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Relationship Between Physical Activity in Urban Green Space and Dietary Patterns among Obese Children in Kuala Lumpur, Malaysia

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ABSTRACT

In the past three decades, obesity rates affecting children in Malaysia have been rising rapidly, thereby presenting a major public health concern. However, physical activity and diet patterns in green space have been seen as effective environmental components that improve the quality of life. Hence, this study would determine the obesity levels at baseline (phase 1), after 90 days (phase 2) and after 180 days (phase 3). It further aimed to investigate the association of physical activity and diet pattern with the body mass index (BMI) of the respondents. The sample consisted of 12 respondents and this experimental study utilized a questionnaire and a checklist to record the measurements of height and weight by calculating the respondents' physical activity, daily diet, and BMI. The scores were calculated to determine the level of obesity of the respondents by using paired sample t-test and linear regression model to analyze the influence of physical activity and diet patterns on the respondents' BMI. The findings of this study show that there was a significant decrease in the levels of BMI before and after the study as participation in moderate to vigorous physical activities and more intake of fruits and water influence the respondents' BMI. Therefore, this study reveals that physical activity and diet patterns in urban green space can have significant impacts on BMI and also play important roles in reducing childhood obesity.

Keywords: Body Mass Index (BMI), children diet pattern, green space, outdoor physical activity

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INTRODUCTION

The worldwide prevalence of overweight and obesity has more than doubled between 1980 and 2014, with no country achieving success in reducing obesity rates. In 2014,

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an estimated 41 million (6 percent of the world's population) of children under 5 years of age were affected by obesity or overweight (World Health Organization [WHO], 2014). Therefore, it is estimated that 70 million young children will be overweight or obese by 2025 (WHO, 2016). The prevalence is rising continuously and may cause serious complications by reducing the quality of life for children and posing a risk for adult obesity (Davidson et al., 2017; Saneei et al., 2016)

Childhood obesity has been shown to lower children's quality of life as it is associated with insulin resistance, dyslipidemia, and elevated blood pressure, negative self-image, declining degrees of self-esteem associated with sadness, loneliness, and nervousness. Furthermore, it is an influential determinant of adult obesity (Davidson et al., 2017; Saneei et al., 2016). Besides obesity in children, adolescents and adults are associated with a significant reduction in life (WHO, 2014; Ruderman et al., 2013; Tsiros et al., 2009; Zuckerman et al., 2014) and a greater risk of teasing, bullying, and social isolation (Bacchini et al., 2015). It is presumed that dietary intake and physical inactivity in green space are the major causes of obesity. However, in examining the physical and health implications of childhood obesity, some studies have suggested that weight loss through participation in physical activity in green space and diet habits may avert these problems. An archival government report (US Centers for Disease Control and Prevention [CDC], 2004) recommends at least 30 minutes a day of physical activity with a moderate intensity most days of the week and sensible food portion size. Furthermore, the US National Institute of Health Obesity Education Initiative Expert Panel suggests a caloric deficit of 500 kcal to 1000 kcal per day using an individualized dietary strategy, along with 45 minutes of physical activity with moderate intensity for 5 days a week (Foster-Schubert et al., 2012). Although many studies have focused on intervention on obesity, few studies have been conducted on children compared to adults (Summerbell et al., 2009). Findings from studies by Akpinar (2016) and Watson (2014) showed that decreased sedentary behavior and increased physical activity using urban green space were associated with a remarkable decrease in energy intake, percentage of overweight and body fat in children. Hence, living in close proximity to urban green space and contact with it have been shown to reduce childhood obesity rates (Ekkel & De Vries, 2017; Jansson et al., 2016; Sander et al., 2017; Schipperijn et al., 2013; Wolch, 2011). However, Metcalf et al. (2012) claimed that physical activity and intervention with green space had small effects in reducing the body mass index (BMI) of children. The term green space has no universally agreed definition (Yusof & Rakhshandehroo, 2016). Hence, in this study, green space refers to any area or land covered with vegetation or water and it is including the use of parks, gardens, green corridors, playing fields and derelict or vacant land which is vegetated.

A study by Tandon et al. (2016) suggests that physical activity and a healthy diet in early childhood are associated with better cognitive outcomes and obesity prevention in young children. Similarly, James et al. (2015) claimed that a reduction in the number of carbonated drinks consumed was associated with a reduction in the number of overweight and obese children. Another study by Wang et al. (2016) suggests that more frequency of eating can lead to a decreased risk of obesity. Furthermore, Murakami et al. (2016) suggested that a higher snack frequency was associated with overweight and obesity. Additionally, Oda-Montecinos et al. (2013) claimed that diet patterns and eating behavior could contribute to a rapid increase in overweight and obesity levels.

These studies have pointed out obesity as a huge emerging problem and there is a need to investigate this problem especially among children. Therefore, this study aims to determine the impacts of physical activity and diet patterns in urban green space on obesity in children. The results may reveal evidence that green space provides the opportunity for physical activity and can be an important environmental determinant of the health of children.

METHODS

Enrolling of the participants for this study was done through email messages sent randomly to parents within Kuala Lumpur, with the purpose clearly stated as fighting obesity through investigating the association with the frequency of green space visits and diet pattern with childhood obesity in children aged 6-12 years. A total of replies by 18 emails were received from parents indicating their interests and willingness to voluntarily allow their children who were within the age range to participate in the program. A follow up of email messages were forwarded to the parents who had indicated their interests to allow their children to participate in the program. Meetings were also scheduled to brief the parents and their children on the details of the program.

This study comprised three phases: phase 1 at the baseline, phase 2 after 90 days, and phase 3 after 180 days. Anthropometric data were collected from the children at the baseline (phase 1) and after 90 days (phase 2). Initially, parents were requested to fill up a questionnaire with information including demographic data which were recorded. Checklist booklets were issued to the parents to record information on the daily physical activity and daily diet patterns of the children at the baseline and after 90 days. The checklist booklets were used to collect information about the types of food, fruits, snacks, drinks, where these foods were eaten, portion sizes of these meals, types of physical activity, time spent in green space, and the number of time the respondents visited green space a week for the whole study period.

When this study continued to the third phase, a meeting session was held with the parents to collect anthropometric information on the children and the checklist booklets on their diets and physical activities. A flying

disc was given to each respondent as a token of appreciation for participating at the end of the session. For this study, a sample of 12 respondents with 5 male and 7 female obese primary school children aged 6-12 years old were recruited. However, 3 respondents later withdrew from participating in this study.

Measurements

The height and weight of the recruited children were measured according to the International Standard for Anthropometric Assessments (Norton et al., 1996) whereas the body anthropometry measurement was based on the National Health and Nutrition Examination Survey [NHANES] (2017). The height of the respondents was measured with a stadiometer for stature (to the nearest 0.1cm). The stretch stature technique was used to measure the stature and measurements taken in the morning with the head placed in the Frankfort plane position. The bodyweight of the respondents was also measured with a body weighing scale Tinata (HD-314 digital weight scale) to the nearest 0.1kg. The respondents wore light clothes and no shoes with the head held straight following the Frankfort plane position. The respondents' BMIs were then calculated using the standard formulae, issued by WHO (2014). In epidemiological studies, the BMI has been suggested for use due to its simplicity in measurement and correlation with body fat (Himes & Reynolds, 2012). However, the amount of body fat alters with age and differs between boys and girls, the BMI for age percentiles were used to interpret the BMIs of the respondents. Referring to NHANES (2017), the BMI charts on age growth percentiles for boys and girls have taken into consideration the differences and allow the conversion of BMI into percentiles.

Data Analysis

This study utilized the following methods to analyze the data obtained from the anthropometric measurement, questionnaire, and checklists. To achieve the goal of this study, paired sample t-test and ANOVA were used to determine the levels of obesity of the respondents at the baseline, after 90 days, and after 180 days of the experiment. Linear regression was also used to determine the influence of physical activity in urban green space and diet patterns on the respondent's weight at the baseline, after 90 days, and after 180 days**.**

FINDINGS

Obesity Level Among Children Aged 6-12 Years Between the Baseline (phase 1) and After 90 Days (phase 2)

To determine the obesity levels among children aged 6-12 years between the baseline (phase 1) and after 90 days (phase 2), a paired sample t-test was conducted. As seen in Table 1, the total number of respondents was multiplied by 90 days (represented by N in the table). A significant difference was found ($t=5.99$, $p<0.05$) between BMI levels for phase 1 ($M=26.05$, $SD=4.80$) and phase 2 ($M=25.48$, $SD=4.21$). The decrease in the mean BMI difference between the scores of phase 1 and phase 2 was 0.56, as a result of intervention by diet

pattern and frequent use of urban green space by the children. Hence, it can be concluded that the levels of BMI among the children at the beginning of this study and after 90 days decreased significantly, as the p value was 0.00 which was less than 0.5% level of significance. The present findings are supported by several empirical studies which point out that frequent visits to green space and participation in moderate or vigorous physical activity are associated with decreased BMI (Goss, 2003; He et al., 2004; Maas et al., 2009; Potwarka et al., 2008; Monyekil et al., 2012). However, none of these studies consider diet along with green space to be associated with BMI, in contrast to this study where supports diet patterns especially the intake of fruits to be associated with a decrease in BMI (Schroder, 2010).

Association of Children's Diet Pattern and Physical Activity with Obesity After 90 Days (Phase 2)

Linear regression analyses were performed to determine the influence of dietary patterns on the BMI of the respondents after 90 days (phase 2). Based on Table 2, the results from breakfast showed that a significant regression equation ($f(4, 25) = 2.41$, $p=0.02$ with $R^2= 0.27$) was found with an increase in fruit portion which predicted a reduction in BMI of the respondents. The results from lunch indicated that increases in fruit portion ($f(4, 16) = 79.04$, $p=0.04$ with $R^2=0.95$) and drink portion ($f(4, 16) = 79.04$, $p=0.00$ with

Table 1
Levels of BMI among children aged 6-12 years before and after 90 days

BMI	N	Mean	Mean Difference	Std. Deviation	t	Sig. (2-Tailed)
Phase 1	810	26.05	0.56	4.80	5.99	0.00
Phase 2	810	25.48		4.21		

Table 2
Regression model for portions at breakfast, lunch, and dinner (β value) after 90 days (phase 2) (Dependent variable: BMI)

	Breakfast	Lunch	Dinner
(Constant)	30.09 (1.68)***0.00	9.65 (1.70)***	26.66 (3.97)***
Food	0.34 (0.98)	0.81 (0.52)	3.49 (2.41)
Fruit	-2.36 (1.00)**	-0.95 (0.44)**	-0.783 (1.45)
Snack	0.736 (1.40)	-0.88 (0.48)	4.02 (3.12)
Drink	1.07 (0.79)	10.96 (0.66)***	-5.84 (2.53)
R-squared	0.27	0.95	0.49

Note: values in parenthesis are standard error. *, ** & *** denote significance at 10%, 5% & 1% levels respectively.

R^2=0.95) were significant predictors of BMI of the respondents. However, the results from dinner showed no significant predictor influencing the BMI of the respondents. The results of this study are supported by findings of other empirical studies that claim that the intake of fruits was predictive of BMI (Goss, 2003; He et al., 2004; Schroder, 2010). In contrast, a study by Field et al. (2003) found that the intake of fruits and fruit juice was not predictive of changes in BMI with no significant influence between fruit consumption and BMI. Therefore, not all meals can influence BMI but frequent visits to green space can have an influence.

This analysis further explores the influence of time spent in green space and moderate or vigorous physical activity on the BMI of the respondents. The linear regression analysis is presented in Table 3. The results showed that among the covariates, only the vigorous physical activity had a significant influence on the BMI of the respondents (f (3, 65) =3.09, p = 0.00, with R^2=0.10). Other empirical findings on the influence of green space on weight outcomes are mixed and inconsistent. However, the findings of this study are supported by several empirical studies which reveal that green space is positively connected to a higher level of physical activity which consequently could lower BMI (Akpinar, 2017; Giles-Corti et al., 2005; Nielsen & Hansen, 2007; Roemmich et al., 2006). None of these studies investigated the effects of green space and diet on BMI. In contrast, other studies found no statistically significant influence between green space use, the level of physical activity and BMI (Hillsdon, et al., 2006; Hoehner et al., 2005; Maas et al., 2009; Potwarka et al., 2008).

Table 3
Regression model for time spent in green space, moderate and vigorous physical activities after 90 days (phase 2) (Dependent variable: BMI)

Model	β coefficient
(Constant)	31.24
	(1.18)***
Time spent on green space	-0.19
	(0.46)
Moderate activity	-0.09
	(0.44)
Vigorous activity	-1.21
	(0.42)***
R-square	0.10

Note: values in parenthesis are standard error. *, ** & *** denote significance at 10%, 5% & 1% levels respectively

Obesity Level Among Children Aged 6-12 Years After 180 Days (Phase 3)

To determine the obesity level among the children aged 6-12 years after 180 days (phase 3), a one-way ANOVA was done. As seen in Table 4, there was a significant difference in BMI levels for all phases, with F (2, 2427) = 13.63, P=0.00, as the p value was at 0.00, less than 0.5% level of significance, as a result of intervention by frequency of visits to green space and diet pattern. Hence it can be concluded that the levels of BMI for all the phases of this study were significant.

Based on Table 5, the post-hoc comparison using the Turkey HSD test indicated that the difference in the mean scores of BMI levels between phase 1 and

phase 2 (m=0.57, p=0.03) was significant. However, the difference in the mean scores of BMI levels for phase 1 and phase 3 (m= -0.60, p=0.02) was also significant. Furthermore, the difference in the mean scores of BMI levels for phase 2 and phase 3 (m= -1.16, p=0.00) was found to be statistically significant as the p value was at 0.00, less than 0.5% level of significance. These results suggest that diet patterns and visits to green space can reduce the weight of the children. These findings are supported by several empirical studies that frequent visits to green space and participation in moderate or vigorous physical activity are associated with decreased BMI (Maas et al., 2009; Potwarka et al., 2008; Monyekil et al., 2012; Van den Berg et al., 2017). Other studies (Goss, 2003; He et al., 2004; Schroder, 2010) also support the fact that diet pattern especially the intake of fruits is associated with a decrease in BMI.

Table 4
ANOVA table for the level of BMI after 180 days (phase 3)

Source	Ss	df	ms	f-value	Sig-value(p)
Between groups	551.40	2	275.70	13.63	0.00
Within	49085.40	2427	20.22		
Total	49636.80	2429			

Table 5
Post-hoc test for multiple BMI levels between phases

Item	Phase 1	Phase 2	Phase 3
Mean	26.05*	25.48*	26.65*
N	1620		

Note: * indicates significant difference

Association of Diet Pattern and Physical Activity with Obesity After 180 Days (Phase 3)

In the third phase (after 180 days), a linear regression analysis was done to examine the influence of time spent in green space, moderate and vigorous physical activities on the BMI of the respondents. Based on Table 6, the results showed that the time spent on green space was statistically significant on BMI, with f (3,164) =28.10, p= 0.00, and r^2= 0.34. Similarly, moderate physical activity was found to be statistically significant on BMI, with f (3,164) =28.10, p= 0.00, and r^2= 0.34. Vigorous physical activity was also statistically significant on BMI, with f (3,164) =28.10, p= 0.03, and r^2= 0.34, as the p value was less than 0.05 level of significance. Other empirical findings on the influence of physical activity in green space on weight outcomes are varied and inconsistent. However, the findings of this study are supported by several empirical studies which reveal that green space is positively connected to a higher level of physical activity which then lowers BMI

(Akpinar, 2016; Frank, et al., 2004; Giles-Corti, et al., 2005; Roemmich et al., 2006; Nielsen & Hansen, 2007). In contrast, other studies found no statistically significant influence between green space use and the level of physical activity on BMI (Hoehner et al., 2005; Hillsdon et al., 2006; Maas et al., 2009; Potwarka et al., 2008).

Table 6
Regression model for time spent in green space, moderate physical activity, and vigorous physical activity after 180 days (phase 3) (Dependent variable: BMI)

Model	β coefficient
(Constant)	26.68
	(0.68)***
Time spent on green space	1.65
	(0.26)***
Moderate activity	-960
	(0.20)***
Vigorous activity	-1.00
	(0.22)***
R-square	0.34

Note: values in parenthesis are standard error. *, ** & *** denote significance at 10%, 5% & 1% levels respectively.

Linear regression analysis was performed to determine the influence of diet patterns on the BMI of the respondents after 180 days (phase 3). As seen in Table 7, the results for breakfast indicated a statistically significant regression equation for food with $f(4, 34) = 12.05$, $p=0.00$, and $R^2=0.58$, snacks with $f(4, 34) = 12.05$, $p=0.01$, and $R^2=0.58$, and drinks with $f(4, 34) = 12.05$, $p=0.00$, and $R^2=0.58$. These portions were statistically significant predictors of BMI. The results for lunch indicated an increase in only drink portion, with $f(4, 34) = 12.05$, $p=0.00$, and $R^2=0.75$, which was a statistically significant predictor of BMI, as the p value is less than 0.05. However, the results for dinner showed no statistically significant regression equation was found for all covariates to influence BMI. The results of the present findings are supported by several empirical studies that claim that the intake of fruits is predictive of BMI (Goss, 2003; He et al., 2004; Schroder, 2010). In contrast, a study by Field et al. (2003) found that the intake of fruits and fruit juice was not predictive of changes in BMI, with no statistically significant influence between fruit consumption and BMI.

To the best of our knowledge, this study is the first to determine the association of the time spent on physical activity in urban green space and diet pattern with children's obesity in Kuala Lumpur, Malaysia. After investigating the association for the different phases, the results showed a significant association of physical activity in urban green space and diet pattern with children's obesity, demonstrating their definite roles in fighting the epidemic of obesity in children and perhaps adults. Not all meals were found to have positive relationships with BMI, although the majority of the respondents drank plain water and had their meals at home while maintaining considerable food portions throughout the study duration. Furthermore, the results showed that most of the respondents participated in 30 minutes of moderate to vigorous physical activities a day for most days of the week, consistent with the findings by Foster-Schubert et al. (2012).

Table 7
Regression model for portions at breakfast, lunch, and dinner after 180 days (phase 3) (Dependent variable: BMI)

	Breakfast	Lunch	Dinner
(Constant)	20.23 (2.24)***.000	8.95 (1.16)***	12.29 (1.86)***
Food	4.79 (1.14)***	0.74 (1.00)	3.08 (1.73)
Fruit	0.109 (1.06)	1.46 (0.81)	1.84 (1.06)
Snack	-3.22 (1.22)***013	0.50 (0.72)	0.16 (1.77)
Drink	3.08 (0.40)***	7.28 (1.04)***	2.36 (1.42)
R-squared	0.58	0.75	0.33

Note: values in parenthesis are standard error. *, ** & *** denote significance at 10%, 5% & 1% levels respectively.

DISCUSSIONS

In summary, this study is the first to examine and evaluates physical activity and diet pattern using descriptive statistic, it also determined the level of obesity among the respondents at different phases using paired sampled t-test and one-way ANOVA and further determined the association of physical activity and diets pattern of the respondents on their weight in Kuala Lumpur city. The results show that physical activity and diet significantly impact on the respondent's weight during the study. The findings show that more than half of the respondents 54.5% engage in moderate physical activity (brisk walking), less than half of the respondents 39.1% engage in vigorous physical activity (jogging) and less than half of the respondents 39.5% participate in physical activity in green space for (1-2hrs). However, the diet pattern results also show that at breakfast, more than half of the respondents had nasi lemak 54.3%, and majority had apples 62.0% while at lunch majority of the respondents had plain water 71.0%. Nevertheless, at dinner, the findings show that more than half of the respondents had other foods 59.1% and more than half of the respondents drank plain water 53.0%. Additionally, for serving portions at breakfast, the result of the study shows that more than half of the respondents had ½-1cup of food 59.8% and ½-1glass of drink more so the majority of the respondent had 2-3pieces of fruits and snacks 65.4% and 65.1%. Further, at lunch, majority of the respondent had ½-1cup of food 63.6% and 2-3glasses of drinks 62.9% and more than half had 2-3 pieces of fruits 51.4%. Finally, at dinner, the study result shows that the majority of the respondent had ½-1cup of food 61.8%, 2-3pieces of snacks 65.4%, followed by 2-3 glasses of drinks 66.8% and more than half had 1piece of fruits 52.9%.

Hence, the study results show that the majority of the respondents have dinner 72.1% at home and more than half of the respondents have breakfast and lunch at home 57.3% and 58.6 at home. Nonetheless, the findings also show that there was a significant decrease in the level of BMI after the study and participation in moderate to vigorous physical activity, more intakes of fruits and water influence the respondent's BMI. To reduce the rising prevalence of obesity, parents should ensure that their children participate in frequent moderate to vigorous physical activity and should also encourage the intake of more fruits and water along with their meals.

CONCLUSION

Malaysia is known as Asia's fattest country which recorded an increase in its obesity rate according to the national health and morbidity survey of 2015. Physical activities in green space and diet patterns have become the cornerstone of intervention on overweight and obesity. However, to the best of our knowledge, this study provides one of the first findings on the association of physical activity in urban green space and diet pattern with childhood obesity in Malaysia. It reveals that frequent physical activity in green space and diet patterns can significantly affect BMI and further play important roles in reducing childhood obesity. Therefore, the primary schools should be encouraged to conduct courses on physical activity in their curriculum. Parents too ought to encourage children's visits to green space, participate in physical activity and promote the intake of fruits and plain water alongside meals with smaller portions to improve the general health of children. Based on the results of the study, this research team recommends that future studies should consider using different approaches, for examples, pedometer and GPS trackers to record distances and time spent on green space and use a subjective dietary assessment method (with 24 hours of diet recall) to reveal the effectiveness of physical activity and diet pattern in addressing the prevalence of childhood obesity. It is further recommended that other age groups and adults be investigated in longitudinal studies to disclose any casual association.

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