.43)	128.57 (18.26)	<0.001	125.98 (18.0711)	127.24 (17.52)	0.184	<0.001	0.373
Diastolic blood pressure (mmHg)	78.41 (10.)	74.87 (9.60)	<0.001	75.68 (10.31)	76.86 (10.15)	0.034	0.001	0.015
Waist Circumference (cm)	83.54 (9.45)	81.84 (9.26)	<0.001	82.17 (9.35)	81.03 (9.84)	0.003	0.080	0.306
Hip Circumference (cm)	96.54 (7.61)	95.54 (7.44)	<0.001	95.43 (7.51)	94.25 (7.97)	<0.001	0.078	0.044
Waist-Hip Ratio	0.87 (0.07)	0.86 (0.07)	0.010	0.86 (0.07)	0.86 (0.07)	0.737	0.407	0.562
Weight (kg)	56.80 (9.21)	56.23 (9.11)	<0.001	55.49 (8.91)	55.44 (8.94)	0.770	0.082	0.293
Body Mass Index (kg/m^2)	23.35 (3.48)	23.11 (3.43)	<0.001	23.02 (3.42)	23.00 (3.45)	0.789	0.249	0.696
Percentage body fat (%)	32.71 (8.05)	30.58 (8.03)	<0.001	29.93 (8.65)	30.23 (8.50)	0.282	<0.001	0.612
Blood glucose (mM) [e]	5.21 (0.99)	5.10 (0.96)	0.027	5.14 (0.85)	4.95 (0.91)	<0.001	0.148	0.004
Total Cholesterol (mM)	5.34 (0.97)	5.35 (1.06)	0.828	5.48 (0.90)	5.58 (0.99)	0.041	0.070	0.009
Low-Density Lipoprotein Cholesterol (mM)	3.08 (0.86)	3.09 (0.91)	0.782	3.30 (0.83)	3.29 (0.93)	0.648	0.001	0.011
Non-High-Density Lipoprotein Cholesterol (mM)	3.66 (0.92)	3.67 (1)	0.975	3.77 (0.92)	3.84 (1)	0.068	0.178	0.031
Cholesterol ratio	3.32 (0.87)	3.33 (0.89)	0.727	3.37 (0.93)	3.39 (0.94)	0.606	0.442	0.422
Triglyceride (mM) [e]	1.28 (0.60)	1.28 (0.58)	0.393	1.23 (0.56)	1.26 (0.62)	0.699	0.281	0.323
High-Density Lipoprotein Cholesterol (mM)	1.69 (0.44)	1.69 (0.45)	0.780	1.71 (0.44)	1.73 (0.42)	0.126	0.548	0.208

[a] Paired t-test between baseline and post-test for the intervention group.

[b] Paired t-test between baseline and post-test for the control group.

[c] Independent t-test between intervention and control group at baseline.

[d] Independent t-test between intervention and control group at post-test.

[e] Non-parametric tests applied.

SD: Standard Deviation.