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Multimodal Nutrition Education Intervention: A Cluster Randomised Controlled Trial Study on Weight Gain and Physical Activity Pattern Among University Students in Terengganu, Malaysia

Lua PL, Wan Dali WPE & Shahril MR

Centre for Community Development and Quality of Life (CCDQ), Faculty of Medicine and Health Sciences, Universiti Sultan Zainal Abidin (UniSZA), Kampus Kota, Jalan Sultan Mahmud, 20400 Kuala Terengganu, Terengganu, Malaysia

ABSTRACT

Introduction: This cluster randomised controlled study design aimed to evaluate the effectiveness of implementing nutrition education intervention (NEI) that targeted at incremental reduction of body weight and increased physical activity level among university students. **Methods:** Body weight and physical activity level were assessed before and after intervention. A total of 417 university students from four public universities in Terengganu participated in the study. They were randomly selected and assigned into two arms, that is, intervention group (IG) or control group (CG) according to their cluster. The IG received 10 weeks intervention focused on NEI promotion using three modes which were conventional lecture, three brochures as take-home messages and text messages for intervention reinforcement while CG did not receive any intervention. Analysis of covariance (ANCOVA) and adjusted effect size were used to determine differences in body weight and physical activity levels between groups and time. **Results:** No significant changes in body weight were observed among both groups. The average weight and body mass index (BMI) were slightly reduced in IG compared to CG after the 10-week intervention ($p>0.05$). Nevertheless, physical activity level improved significantly among IG participants compared to CG with increased metabolic equivalent (MET) min/ week spent for walking, moderate and vigorous activities and significantly decreased sitting time. The largest adjusted effect size was shown in total physical activity (0.75). **Conclusion:** The multimodal NEI had a positive influence on physical activity outcomes among university students. NEI should be continuously implemented in this particular population group.

Key words: Brochure, nutrition lecture, physical activity, text messaging, university students

INTRODUCTION

Nutrition education intervention (NEI) has shown some success in promoting dietary behaviours and physical activity in children, adolescents, housewives, pregnant women and older adults (Contento, Rande & Basch, 2002). However, few efforts have specifically

Correspondence author: Pei Lin Lua: Email: *peilinlua@unisza.edu.my*

targeted university students (Lua & Wan Putri Elena, 2012). Designing NEI for university students is challenging as just conventional methods to deliver NEI might not attract these age group. Therefore, different modes of mass education delivery or "multimodal" approaches that combine both the latest technology and conventional method appear to be a viable means of disseminating NEI. Previous researchers have shown that providing class-based NEI (Ha & Caine-Bish, 2009) and brochures (Shive & Morris, 2006) improved dietary habits of university students. Another way which is not only effective but also interesting and practical for the current generation of students is through new media channels/ technologies such as usage of the short messaging system (SMS). The effectiveness of this innovative method has been encouraging and proven among smokers, diabetic and bulimia nervosa patients (Fjeldsoe, Marshall & Miller, 2009). An estimated 2.25 trillion text messages, consisting of almost immediate delivery of synchronous short messages (160 characters maximum), were sent in 2011, an increase from 1.68 billion in 2006, showing remarkable growth in wireless communication (Cole-Lewis & Kershaw, 2010). Text messaging is widely accessible and a relatively inexpensive tool for health behaviour change and several research studies have demonstrated that text messaging has positive short-term behavioral outcomes (Fjeldsoe *et al.*, 2009). Besides, young people are early adopters of new technologies and the largest users of text messaging, making it one of the best choices as a means of intervention delivery. Mobile interventions have the ability to interact with individuals with much greater frequency compared to internet interventions delivered by computers (Riley *et al.*, 2011). Text messaging might also be useful as a reinforcement tool for NEI along with other conventional methods in a multimodal intervention setting.

Physical activities are beneficial for university students as they can increase body fitness and the well-being of the brain. The activities also relieve tension and stress, encourage better sleep, improve performance in academics, increase potential to achieve and maintain a healthy weight, build stronger muscles and bones and facilitate independent living in later life (You, Sung & Chang, 2009). Conversely, physical inactivity is one of the important lifestyle factors that contribute to overweight and obesity because of its impact on energy balance. Those who have higher leisure time physical activity such as jogging, aerobics and swimming tend to have a normal range body mass index (BMI) (Ball *et al.*, 2001).

Research has shown that individuals whose BMI is in the overweight or obese categories are more likely to experience health problems associated with excess weight such as type 2 diabetes, heart disease, hypertension and certain type of cancers (Ball *et al.*, 2001). Therefore, improving students' knowledge about nutrition and healthy eating habits may promote positive body weight management and reduce the possibility of weight increment (You *et al.*, 2009). College and university life is an important stage for individuals as during this time their behaviours could still change, therefore, representing an important opportunity for health and NEI (Sajwani *et al.*, 2009).

This paper details the efficacy testing of this multimodal intervention in a cluster randomised controlled trial. The aim of the present study was to assess the impact of NEI on preventing increment in body weight and increasing physical activity level among undergraduates.

METHODS

Participants

This longitudinal study focused on four public universities in Terengganu namely

Universiti Sultan Zainal Abidin (UniSZA), Universiti Malaysia Terengganu (UMT), Universiti Teknologi Mara (UiTM) Dungun and UiTM Kuala Terengganu from September 2011to February 2012. Participants from these four universities that met the inclusion criteria were invited to participate in this study. Before the study begun, inclusion criteria were determined. The criteria were: Malaysian university students aged between 18 to 24 years; actively using a mobile telephone; first or second year diploma or degree from management studies; generally healthy and able to read, write, speak and understand Malay or English language. Respondents were excluded if their age was below or above the stated age (<18 years or >24 years); did not have mobile phones; were in the final year and in other studies; have been diagnosed with any diseases and were unable to read, write, speak or understand Malay or English. The lists of all available classes (also considered as clusters) were gathered from heads of department from each university. All randomly selected clusters were then randomised into intervention group (IG) and control group (CG) by drawing sealed envelopes containing group assignments.

It was aimed to gather at least 290 respondents throughout the research period. The sample size calculation was based on the formula for sample size determination in experimental studies (Hedeker, Gibbons & Waternaux, 1999) as follows:

$$n = \frac{2\sigma^2 (Z_\alpha + Z_\beta)^2}{\Delta^2}$$

where n = required sample size; σ = standard deviation of total score of IPAQ METs min/ week (Kurtze, Rangul & Hustvedt, 2008); Z_α = value from the standard normal distribution corresponding to α which was equal to 2.58; Z_β = value from the standard normal distribution corresponding to β which was equal to 1.28; Δ = value of the clinically important mean difference to be detected.

Hence

$$n = \frac{2(6096)^2 (2.58 + 1.28)^2}{3048^2}$$

$$= 119.2 \sim 120$$

According to the formula, the required sample size per group was 120. For two groups, the sample size needed was 240. Taking into consideration 20% drop-out, the final sample size required for this study was 290, that is, 145 respondents per group. Thus, from a total of 50 classes from all four universities, only 16 (range = 20 to 25 students in each class) classes were randomly selected using simple random sampling to represent the target population of this study to achieve our sample size requirement. A higher number of respondents was chosen to ensure sufficient data were obtained for more accurate and precise results.

At the end of this study, 417 university students agreed to participate (IG=205, CG=212). However, only 380 students [IG = UniSZA (86), UMT (22), UiTM Dungun (13) and UiTM Kuala Terengganu (57); CG = UniSZA (99), UMT (24), UiTM Dungun (17) and UiTM Kuala Terengganu (62)] completed the entire study (IG=178, CG=202) (Figure 1).

Measures

A set of measures was given at baseline and after 10 weeks of NEI. At the baseline, all students initially completed a personal information form, which comprised demographic questions on gender, living arrangements, academic year, funding status and body mass index (BMI). Anthropometric measurements were conducted for each respondent. Body weight, height, waist and hip circumference were assessed before and after intervention was provided. The BMI (kg/m^2) was calculated using the individual's height and weight, and classified according to the Asian population categorisation (Ikram *et al.*, 2004).

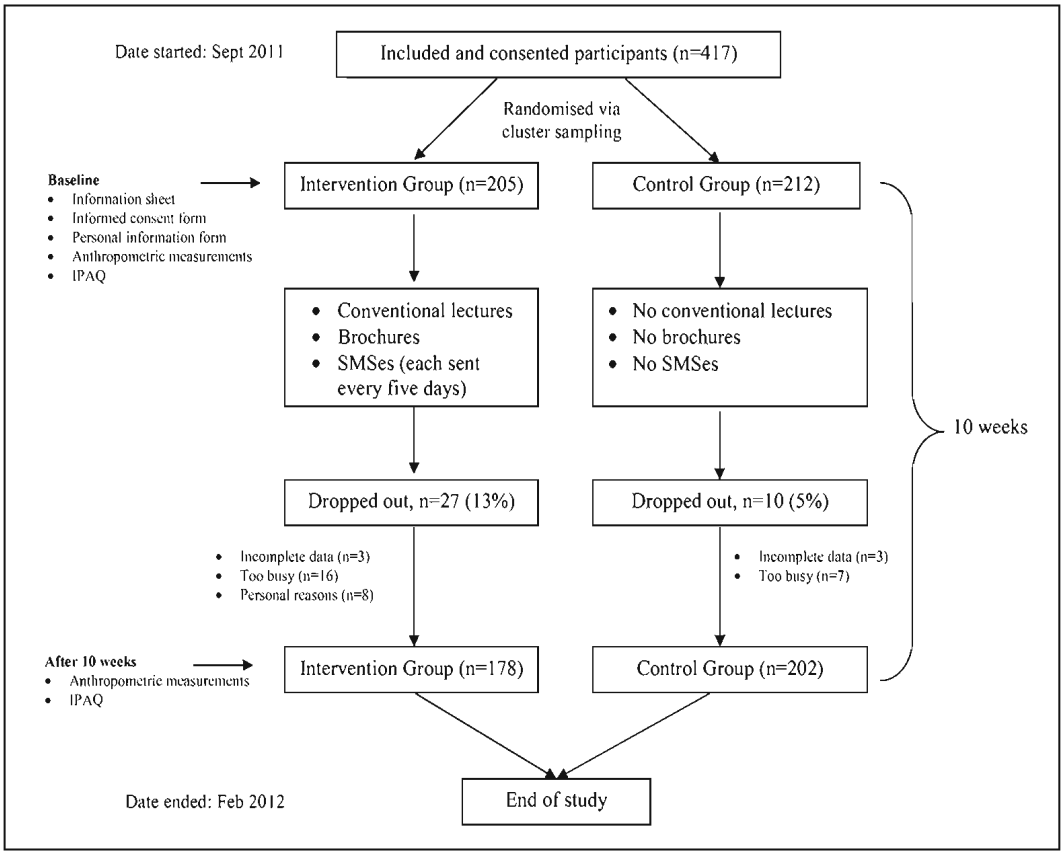

Figure 1. Flowchart of respondent's recruitment

International Physical Activity Questionnaire (IPAQ)

The IPAQ short form is an instrument designed for recall of physical activity among adults between 15 to 65 years old (Craig *et al.*, 2003). It has been tested in 12 countries (Craig *et al.*, 2003). The test-retest reliability was good (r_s=0.8) and the criterion validity was acceptable when activity estimates were compared against accelerometer readings (r_s=0.3). The use of the IPAQ with older and younger age groups than specified is not recommended. One measure of the volume of activity can be computed by weighting each type of activity by its energy requirements, defined as metabolic equivalent (MET), to yield a score in MET minutes.

The following values were used for the analysis of IPAQ data: (1) walking MET-minutes/week = 3.3 x walking minutes x walking days; (2) moderate MET-minutes/week = 4.0 x moderate-intensity activity minutes x moderate days; (3) vigorous MET-minutes/week = 8.0 x vigorous-intensity activity minutes x vigorous-intensity days; and (4) total physical activity MET-minutes/week = sum of walking + moderate + vigorous MET-minutes/week scores. We also used the recommended categorical score or three levels of physical activity (low, moderate and high) as proposed in the IPAQ scoring protocol (short form). Individuals who did not meet the criteria for moderate and vigorous intensity categories (<599 MET-minutes/week) were considered to

Table 1. Selected key messages from the MDG (NCCFN, 2010)

	Messages
1.	Eat a variety of foods within your recommended intake
2.	Maintain body weight in a healthy range
3.	Be physically active everyday
4.	Eat adequate amount of rice, other cereal products (preferably whole grain) and tubers
5.	Eat plenty of fruits and vegetables everyday
6.	Consume moderate amounts of fish, meat, poultry, egg, legumes and nuts
7.	Consume adequate amounts of milk and milk products
8.	Drink plenty of water daily
9.	Limit intake of foods high in fats and minimise fats and oils in food preparation
10.	Choose and prepare foods with less salt and sauces
11.	Consume foods and beverages low in sugar
12.	Consume safe and clean foods and beverages
13.	Make effective use of nutrition information on food labels

have a low physical activity level. Those who achieved a minimum of at least 600 MET-minutes/week were considered to have a moderate physical activity level while those who achieved a minimum of at least 3000 MET-minutes/week were categorised as having a high physical activity level.

Intervention

The intervention programme employed was developed based on the latest Malaysian Dietary Guidelines (MDG) (NCCFN, 2010) which comprised 13 out of 14 nutrition key messages (Table 1). Messages which deliberated on *Practise Exclusive Breastfeeding from Birth until Six Months and Continue to Breastfeed until Two Years of Age* were excluded due to their irrelevance to the current participants who were young undergraduates. The MDG is applicable for healthy Malaysians over the age of two years. All included messages were delivered through three modes: (1) conventional lecture; (2) brochures; and (3) text messaging. Details on delivery of programme are shown in Table 2. Malay language as the national language was used in delivering this multimodal NEI.

Content validity and face validity of these multimodal NEI were initially evaluated by two qualified researchers experienced in nutrition and dietetics and were then pre-tested among 116 university students for clarity and readability as well as the overall content (Lua, Wan Dali & Shahril, 2012). Subsequently, the contents in this multimodal NEI were modified based on the inputs and feedback obtained from respondents recruited during the pre-test.

Four hundred and seventeen students were randomised according to their cluster to one of these groups: (1) IG (n=205); and (2) CG (n=212). On completion of randomisation, research assistants (RAs) arranged a first meeting with all participants according to their respective clusters to gather baseline data prior to the start of intervention. During the first session, all participants, both from IG and CG signed the consent form and then completed the baseline dietary intake assessment. Participants in IG were scheduled for a second 1.5 hours meeting in a week's time from baseline during which they received a conventional nutrition lecture (for each selected cluster) by a nutrition expert and three sets of brochures as take home messages. They also received one text message every five days starting from baseline until end of week 10. A total of 13 text messages were delivered for each participant in IG during intervention. CG

Table 2. Details of intervention through three modes of delivery

Modes	*Description*
Conventional lecture	- Compiled into a 64-slide multimedia Microsoft PowerPoint presentation - Clearly visible for approximately 100 students with appropriate font sizes - Attractive graphics and suitable combination colours were additionally used to stimulate their interest on the topics delivered in a 1-hour session by a nutrition expert - Question and answer session was conducted along with the lecture for active participations of the audience.
Brochure	- Designed as take home messages to enhance their understanding and memory after the lecture. - Contained key recommendations and how to achieve the recommendations for each key message through three different theme namely: *Always Be Healthy!*, *Eat Moderately!* and *Live the Future!*. - Displayed on the coloured art papers in 35.8 cm x 25 cm-sized with four folded and printed double-sided. - Pictorial graphics which included food pictures, cartoon pictures and symbols w to attract the readers. - Text language with black 12-font sized.
Text messaging	- Delivered to all forms of cellular telephones with a limitation of 152 characters for each text message. - 13 text messages based on the MDG [23] was delivered and were designed to be sent once in every five days at 10 a.m. throughout the intervention period. - Sent manually through the Mobile Nutritional Education System (MNES) which was developed by the mobile content and services provider based in Kuala Lumpur, Malaysia. - Abbreviations were avoided to prevent misunderstanding of the information received.

participants received no intervention and were instructed to maintain their normal daily activity. Ten weeks after completing the baseline session, all participants were called back according to their clusters to complete the follow-up assessment. Participants were not given any incentives in return for their involvement in this study.

Ethical approval

Ethical permission for this study was received from the Institute of Health Behavioral Research (IHBR), Clinical Research Centre (CRC) and Ministry of Health Research and Ethics Committee (MREC), Malaysia (reference number: NMRR-10-1153-7768). Further, permission to conduct the study in each participating university was also obtained from the vice chancellors and heads of departments prior to data collection process. Agreement to use the latest MDG was also obtained from the Nutrition Division, Ministry of Health Malaysia.

Statistical analysis

Data entry and statistical analyses were carried out using SPSS 16.0 statistical software packages. The IG and CG were compared descriptively with respect to socio-

Table 3. Selected characteristics of study participants (n=380).

Characteristics	*CG (n=202)*	*IG (n=178)*
Age (year)*	19.2 ± 1.1	19.0 ± 1.2
Height (cm)*	157.8 ± 7.2	156.5 ± 7.1
Weight (kg)[b]	53.6 ± 12.3	51.9 ± 9.5
Energy intake (cal)[b]	1564.0 ± 270.0	1563 ± 263
Total PA MET (min/week)[b]	2753.4 ± 2218.9	2639.9 ± 1497.6
Gender[a]		
Male	35 (17.3)	12 (6.7)
Female	167 (82.7)	166 (93.3)
Living arrangement[a]		
Alone	2 (1.0)	9 (5.1)
With family	17 (8.4)	27 (15.2)
With friends	183 (90.6)	142 (79.8)
Academic year[a]		
First year	129 (63.9)	114 (64.0)
Second year	73 (36.1)	64 (36.0)
Funding status[a]		
Funded	149 (73.8)	130 (73.0)
Not funded	52 (25.7)	48 (27.0)

* Data expressed as mean ± standard deviation.
[a] Data expressed as n (%)
[b] p value<0.05 indicates significance

demographic characteristics. Initial normality test was carried out utilising the age, weight and physical activity as dependent variables. The overall outcomes complied with normality requirements in which the Kolmogorov-Smirnov statistics emerged as $P>0.05$. Thus, analysis of covariance (ANCOVA) was utilised to examine the changes in anthropometry measurements and physical activity level from baseline to 10-week after intervention between IG and CG with potentially confounding factors (baseline readings) included as covariates. Adjusted effect sizes using Cohen's interpretation were also added (adjusted mean difference ÷ √ mean square error) and measured (0.20-0.49=small; 0.50-0.79=medium; ≥0.80=large) (Cohen, 1988). Significance was set a priori at $P<0.05$.

RESULTS

Demographic characteristics

A description of the participating respondents is presented in Table 3. Their mean age was 19.14 years (SD=1.2; range=18-24). The majority were females, studied in the first year with their studies being funded by the National Higher Education Fund (*PTPTN*) or Council of Trust for Indigenous People (*MARA*).

Changes in anthropometry measurements

Changes in body composition parameters for both intervention and control groups are presented in Table 4. After the 10-week programme, no changes were observed in weight and BMI in both IG and CG ($p>0.05$). However, the average waist and hip

Table 4. Mean anthropometry measurements (n=178) and control (n=202) groups

Anthropometry measurements	*Mean ± SE*		*Adj. mean (95% CI)*	*Adj. mean diff. (95% CI)*	*F-stat (df)*	*p value*	*Adjusted effect size (Cohen's d)*
	Baseline	*After 10 weeks*					
Weight (kg)				-0.4 (-0.9, 0.1)	2.7 (1, 376)	0.104	0.17 (N)
Intervention	51.90 ± 0.71	51.81 ± 0.71	52.7 (52.3, 53.0)				
Control	53.60 ± 0.86	53.86 ± 0.87	53.1 (52.8, 53.4)				
BMI (kg/m²)				-0.1 (-0.3, 0.0)	2.2 (1, 376)	0.136	0.15 (N)
Intervention	21.23 ± 0.29	21.20 ± 0.29	21.3 (21.2, 21.5)				
Control	21.46 ± 0.29	21.57 ± 0.30	21.5 (21.3, 21.6)				
Waist circumference (cm)				0.3 (-0.2, 0.8)	1.2 (1, 376)	0.282	0.12 (N)
Intervention	67.57 ± 0.74	67.77 ± 0.73	68.4 (68.0, 68.7)				
Control	68.76 ± 0.79	68.63 ± 0.79	68.1 (67.7, 68.4)				
Hip circumference (cm)				0.2 (-0.4, 0.8)	0.4 (1, 376)	0.534	0.07 (N)
Intervention	89.93 ± 9.62	89.95 ±9.43	90.0 (89.6, 90.4)				
Control	90.03 ± 10.43	89.99 ± 10.4	89.8 (89.4, 90.2)				

[a] Adj. mean = Adjusted mean using ANCOVA after controlling for the baseline for each variable.
[b] Adj. mean diff = Adjusted mean difference (Bonferroni adjustment for 95% CI for difference).
Adjusted Effect size (N = Negligible).
SE = Standard error mean.

circumferences were slightly increased in IG compared to CG ($p>0.05$). The frequency of BMI categorisations between IG and CG is also presented in Table 4. No significant changes in BMI categorisations occurred after the 10-week programme for both groups.

Changes in physical activity pattern

Mean weekly MET min expenditure, estimated using IPAQ among IG and CG at baseline and after the 10-week intervention, is tabulated in Table 5. Compared to baseline, IG participants saw a marked decrease in their MET minutes spent sitting and an increase in their energy expenditure for walking, moderate and vigorous activity after the 10-week intervention as indicated by weekly MET min expenditure. This led to increased total MET min per week among IG participants at week 10 compared to baseline. No changes in physical activity pattern were observed among CG participants. ANCOVA analysis controlling for potential confounders set a priori further illustrate that after the 10-week multimodal NEI, weekly MET min expenditure for walking [$F(1, 376) = 22.0$, $p < 0.001$], moderate activity [$F(1, 376) = 13.8$, $p < 0.001$] and vigorous activity [$F(1, 376) = 11.1$, $p < 0.001$] improved significantly in IG compared to CG. IG participants also saw a decrease in MET min expenditure per week for sitting [$F(1, 376) = 11.6$, $p< 0.001$] compared to their counterparts in CG after the 10-week intervention. However, the adjusted effect sizes observed were still considered small. There was a significant interaction between time and group on total MET min per week as the estimated physical activity measures from IPAQ were affected by the 10-week multimodal NEI in this study [$F(1, 376) = 53.3$, $p < 0.001$] with a medium adjusted effect size.

DISCUSSION

Overall, these findings suggest that the NEI was well accepted and has been delivered successfully to improve physical activity outcomes. Additionally, the baseline data indicated that undergraduates in this study were already moderately engaged in physical activity, results which were congruent with the previous literature (Choi, Kim & Park, 2007; Silliman, Rodas-Fortier & Neyman, 2004; Troyer *et al.* 1990. Essentially, exposure to a multimodal NEI using conventional lecture, take-home brochures and periodical reminders through text messaging for 10-weeks among university students was beneficial in improving their physical activity pattern. Previously, this multimodal NEI had also been used to enhance food choices and nutrition-related quality of life among undergraduates (Wan Dali, Lua & Shahril, 2013; Shahril, Wan Dali & Lua, 2013).

The present study specifically demonstrated an increase in physical activity level among those who received intervention. Although at baseline, participants were moderately engaged in physical activities based on their mean total MET values of less than 3000 MET min/ week but more than 600 MET min/week, those in IG were seen to increase their physical activity intensity to a higher level reaching more than 3000 MET min/week indicating a highly active physical activity pattern as suggested by IPAQ scores (IPAQ, 2005). A significant shift from sitting activities to other activities burning more energy such as walking, moderate and vigorous activities were also observed in IG after 10-weeks of multimodal NEI. A report which reviewed current available evidence concluded that text messaging is an effective tool when coupled with additional strategies to increase physical activity in healthy adults and recommends testing them in larger and diverse samples (Williams, 2012). Another report which focused only on randomised controlled trial design studies also provided evidence supporting the positive effects of Internet and mobile phones in physical activity interventions for children and adolescents, especially when

Table 5. Mean weekly MET min expenditure as estimated using IPAQ in intervention (n=178) and control (n=202) group and ANCOVA analysis after controlling for potential confounders

MET min/ week	*Mean ± SE*		*Adj. mean*	*Adj. mean diff.*	*F-stat (df)*	*p value*[a]	*Adjusted effect*
	Baseline	*After 10-weeks*	*(95% CI)*[a]	*(95% CI)*[b]			*size (Cohen's d)*
Sitting				-56.1 (-88.6, -23.7)	11.6 (1, 376)	< 0.001	0.35(S)
Intervention	473.5 ± 13.7	346.9 ± 11.9	345.4 (321.8, 369.1)				
Control	440.5 ± 13.5	400.9 ± 11.2	401.5 (379.3, 423.7)				
Walking				764.2 (444.1, 1084.3)	22.0 (1, 376)	< 0.001	0.48 (S)
Intervention	1431.3 ± 80.2	2484.4 ± 137.5	2500.0 (2266.2, 2733.2)				
Control	1549.5 ± 98.9	1742.2 ± 94.5	1736.0 (1516.5, 1954.5)				
Moderate activity				333.4 (157.1, 509.6)	13.8 (1, 376)	< 0.001	0.38 (S)
Intervention	722.4 ± 56.5	976.4 ± 74.3	967.6 (839.0, 1096.2)				
Control	662.1 ± 63.9	628.9 ± 55.4	634.2 (513.6, 754.9)				
Vigorous activity				413.4 (170.1, 656.7)	11.1 (1, 376)	< 0.001	0.34 (S)
Intervention	490.5 ± 67.1	952.2 ± 110.1	964.7 (787.3, 1142.2)				
Control	541.7 ± 90.1	555.2 ± 70.4	551.3 (384.8, 717.8)				
Total MET				1545.8 (1129.4, 1962.2)	53.3 (1, 376)	< 0.001	0.75 (M)
Intervention	2639.9 ± 112.2	4419.3 ± 180.9	4456.0 (4152.4, 4759.7)				
Control	2753.4 ± 156.1	2921.6 ± 136.3	2910.0 (2625.3, 3195.1)				

[a] Adj. mean = Adjusted mean using ANCOVA after controlling for the baseline for each variable.
[b] Adj. mean diff = Adjusted mean difference (Bonferroni adjustment for 95% CI for difference).
MET = Metabolic equivalent
Effect size (S = Small, M = Medium).
SE = Standard error mean.

used with face-to-face instruction (Lau *et al.*, 2011). The current study indicates that text messaging together with conventional lecture and brochures used in this study is an effective tool in increasing physical activity level among undergraduates using a cluster randomised controlled trial design.

A study among Korean female college students showed that NEI including exercise therapy with specific exercise regime recommendations for eight weeks could significantly decrease body weight and body fat (You *et al.*, 2009). Interestingly, body weight, waist and hip circumference remained unchanged throughout the intervention period in both groups in the present study although physical activity level was shown to have increased despite the fact that our intervention did not involve practical demonstration of physical activities. This was expected earlier because of the short programme period and an intervention design focusing on improved physical activity. A study with a longer period of implementation for nutrition intervention has consistently reported better outcomes (Belansky *et al.*, 2006). On a positive note, weight gain which is common among the population in the current study was prevented, similar to previous outcomes from a study in United States among female college freshman reported by Matvienko, Lewis & Schafer (2001) suggesting that it is important to control weight gain among university students from their first year.

The results of the current study also suggest that one potentially effective way of increasing physical activity level might be the use of modern technology through text messaging. Text messaging has been shown to be acceptable for providing support, affecting behaviour change among diabetes patients, asthma sufferers, cigarette smokers and those with bulimia nervosa (Fjeldsoe *et al.*, 2009). Text messaging represents a fully integrated technology in the lifestyle of university students along with other social media. In the current study, text messages were designed to encourage and reinforce the NEI, after the delivery of the conventional lecture and brochures.

LIMITATIONS OF THE STUDY

However, our study has several limitations which need to be addressed. It cannot be ascertained that the participants in IG rigorously complied with the information provided from MDG 2010 through the lectures, brochures and SMS. However, it was assumed that respondents in IG who wanted to change their lifestyles and maintain a healthy weight range would make an effort to adhere to our intervention. Whether the positive effects of physical activity outcome would persist and be maintained in the long run is beyond the scope of this study. Thus, the need for follow-up is crucial, since many individuals commonly revert to previous habits on completion of an intervention programme. Therefore, education on physical activities and encouragement to perform them need to be continuously provided. Also, the sample was not balanced in terms of gender due to difficulty in recruiting males compared to females, a common trend in the universities in Malaysia and elsewhere (Goldin, Katz & Kuziemko, 2006). Furthermore, the dropout percentage was quite high among males compared to female respondents (male = 16.1%; female = 7.8%). Nonetheless, the strengths of our study are the inclusion of a large sample with adequate randomisation as well as the direct weight measurements. The overall data was also rechecked for consistency by another research assistant for quality control purposes.

CONCLUSION

In conclusion, the NEI package tested has the potential to increase university students' physical activity which could help motivate them to adopt a healthy lifestyle, thus reducing long-term morbidity risk and health

care costs. Providing the information on physical activity particularly among university students is a priority since this group represents future generations who are expected to enjoy a healthy lifestyle, attain an appropriate weight as well as reduce the risks of non-communicable diseases. Delivering MDG 2010 through these three varieties of modes may also have been an effective approach to positively alter their physical activity with minimum manpower and financial resource requirements. Despite the high prevalence of normal-weight undergraduate students, results suggested that university students could benefit from this NEI to maintain their body weight within a healthy range. In addition, due to the shorter period of implementation of the intervention study, it was difficult to examine a change in weight gain. Encouraging a healthy lifestyles and an intervention programme that delivers the latest MDG 2010 should be actively implemented over a longer period of NEI, hence, generating better outcomes in reducing body weight increment in this particular population.

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CONFLICT OF INTEREST

The authors have no conflict of interest or financial relationship relevant to this study.

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