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A Randomised Controlled Trial of a Facebook-based Physical Activity Intervention for Government Employees with Metabolic Syndrome

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ABSTRACT

Introduction: This study aimed to ascertain the effects of a Facebook-based physical activity intervention on improvements in step counts and metabolic syndrome. **Methods:** Government employees with metabolic syndrome were randomly assigned by cluster to the Facebook group (n = 44) or the control group (n = 103). All participants were asked to complete self-administered questionnaires at baseline, after the first and second phases. Data from anthropometric (weight, body mass index, fat mass, body fat percentage, waist circumference, hip circumference and waist-to-hip ratio), biochemical (total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides and fasting glucose) and clinical examinations (systolic blood pressure and diastolic blood pressure) were collected. The number of steps per day was determined by a Lifecorder e-STEP accelerometer. **Results**: A significant difference in the number of steps per day between the baseline and the first phase (p<0.001) was observed in both the Facebook and control groups. A significant group main effect (p<0.001) was found for the number of steps per day; the Facebook group had a significantly greater increase in the number of steps per day than the control group. Overall, a significant strong to very strong correlation was found between the changes in the number of steps per day and the changes in the other variables**. Conclusion**: The Facebook-based intervention approach has the potential to increase physical activity among government employees with metabolic syndrome.

Key words: Employees, metabolic syndrome, physical activity, randomised controlled trial, social networking

INTRODUCTION

Metabolic syndrome is a clustering of numerous metabolic disorders, particularly hyperglycemia, hypertension, abdominal obesity and dyslipidemia (Grundy *et al.*, 2005). Given the growing evidence that regular physical activity favourably affects the individual components of metabolic syndrome (Andersen, Høstmark & Anderssen, 2012), physical activity intervention offers essential opportunities to lessen these metabolic risks and provide benefits to individuals with metabolic syndrome. At present, approximately 42.5% of the Malaysian population have metabolic syndrome (Wan Nazaimoon *et al.*, 2011).

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However, there is a dearth of randomised controlled physical activity intervention studies among individuals with metabolic syndrome (Andersen *et al.,* 2012). Hence, there is a need for effective physical activity intervention trials for such individuals.

Online social networking websites are increasingly being employed for health communication (Chou *et al.*, 2009) and have the potential to promote healthy behaviours (Neiger *et al.*, 2012). A survey (n = 1,060) among those aged 18 to 24 found that about 90% have viewed health-related information or have ever done health-related activities via social networking websites, and that over 80% were likely to share health-related information through these websites (PricewaterhouseCoopers Health Research Institute, 2012). Facebook gives patients and healthcare professionals the opportunity to share experiences and communicate about diseases and their management (Farmer *et al.*, 2009). As approximately 92% of adults on social networking websites are using Facebook (Hampton *et al.*, 2013), it has become increasingly important to empirically examine the potential to deliver physical activity intervention through this technology platform.

In this study, a randomised controlled physical activity intervention trial was carried out to assess the effectiveness of the physical activity intervention delivered through Facebook. This intervention aimed to improve physical activity level among individuals with metabolic syndrome. This study aims to evaluate whether the approach would yield differences in the number of steps per day and its effects on the components of metabolic syndrome. It is hypothesised that participants with metabolic syndrome assigned to the Facebook group would attain a greater number of steps per day after the four-month Facebook-based intervention (first phase) and after the two-month follow-up (second phase). Secondary assessments incorporated metabolic parameters.

METHODS

Participants

The participants were randomly chosen government employees who agreed to join the study. The participants met the following eligibility criteria: male or females between 18 to 59 years old; with metabolic syndrome according to the 'harmonised' definition (Alberti *et al.*, 2009); at Stage 1 (pre-contemplation), Stage 2 (contemplation) or Stage 3 (preparation) of the stages of change for physical activity behaviour; and Facebook users who log in to their account at least once a week. The exclusion criteria were: pregnant women; individuals on medication that may affect body weight, lipid profile, blood pressure and fasting glucose; individuals with medical history such as type 2 diabetes mellitus, cardiovascular disease, hyperthyroidism and cancer; individuals with physical impairment that may influence physical activity intervention; and individuals who answered 'yes' to one or more questions in the Physical Activity Readiness Questionnaire (PAR-Q).

Study design

The randomised controlled physical activity intervention trial was designed to investigate the effects of physical activity intervention delivered through Facebook on the number of steps taken by each individual per day and the effects of the number of steps on the components of metabolic syndrome. Two groups of government employees were recruited: a Facebook group (n = 44) and a control group (n = 103) (Figure 1). G-power analysis set for ANOVA - repeated measures for within-group and between-group interactions - was used to calculate sample size. Power was set at 0.9, alpha level at 0.05, and the effect size was set at 0.25 (moderate) for the two groups (intervention and control). A control group tends to have a higher dropout rate than an intervention group (Lindstrom *et al.*, 2010); hence, more participants were recruited for the control

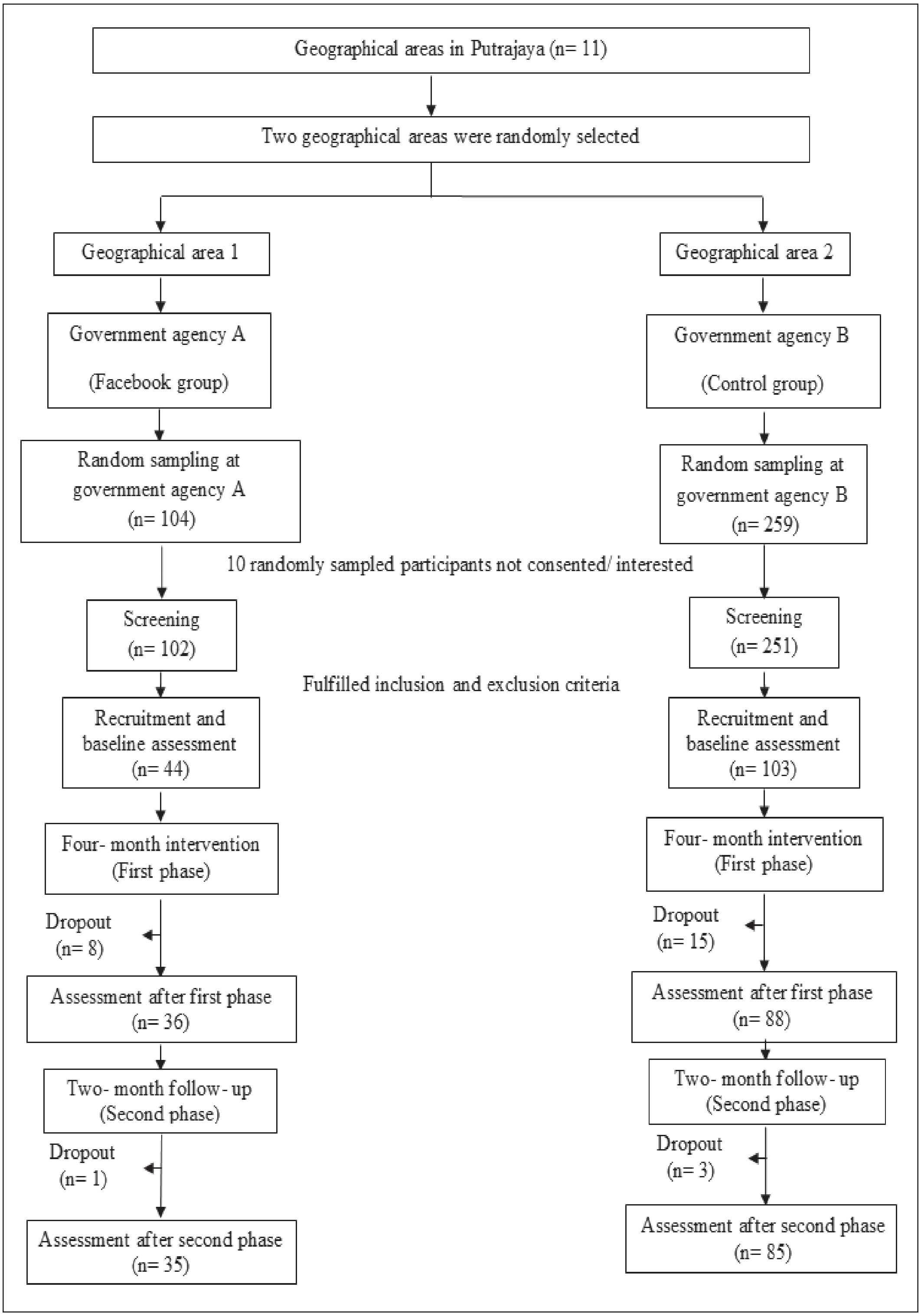

Figure 1. Flow of recruitment of participants, data collection and intervention conducted

group in this study. The intervention group was a Facebook group. Prior to the screening of participants, ethical approval was obtained from the Medical Research Ethics Committee of the Faculty of Medicine and Health Sciences at Universiti Putra Malaysia. Upon screening, all the randomly selected government employees were given participant information sheets. Each of them signed and returned a consent form on agreeing to participate in the study.

Subject selection

Putrajaya was grouped into 11 geographic regions based on geographically continuous areas with identified boundaries to minimise the possibility of participants from different groups influencing each other. This technique is used to avoid the exposure of the control group to the intervention effect (Christie, O'Halloran & Stevenson, 2009). Two geographic regions containing government agencies were randomly selected. Then, two government agencies from the two geographic regions were randomly chosen. The two government agencies were then randomly assigned to recruit participants for the Facebook group and the control group. The names of the government agencies were written on slips of paper, which were drawn one by one from a box, and matched with the groups. The screening and recruitment of participants were conducted in the government agencies.

Measurement of outcomes

Baseline data were collected from the participants in both groups. With the exception of the socio-demographic questionnaire that was used only at baseline, similar methods and instruments were applied again at the end of the first and second phases to collect data.

Socio-demographic information

The questionnaire was self-administered. The participants were asked about their gender, ethnicity, religion, age, marital status, education, position, grade and contact information. The socio-demographic information was obtained at baseline only.

Physical examinations

Anthropometric and blood pressure measurements were performed. All enumerators were trained before they began actual work in the field. The participants' weight was measured to the nearest 0.1 kg while they were in light clothing without shoes, using the Tanita Segmental Body Composition Analyser model 418 (Tanita Co., Tokyo, Japan). Their height was measured to the nearest 0.1 cm with a height measuring rod (Seca, Hamburg, Germany). Their body mass index (BMI) was calculated as weight in kilograms divided by the squared height in meters. It was then categorised according to World Health Organisation (WHO) (1998) cut-off points.

The participants' waist circumference was measured to the nearest 0.1 cm at the end of normal expiration between the lowest rib and the iliac crest using an inelastic measuring tape. Waist circumference was categorised as 'normal' ($<$90 cm for men and $<$80 cm for women) and 'high risk' ($\geq$90 cm for men and $\geq$80 cm for women). The participants' hip circumference was taken at the maximal protrusion of buttocks with their feet together. Waist and hip circumference measurements were used to calculate the waist-to-hip ratio (WHR). The WHR was classified based on WHO cut-off points (1998), where men with a WHR $\geq$ 0.90 and women with a WHR $\geq$ 0.85 were considered at risk of non-communicable diseases.

The participants' percentage of body fat was assessed by bio-electrical impedance, using the Tanita Segmental Body Composition Analyser model 418 (Tanita Co., Tokyo, Japan), which incorporates eight tactile electrodes. The classification of the percentage of body fat was based on guidelines suggested by Wardlaw & Kessel (2000).

Duplicate measurements of blood pressure (in mmHg) were measured two minutes apart with a digital automated blood pressure monitor, Omron HEM-907 (Omron, Japan), after the participants had rested in a seated position for five minutes (Murphy *et al.*, 2006). An average of two readings was taken. The right arm was placed on a table and a cuff was placed on the upper right arm. The mean value of the two measurements was computed. Elevated blood pressure was defined as either elevated systolic blood pressure ($\geq$130 mmHg) or diastolic blood pressure ($\geq$85 mmHg) alone or a combination of both.

Biochemical assessment

Blood samples were collected in the morning after participants had undergone an overnight fast by the phlebotomist at the respective government agencies. A total of 5 ml of venous blood was collected from each participant with a syringe and needle. All vials were delivered in a cool box packed with dry ice to an accredited pathology laboratory (Gribbles Pathology (M) Sdn Bhd, Bangi, Malaysia) after all blood samples were collected.

Individuals with metabolic syndrome were identified based on the criteria proposed by the 'harmonised' definition (Alberti *et al.*, 2009) after obtaining the data from the physical examinations and biochemical tests. The 'harmonised' definition of metabolic syndrome was used in an effort to standardise the criteria for metabolic syndrome. This definition is the most recent one developed by a collaborative team consisting of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung and Blood Institute; American Heart Association; World Heart Federation; and the International Association for the Study of Obesity. The percentage of individuals with metabolic syndrome was computed at baseline, after the first and second phases.

Physical activity assessment

An objective measure, taken with the Lifecorder e-STEP accelerometer (Suzuken Company Limited, Nagoya, Japan), was employed to quantify physical activity. Participants were instructed to clip the accelerometer onto the belt, trouser or skirt waistband on the right side and centre it over the foot. Participants were asked to wear the accelerometer from the time they woke up in the morning until they went to bed at night, excluding water-based activities and bathing time (Takeda *et al.*, 2011). In a similar study by Gretebeck & Montoye (1992), the participants' physical activity level varied considerably between weekdays and weekend days. In addition, previous research has shown that between three to five days of assessment is needed to monitor physical activity consistently using an accelerometer (Trost, Mciver & Pate, 2005). Hence, the participants of this study were requested to wear the accelerometer for three days (two consecutive weekdays and one weekend day). The participants were asked to wear the accelerometer for a day, and a valid day was defined as at least 10 hours of wear. The mean number of steps per day was then computed as the average of the number of steps per day for those three days.

Procedure for the intervention (Facebook) group

The intervention activities consisted of using Facebook to promote physical activity and fortnightly group meetings to monitor the participants' progress in the number of steps per day. At the start of the intervention, the participants received a card to log the number of steps taken per day and a pamphlet on physical activity information that summarised the information provided on Facebook. Participants were able to gain information on physical activity and view and comment on each other's posts in addition to logging their daily step counts through the Facebook group page.

During the four-month intervention, materials were uploaded to the Facebook group page. There was open dialogue among participants and between the participants and the researcher. The researcher added the participants as friends on Facebook, and then added them to a specific group so that each participant was notified of every post uploaded by the researcher or the participants. Furthermore, posts that encouraged the participants to park their vehicles far from their destinations and to use the stairs instead of the elevator were uploaded every week. Posts were also uploaded to the researcher's Facebook timeline. The content of the posts are presented in Table 1.

At the end of the four-month intervention, participants were assessed on their frequency of logging into Facebook and the number of researcher's posts read. In addition, the 'seen by' feature was used to identify who had viewed the posts after joining the group, which was the standard usage metric (Bennett & Glasgow, 2009; Munson *et al.*, 2010). During the subsequent two-month follow-up period, the Facebook profile and group page were deactivated. The fortnightly meetings were retained to monitor the participants' progress.

Procedure for the control group

The control group did not receive a weekly physical activity-related intervention. Fortnightly group meetings were held for the control group participants to monitor their progress in the number of steps taken per day. Similar to the Facebook group participants, the control group participants also received a log card for the number of steps taken per day and a pamphlet on physical activity information at the start of the first phase. During the subsequent two-month follow-up period, fortnightly meetings were continued to monitor the control group's progress.

An Omron pedometer HJ-005 (Omron, Japan) was distributed to the participants in the Facebook group and the control group as a self-monitoring tool during the four-month intervention and the two-month

Table 1. Content of the Facebook posts

Week		*Content of the posts*
Week 1	-	Healthy every day with 10,000 steps per day
Week 2	-	Physical activity recommendations (Short message: 10,000 steps per day OR 150 minutes of moderate intensity physical activity per week OR 75 minutes of vigorous intensity physical activity per week)
Week 3 Week 4 Week 5	-	Benefits of walking
Week 6 Week 7 Week 8	-	Walking as the physical activity
Week 9	-	Physical activity level based on number of steps per day
Week 10 Week 11 Week 12 Week 13 Week 14 Week 15	-	Strategies to increase number of steps per day (e.g. to park the vehicle far away from the office; to use the stairs instead of the elevator; to take 10-minute walks for every 2-hour worked etc.)
Week 16	-	Physical activity pyramid

Table 2. Descriptive data of socio-demographic characteristics

Variables		*Facebook* *(n= 35)* n (%)	*Control* *(n= 85)*	X^2	*p*
Gender	Male	11 (31.4)	23 (27.1)	0.233	0.629
	Female	24 (68.6)	62 (72.9)		
Ethnicity	Malay	32 (91.4)	76 (89.4)	7.373	0.061
	Chinese	2 (5.7)	0 (0.0)		
	Indian	1 (2.9)	3 (3.5)		
	Other ethnics	0 (0.0)	6 (7.1)		
Religion	Islam	32 (91.4)	78 (91.8)	2.666	0.446
	Buddhism	1 (2.9)	0 (0.0)		
	Hinduism	1 (2.9)	3 (3.5)		
	Christian	1 (2.9)	4 (4.7)		
Age (Year)	Below 40	32 (91.4)	66 (77.6)	3.145	0.076
	40 and above	3 (8.6)	19 (22.4)		
Marital status	Single	14 (40.0)	23 (27.1)	1.947	0.163
	Married	21 (60.0)	62 (72.9)		
Education	Secondary level	4 (11.4)	17 (20.0)	1.361	0.715
	Preparatory course	3 (8.6)	8 (9.4)		
	Diploma	9 (25.7)	19 (22.4)		
	Degree (Bachelor/ Postgraduate)	19 (54.3)	41 (48.2)		
Grade of position	Implementer	22 (62.9)	52 (61.2)	0.030	0.863
	Professional and management group	13 (37.1)	33 (38.8)		

Note: Values are expressed as the number (percentage) of participants

follow-up period. Instructions were provided on the appropriate way to wear the pedometer. Participants logged their daily step counts using the log card provided. The goal for the participants in the Facebook group and the control group was to increase their physical activity levels by walking and increasing 1,000 steps per day every two weeks until they reached the goal of at least 10,000 steps per day (American College of Sports Medicine, 2005). Their progress in the number of steps taken per day was monitored through the fortnightly meetings until the end of the follow-up period. A similar study approach was used by Coghill & Cooper (2009), Eriksson, Franks & Eliasson (2009) and Yates *et al.* (2012).

Data analysis

Data were analysed using SPSS for Windows (version 20, SPSS, Chicago IL). Interval and ratio values are presented as means and standard deviations (SD). Nominal and ordinal values are presented as frequencies and percentages. A chi-square test was used to determine a significant association between categorical variables. An independent sample *t*-test was employed to determine significant between-group differences at baseline. If there was no significant difference between the groups at baseline, a general linear model repeated-measures ANOVA was used to determine whether any significant between- or within-group differences existed over time for the selected variables. If a significant between-group difference was found at baseline, an analysis of covariance (ANCOVA) was used, using the baseline data as covariates. A statistical probability level of $p < 0.05$ (two-sided) was considered significant.

RESULTS

A total of 147 eligible participants were recruited for the study. At the end of the four-month intervention, a number of participants had dropped out and 124 participants continued to the follow-up phase. The programme continuation rate for the Facebook group and the control group was 81.8% and 85.4%, respectively. After the two-month follow-up period, the final sample consisted of 120 participants, with an average programme completion rate of 81.6%.

The participants in this study were classified as being at an early stage of change with regard to physical activity. The majority of the participants in both the intervention (54.3%) and control (63.5%) groups were contemplating change. A total of 8.6% and 37.1% of the participants in the intervention group were classified in the pre-contemplation and preparation stage of change for physical activity, respectively. On the other hand, 14.1% and 22.4% of the participants in the control group were at the pre-contemplation and preparation stage, respectively.

Observing the within-group difference between baseline, the first phase and the second phase, a significant difference in the number of steps per day ($p<0.001$) was found in both the Facebook group and the control group. The Bonferroni post-hoc test indicated that step counts after the first and second phases were significantly higher than the step counts at baseline. Similar findings were noted for the five metabolic parameters according to the harmonised definition, namely waist circumference, HDL cholesterol, triglycerides, fasting glucose, systolic and diastolic blood pressure (Alberti *et al.*, 2009).

ANCOVA was conducted to detect significant differences between groups, with baseline values as covariates (Table 3). Further analyses were conducted with two-way repeated-measures of ANOVA when there was no significant difference between groups at baseline, to detect any group and time interaction for variables (Table 4). There was a significant time main effect ($p < 0.001$) on the number of steps taken per day. The number of steps per day differed significantly between baseline and the first phase, between the first and second phases and between baseline and the second phase. A significant group main effect ($p< 0.001$) was observed for the number of steps per day. The Facebook group was found to have a significantly greater increase in the number of steps per day than the control group. There was a significant time-by-group interaction effect ($p< 0.001$) on the number of steps per day. The pattern of change in the number of steps per day over time differed between the groups, with a non-parallel pattern of change. The Facebook group increased their number of steps per day by 3,295 (84.5%) from the baseline to the first phase. Their number of steps per day was lower after the second phase than after the first phase but was still 2,264 steps (58.1%) higher than at baseline. On the other hand, the control group increased their number of steps per day by 520 steps (13.2%) from the baseline to the first phase. Their number of steps per day was lower after the second phase than after the first phase but was still 379 steps (9.6%) higher than at baseline.

Figure 2 shows the number and percentage of participants with metabolic syndrome by group at baseline, after the first phase and after the second phase, according to the harmonised definition. The greatest reduction of metabolic syndrome was observed in the Facebook group (reduction of 94.3%, compared to 21.2% for the control group) from the baseline to the first phase.

Table 3. Anthropometric assessment, body composition and blood parameters by group at baseline, and after first and second phases

Group	*Assessment during baseline*	*Assessment after first phase*	*Assessment after second phase*	*P- value*		
	Mean ± standard deviation (95% confidence interval)			*Assessment during baseline*[b]	*Assessment after first phase*[a]	*Assessment after second phase*[a]
Weight (kg)						
Facebook	63.79±13.33	59.15±13.49#	60.99±13.31#*	-2.907	421.975	321.928
(n= 35)	(59.22 - 68.37)	(54.52 – 63.78)	(56.42 – 65.57)	(p=0.004)	(p<0.001)	(p<0.001)
Control	70.92±11.70	70.16±11.65#	70.54±11.70#*			
(n= 85)	(68.39 – 73.44)	(67.65 – 72.68)	(68.02 – 73.06)			
BMI (kg/m^2)						
Facebook	25.67±4.52	23.78±4.57#	24.53±4.49#*	-3.517	368.485	288.933
(n= 35)	(24.12 – 27.23)	(22.21 – 25.35)	(22.99 – 26.08)	(p=0.001)	(p<0.001)	(p<0.001)
Control	28.79±4.37	28.49±4.36#	28.64±4.37#*			
(n= 85)	(27.85 – 29.74)	(27.55 – 29.43)	(27.70 – 29.58)			
Fat mass (kg)						
Facebook	21.55±7.84	16.66±7.20#	18.51±7.48#*	-2.792	231.626	1.550
(n= 35)	(18.85 – 24.24)	(14.19 – 19.13)	(15.94 – 21.08)	(p=0.006)	(p<0.001)	(p=0.216)
Control	25.91±7.75	24.90±7.67#	25.20±7.69#*			
(n= 85)	(24.23 – 27.58)	(23.24 – 26.55)	(23.55 – 26.86)			
HDL cholesterol (mmol/ L)						
Facebook	1.20±.0.23	1.39±0.27#	1.31±0.27#*	2.307	107.505	36.801
(n= 35)	(1.12 – 1.28)	(1.30 – 1.49)	(1.21 – 1.40)	(p=0.026)	(p<0.001)	(p<0.001)
Control	1.10±0.15	1.14±0.15#	1.12±0.15#*			
(n= 85)	(1.07 – 1.13)	(1.10 – 1.17)	(1.08 – 1.15)			
Triglycerides (mmol/ L)						
Facebook	1.52±0.53	0.99±0.46#	1.22±0.49#*	-2.342	196.123	90.780
(n= 35)	(1.33 – 1.70)	(0.83 – 1.15)	(1.05 – 1.39)	(p=0.021)	(p<0.001)	(p<0.001)
Control	1.86±1.05	1.73±1.04#	1.77±1.04#*			
(n= 85)	(1.63 – 2.08)	(1.51 – 1.95)	(1.55 – 1.99)			
Fasting glucose (mmol/ L)						
Facebook	4.63±0.91	3.79±0.90#	4.09±0.92#*	-2.596	256.110	292.466
(n= 35)	(4.31 – 4.94)	(3.48 – 4.10)	(3.78 – 4.41)	(p=0.011)	(p<0.001)	(p<0.001)
Control	5.05±0.75	4.89±0.76#	5.01±0.75#*			
(n= 85)	(4.88 – 5.21)	(4.73 – 5.05)	(4.85- 5.17)			

Note: P<0.001, Bonferroni post-hoc test; [#] As compared to baseline; * As compared to assessment after first phase
[a] Results from ANCOVA with baseline values as covariates; [b] Results from independent sample *t*-test

Table 4. Step counts, anthropometric data, body composition, blood pressure and blood parameters by group at baseline and after first and second phases

Group	*Assessment during baseline*	*Assessment after first phase*	*Assessment after second phase*	*F- value*		
	Mean ± standard deviation (95% confidence interval)			*Time*	*Group*	*Time x Group*
Step counts (Steps per day)						
Facebook (n= 35)	3897.50±1188.69 (3489.17 - 4305.82)	7192.20±1925.55# (6530.75 – 7853.65)	6161.30±1603.97#* (5610.31 – 6712.28)	291.259 (p<0.001)	31.600 (p<0.001)	156.519 (*p*<0.001)
Control (n= 85)	3938.95±1276.29 (3663.66 – 4214.24)	4459.15±1282.52# (4182.52 – 4735.78)	4318.06±1293.11#* (4039.14 – 4596.98)			
Body fat percentage (%)						
Facebook (n= 35)	33.21±8.57 (30.27 – 36.15)	27.53±8.58# (24.59 – 30.48)	29.77±8.80#* (29.75 – 32.79)	290.110 (*p*<0.001)	11.882 (p=0.001)	127.003 (*p*<0.001)
Control (n= 85)	36.23±7.53 (34.61 – 37.86)	35.15±7.56# (33.52 – 36.78)	35.42±7.56# (33.79 – 37.05)			
Waist circumference (cm)						
Facebook (n= 35)	90.03±7.93 (87.31 – 92.75)	86.00±8.25# (83.17 – 88.83)	87.60±8.00#* (84.86 – 90.35)	431.99 (*p*<0.001)	98.610 (p=0.004)	215.631 (*p*<0.001)
Control (n= 85)	93.08±8.38 (91.27 – 94.89)	92.43±8.36# (90.63 – 94.24)	92.76±8.38#* (90.95 – 94.56)			
Hip circumference (cm)						
Facebook (n= 35)	103.65±8.08 (100.88 – 106.43)	101.17±8.24# (98.34 – 104.00)	102.17±8.05#* (99.41 – 104.94)	384.691 (*p*<0.001)	2.563 (p=0.112)	199.339 (*p*<0.001)
Control (n= 85)	105.11±7.97 (103.39 – 106.83)	104.71±7.95# (102.99 – 106.42)	104.90±7.96#* (103.19 – 106.62)			
WHR						
Facebook (n= 35)	0.87±0.06 (0.85 – 0.89)	0.85±0.06# (0.83 – 0.87)	0.86±0.06#* (0.84 – 0.88)	285.254 (*p*<0.001)	4.229 (p=0.042)	159.443 (*p*<0.001)
Control (n= 85)	0.89±0.06 (0.87 – 0.90)	0.88±0.06# (0.87 – 0.90)	0.89±0.06#* (0.87 – 0.90)			

Systolic blood pressure (mmHg)						
Facebook	127.43±16.24	120.97±15.47#	123.50±15.62#*	482.979	8.944	235.352
(n= 35)	(121.85 – 133.01)	(115.66 – 126.29)	(118.14 – 128.87)	(*p*<0.001)	(p=0.003)	(*p*<0.001)
Control	132.79±12.75	131.65±12.74#	132.11±12.73#*			
(n= 85)	(130.04 – 135.54)	(128.90 – 134.39)	(129.37 – 134.86)			
Diastolic blood pressure (mmHg)						
Facebook	78.59±10.29	73.74±9.88#	75.57±10.00#*	429.945	8.693	199.242
(n= 35)	(75.05 – 82.12)	(70.35 – 77.14)	(72.14 – 79.00)	(*p*<0.001)	(p=0.004)	(*p*<0.001)
Control	81.19±7.01	80.24±7.03#	80.68±7.00#*			
(n= 85)	(79.68 – 82.70)	(78.73 – 81.76)	(79.17 – 82.19)			
Total cholesterol (mmol/ L)						
Facebook	5.08±0.94	4.35±0.92#	4.59±0.93#*	405.942	5.919	135.936
(n= 35)	(4.76 – 5.40)	(4.04 – 4.67)	(4.27 – 4.91)	(*p*<0.001)	(p=0.016)	(*p*<0.001)
Control	5.24±0.99	5.05±0.98#	5.15±0.99#*			
(n= 85)	(5.02 – 5.45)	(4.84 – 5.26)	(4.94 – 5.36)			
LDL cholesterol (mmol/ L)						
Facebook	3.18±0.89	2.50±0.89#	2.72±0.92#*	310.279	12.660	105.298
(n= 35)	(2.88 – 3.49)	(2.20 – 2.81)	(2.41 – 3.04)	(*p*<0.001)	(p=0.015)	(*p*<0.001)
Control	3.29±0.82	3.13±0.81#	3.23±0.81#*			
(n= 82)	(3.11 – 3.47)	(2.95 – 3.31)	(3.05 – 3.41)			

Note: P<0.001, Bonferroni post-hoc test # As compared to baseline; * As compared to assessment after first phase

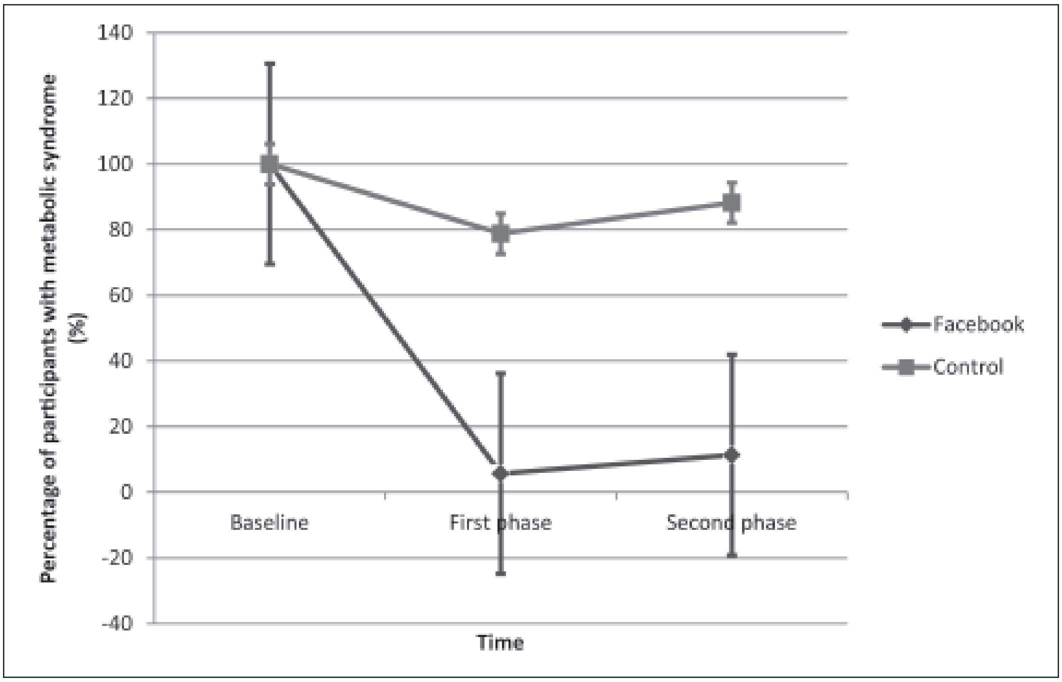

Figure 2. Percentage of participants with metabolic syndrome at baseline, and first and second phases by group

Nonetheless, the Facebook group experienced a slight percentage increase (5.7%) in metabolic syndrome from the first phase to the second phase; the corresponding increase for the control group was 9.4%.

Pearson's correlation was used to examine whether improvements in other variables depended on the change in the number of steps per day after the four-month intervention period (Table 5). Overall, a significant strong to very strong correlation was found between the change in the number of steps per day and changes in other variables. All the significant correlations between the change in the number of steps per day and changes in other variables were negative, except for the correlation between the change in the number of steps per day and the change in HDL cholesterol.

More than half (57.1%) (n = 20) of the participants in the Facebook group logged into Facebook daily, whereas 42.9% (n = 15) logged into Facebook weekly. Nevertheless, all the participants in the Facebook group viewed the posts uploaded by the researcher and were aware of the frequency of those posts. No significant difference was detected in the number of steps per day over time between the daily and weekly Facebook users.

DISCUSSION

The Facebook group increased their number of steps per day by 3,295 (84.5%) from the baseline to the first phase. Their number of steps per day was lower after the second phase than after the first phase, but was still 2,264 steps higher than at baseline. Within-group comparison revealed that the Facebook group significantly increased their number of steps per day (after the four-month intervention and two-month follow-up) compared to the baseline. The number of

Table 5. Pearson's correlation coefficient (r) between changes in number of steps per day and changes in other variables

	Change in number of steps per day		
Change in	*SNW(n= 35)*	*Control(n= 85)*	*Total(n= 120)*
	r (p- value)		
Weight (kg)			
Baseline and after first phase	-0.933 (<0.001)	-0.255 (0.019)	-0.967 (<0.001)
BMI (kg/m^2)			
Baseline and after first phase	-0.926 (<0.001)	-0.288 (0.008)	-0.967 (<0.001)
Body fat percentage (%)			
Baseline and after first phase	-0.881 (<0.001)	-0.181 (0.097)	-0.867 (<0.001)
Fat mass (kg)			
Baseline and after first phase	-0.739 (<0.001)	-0.203 (0.062)	-0.860 (<0.001)
Waist circumference (cm)			
Baseline and after first phase	-0.934 (<0.001)	-0.272 (0.012)	-0.968 (<0.001)
Hip circumference (cm)			
Baseline and after first phase	-0.919 (<0.001)	-0.092 (0.404)	-0.957 (<0.001)
WHR			
Baseline and after first phase	-0.926 (<0.001)	-0.229 (0.035)	-0.953 (<0.001)
SBP (mmHg)			
Baseline and after first phase	-0.925 (<0.001)	-0.276 (0.011)	-0.965 (<0.001)
DBP (mmHg)			
Baseline and after first phase	-0.790 (<0.001)	-0.126 (0.249)	-0.930 (<0.001)
TC (mmol/ L)			
Baseline and after first phase	-0.799 (<0.001)	-0.243 (0.025)	-0.910 (<0.001)
HDL-C (mmol/ L)			
Baseline and after first phase	0.401 (0.017)	0 218 (0.045)	0.745 (<0.001)
LDL-C (mmol/ L)			
Baseline and after first phase (n= 117)	-0.799 (<0.001)	-0.242 (0.029)	-0.910 (<0.001)
TG (mmol/ L)			
Baseline and after first phase	-0.474 (0.004)	-0.339 (0.002)	-0.811 (<0.001)
FPG (mmol/ L)			
Baseline and after first phase	-0.442 (0.008)	-0.234 (0.031)	-0.819 (<0.001)

Footnote: LDL cholesterol was computed using the Friedewald formula (Friedewald, Levy & Frederickson, 1972). Levels of LDL cholesterol were not computed if triglycerides were higher than 4.5 mmol/L.

steps per day differed significantly between the Facebook group and the control group over time. These findings suggest that the Facebook group was more effective than the control group in increasing the number of steps per day. Hence, the difference in the number of steps per day between the Facebook group and the control group is assumed to be due to the differences in the intervention component (Facebook intervention) during the first phase.

The researcher's sharing of posts and the participants' viewing of posts were deemed valuable to the participants based on the 'seen by' features. Participants were less likely to write and share because they thought their insights and opinions were not significant enough to post on the group Facebook page. Another possible explanation for this might be their concern of over-sharing.

Therefore, it is possible that the effects of Facebook intervention were due to the incorporation of the materials into a social networking website that participants regularly visited. The website facilitated access to the materials (Anhøj & Jensen, 2004; Leslie *et al.*, 2005; Tate, Jackvony & Wing, 2003).

The findings of this study support the feasibility of Facebook-based physical activity intervention among individuals with metabolic syndrome. Given the limited physical activity intervention focused specifically on individuals with metabolic syndrome (Andersen *et al.*, 2012), it is challenging to put this increase in step count in context. These findings show that a minimal intervention delivered through Facebook may help promote physical activity among individuals with metabolic syndrome. However, the findings should be interpreted with caution considering the lack of a true control group. This design was based on the experience of Galvão *et al.* (2009) with several physical activity trials that had numerous benefits over a control group with nothing provided. Participants who were assigned to a true control group complied, dropped out early or performed physical activity regardless of the instructions to sustain their typical lifestyle. The study had an extremely low retention rate and a severely contaminated dataset.

This study further supports the idea that physical activity favourably affects the individual components of metabolic syndrome (Andersen *et al.*, 2012), particularly waist circumference, blood pressure, HDL cholesterol, triglycerides and fasting glucose. The increase in the number of steps per day has implications for metabolic parameters. Although the change in the physical activity level was minimal and did not reach the target of 10,000 steps per day, correlation analysis showed that an increase in the number of steps per day was strongly associated with an increase in HDL cholesterol (r = 0.745, p<0.001) and a decrease in systolic blood pressure (r = -0.965, p<0.001), diastolic blood pressure (r = -0.930, p<0.001), triglycerides (r = -0.811, p< 0.001), waist circumference (r = -0.968, p< 0.001) and fasting glucose (r = -0.819, p < 0.001). The observed correlation between the changes in metabolic parameters and the number of steps per day is encouraging, as a fundamental aim of workplace physical activity programmes is to improve risk factors among those who are at high risk. It is likely that a change in step count is more crucial than baseline risk, given the association between step count and changes in metabolic parameters.

The number of steps per day was lower after the second phase than after the first phase, but was still higher than the baseline for both the Facebook group and the control group. It is possible that the decrease in the number of steps per day was due to the barring of intervention components in the second phase. In response to the predetermined open-ended questions in the interview conducted to probe the decrease in the number of steps per day, feedback from the participants revealed that the intervention components had encouraged them to be active. Maintaining the intervention components would help improve the sustainability of such a programme. The decrease in the number of steps per day due to the withdrawal of intervention components has also been suggested in previous studies (Marshall *et al.*, 2002; Shaw *et al.*, 2007). In addition, the decrease may be due to the hot and dry weather. This was in tandem with the smog, which was at its worst due to the Indonesia forest fires towards the end of the programme. Based on the archives of the Air Pollutant Index, the air quality was in the moderate to unhealthy category towards the end of the programme (Department of Environment, 2013). Participants also claimed that the novelty of the pedometer in encouraging them to increase their number of steps per day wore off towards the end of the programme. The weather (Shaw *et al.*, 2007; Takeda *et al.*, 2011) and the decreasing effectiveness of the pedometer in improving step count (Shaw *et al.*, 2007) may have had some effect on the decrease in the number of steps per day, which eventually led to the deterioration of the metabolic parameters.

This study provides preliminary insight into how delivering physical activity information through Facebook can be useful in improving the physical activity level among individuals with metabolic syndrome. Future research is needed to identify more effective interventions to enhance physical activity among individuals with metabolic syndrome within, or as a complement to, a social networking website approach. In addition, how individuals with metabolic syndrome use social networking websites and the potential for Facebook group discussions should be examined to enhance behaviour change in this population.

This study is one of the very few randomised controlled trials to evaluate a physical activity intervention among individuals with metabolic syndrome using a popular and publicly available social networking website. The fact that the intervention was done through a popular social networking website enhances the possibility for future dissemination.

However, this study lacked long-term follow-up. Hence, it is unable to demonstrate the long-term effectiveness of the intervention. In addition, the study did not cater to the needs of individuals with metabolic syndrome who are not on Facebook, and who may be in most need of information on physical activity (Fox & Purcell, 2013).

In conclusion, the findings of this study suggest that social networking websites such as Facebook may be a feasible delivery channel for physical activity intervention among individuals with metabolic syndrome, and that Facebook-based physical activity intervention holds potential for promoting physical activity in this population. Our findings show that delivering information on physical activity through an existing, commonly used social networking website may benefit and may have future implications for individuals with metabolic syndrome.

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