Evidence-Based of Interactive Multimedia-Based Nutrition Education Package Efficacy on Obesity Outcomes Through Game and Video Intervention

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Abstract. This paper presents the effectiveness evaluation of interactive multimedia-based nutrition education package (IMNEP), a game and video-based intervention tool targeting in improving obesity outcomes among obese children. The IMNEP stands for Interactive Multimedia-based Nutrition Education Package which comprise of a digital game namely *MakanSihatSaya* and 6 animated explainer videos, supported with physical activity component using Xbox 360 exergame. The intervention aims at providing the children and parents or caretaker with precise dietary guideline related to childhood obesity and encourage them to practice healthy eating and be active physically. The package was developed based on literature and pilot study, followed by evaluation through a 6-month randomized-controlled trial among obese primary school children in Kota Bharu, Malaysia. Significant improvement in obesity outcomes were evidenced among the children at the end of the trial. In summary, video and game are highly effective modes of intervention, particularly in the prevention and management of obesity problems among children due to their attention-grabbing and engaging features.

Keywords: Obesity · Interactive multimedia · Children · Video-based

1 Introduction

1.1 Background of Research Project

According to the recent National Health and Morbidity Survey, 29.8% of the Malaysian children aged between 5 to 17 years were overweight (15%) and obese (14.8%) [1]. The rate is growing, thus calls for appropriate interventions to improve the healthy eating practice and physical activity status among children. A handful of related studies were carried out to identify the best approaches that deem effective in addressing obesity

among children, ranging from using board game [2], to comic book storytelling [3–5], and even web-based interactive comic [6]. All these studies reported positive impact of intervention on the children's knowledge, attitude, and healthy eating outcomes. However, the new generation which are born as digital natives need intervention that suits their interest the most. We evidenced the popularity of video and game streaming by the younger generation on social media platforms such as YouTube [7], thus the same modes of communication can become an enabler in delivering health-promoting messages to these target population. Previous studies had also demonstrated that computer-assisted instruction or education could improve the nutrition knowledge and results in behavior change among children [8, 9]. Implementation and evaluation of such intervention are still limited in this country, thus, we developed IMNEP, a multimedia nutrition education package which integrates explainer video and education game as possible solution to the obesity problem among school age children in Malaysia. The package development and week 1 evaluation both have been previously published elsewhere [10–12]. This paper will report on the findings of the randomized controlled trial examining the effectiveness of IMNEP on obesity outcomes.

2 Methodology

2.1 Implementation and Evaluation of the Intervention

A 4-arm randomized controlled trial has been conducted involving 139 obese school children from Kota Bharu, Kelantan. The participants were assigned into three intervention groups (**CPI**: Children + Parents Intervention, **COI**: Children only Intervention, **POI**: Parents only Intervention), and one control group (**COC**: Children only Control). They underwent three waves of obesity outcomes measurement at baseline (week 1), post-intervention (week 12) and followed up after withdrawal period (week 24). Only intervention groups received the IMNEP package. The intervention was started soon after the baseline measurements taken. During the intervention period, the CPI group were subjected to watch the explainer videos, play the *MakanSihatSaya* game, and play exergame at school. The parents in POI group are subjected to watch the videos only, and their children will be given access to the tools after the intervention study ends. The children in COI will receive both tools during school session only. The parents of CPI and POI were also contacted either face to face at school or via phone call to identify any problems regarding their child's food habits. A CD-ROM comprised of all the intervention videos and games was then provided to parents in CPI and POI groups for their reference which allowed repeated use of videos and game during their convenient time. This effort further ensures the objectives of this study can be achieved. The children in all intervention groups were also subjected to play exergame at school during physical activity (PA) class. Meanwhile, those in the control group (COC) continued with their normal school activity without any information provided about physical activity, healthy eating, or weight loss throughout the intervention period. However, upon completion of the study period, participants in the COC group were provided with a one-hour video viewing session on healthy eating topics. The flow and retention of the study participants were shown in Fig. 1. Data entry and statistical analyses were performed using IBM Statistical Package for the Social Sciences version 22.0 (SPSS 22.0). Normal distribution of

data was evaluated based on histogram pattern and Kolmogorov-Smirnov test value. A repeated measure ($2 \times 2 \times 2$) analysis of variance (RMANOVA) was used to analyze the effect of the intervention within each group based on time. $P < 0.05$ indicates statistical significance.
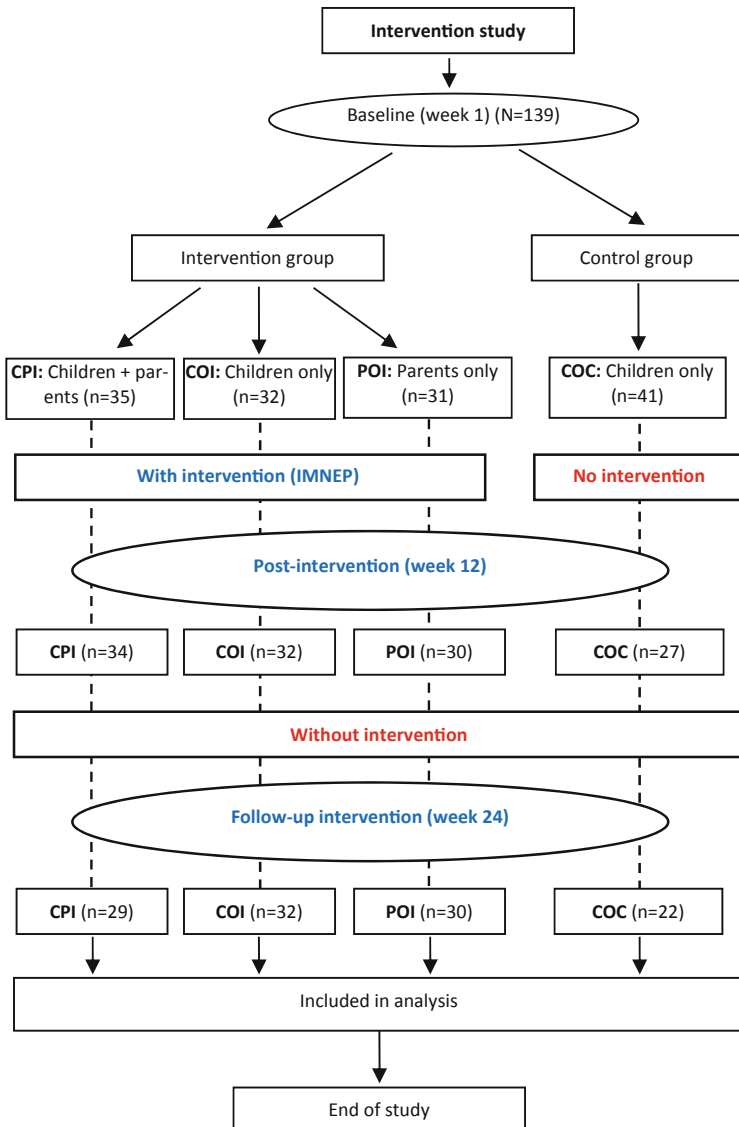

Fig. 1. Study flow and retention of study participant.

3 Findings

3.1 General Characteristics

A total of 2986 Year 5 primary students were screened for obesity status. One hundred and thirty-nine students were finally recruited for the randomized controlled trial. 16.5% and 83.5% of them was in overweight and obese categories based on the BMI z-scores. Most of the children came from families with low household income category [13]. Majority of the parents work either in private or government sectors in Kota Bharu with 48.9% of their children having regular breakfast every day (n = 68). The detailed description on the week 1 characteristics of the participants have been published elsewhere [10]. Out of 139 respondents enrolled at the baseline (week 1), 121 (87.1%) finished the 12-week IMNEP program and 113 (79.1%) completed the whole 24-week intervention trial, with a 20.9% dropout rate - Fig. 1. The remaining 27 students (20.9%) did not submit complete end-line data due to being moved to other schools, being away from school throughout the intervention period and follow-up (2 times consecutively) or refusing to participate due to a busy school schedule.

Table 1. Comparison of obesity outcomes within each group based on time (n = 113).

Measure	Week	CPI (n = 29)	COI (n = 32)	POI (n = 30)	COC (n = 22)
		MD (95% CI) p value	MD (95% CI) p value	MD (95% CI) p value	MD (95% CI) p value
BW (kg)	1–12	0.36 (−0.04, 0.76) 0.094	−0.30 (−0.81, 0.21) 0.439	−0.89 (−1.58, −0.21) 0.007	−0.18 (−0.49, 0.12) 0.411
	12–24	−2.23 (−3.67, −0.79) 0.001	−3.28 (−4.31, −2.24) <0.001	−2.12 (−2.79, −1.45) <0.001	−0.53 (−0.86, −0.20) 0.001
	1–24	−1.87 (−3.38, −0.36) 0.012	−3.58 (−4.73, −2.43) <0.001	−3.01 (−4.13, −1.89) <0.001	−0.71 (−1.13, −0.29) 0.001
BMI	1–12	0.71 (0.37, 1.05) <0.001	0.10 (−0.31, 0.52) >0.950	0.54 (0.13, 0.95) 0.007	−0.05 (−0.25, 0.16) >0.950
	12–24	−0.14 (−0.66, 0.38) >0.950	−0.17 (−0.70, 0.36) >0.950	+0.30 (−0.69, 0.09) 0.187	0.17 (−0.08, 0.42) 0.170

Table 1. (*continued*)

Measure	Week	CPI (n = 29) MD (95% CI) p value	COI (n = 32) MD (95% CI) p value	POI (n = 30) MD (95% CI) p value	COC (n = 22) MD (95% CI) p value
	1–24	0.57 (−0.15, 1.30) 0.162	−0.07 (−0.65, 0.51) >0.950	0.24 (−0.41, 0.89) >0.950	0.12 (−0.02, 0.27) 0.123
FM (kg)	1–12	0.58 (−0.58, 1.75) 0.636	0.57 (−0.59, 1.73) 0.674	0.85 (0.04, 1.65) 0.037	−0.09 (−0.24, 0.06) 0.369
	12–24	−1.22 (−2.89, 0.44) 0.214	−0.69 (−2.01, 0.62) 0.572	−0.67 (−2.00, 0.67) 0.646	−0.31 (−0.44, −0.17) <0.001
	1–24	−0.64 (−2.52, 1.24) >0.950	−0.13 (−1.72, 1.47) >0.950	0.18 (−1.45, 1.81) >0.950	−0.40 (−0.64, −0.16) 0.001
Waist (cm)	1–12	0.64 (−0.66, 1.94) 0.666	0.26 (−1.63, 2.15) >0.950	1.69 (0.32, 3.05) 0.012	−0.24 (−0.59, 0.12) 0.288
	12–24	−4.12 (−5.72, −2.52) <0.001	−0.98 (−2.84, 0.87) 0.563	−2.24 (−3.62, −0.87) 0.001	−0.68 (−0.85, −0.50) <0.001
	1–24	−3.48 (−5.65, −1.32) 0.001	−0.72 (−2.53, 1.08) 0.949	−0.56 (−2.36, 1.25) >0.950	−0.91 (−1.31, −0.52) <0.001
Hip (cm)	1–12	−0.26 (−1.53, 1.02) >0.950	1.40 (−0.16, 2.95) 0.090	2.16 (1.25, 3.08) <0.001	−0.29 (−0.61, 0.03) 0.090
	12–24	−1.10 (−2.85, 0.64) 0.354	−0.97 (−2.49, 0.56) 0.354	−2.79 (−3.98, −1.61) <0.001	−1.25 (−1.61, −0.90) <0.001
	1–24	−1.36 (−3.01, 0.29) 0.134	0.43 (−1.18, 2.04) >0.950	−0.63 (−1.92, 0.65) 0.665	−1.54 (−1.98, −1.10) <0.001

3.2 Effect of IMNEP on Obesity Outcomes

Body Weight (BW). The body weight of the group CPI declined from week 1 to week 12 (MD = 0.36, 95% CI: −0.04, 0.76) before increasing significantly following the intervention (week 12–24) (MD = −2.23, 95% CI: −3.67, −0.79). The other groups steadily gained weight throughout trial (MD = −1.87, 95% CI: −3.38, −0.36). The estimated marginal means plot of body weight throughout trial is shown in Fig. 2(a).

BMI. Based on time, there was a significant difference in mean BMI within each group (F = 11.37, p 0.001). Table 1 shows that only during the intervention period (week 1–12) did respondents in groups CPI (MD = 0.71, 95% CI = 0.37, 1.05) and POI (MD = 0.54, 95% CI = 0.13, 0.95) experience a decrease in BMI (p 0.05). Figure 2(b) shows it clearly in a profile plot.

Fat Mass (FM). Based on time, there was a significant difference in mean fat mass within each group (F = 6.88, p = 0.002). Only during baseline and week 12 (MD = 0.85, 95% CI = 0.04, 1.65; p = 0.037) did POI participants recorded fat mass reductions. Respondents in the COC control group (MD = −0.40, 95% CI = −0.64, −0.16; p = 0.001), on the other hand, experienced fat mass increases from baseline to the end of the study – Table 1 and Fig. 2(c).

Waist and Hip Circumference. There were significant variations in the mean waist (F = 21.49, p < 0.001) and hip (F = 15.48, p < 0.001) circumferences within each group based on time, according to the multivariate test results. Result shows that throughout the intervention period, the waist circumference of the intervention group reduced insignificantly in POI and COI, but significant reduction was observed in CPI (MD = 3.48, 95% CI = −5.65, −1.32) as compared to the control group. In regard to the hip circumference, POI shown a dramatic reduction throughout the intervention (week 1–12) but increased significantly following the intervention period until the completion of the trial (week 12–24), as shown in Table 1, Fig. 2(d) and (e).

4 Discussion

4.1 Impact of IMNEP on Obesity Outcomes

The RMANOVA findings indicated that the IMNEP resulted in significant improvement of BMI among participants in CPI (0.71 kg/m^2 week1–week 12) and POI (0.54 kg/m^2 week 1–week 12) groups; body fat among participants in POI (0.85 kg week 1–week 12) group; and hip circumference among participants in POI (2.16 cm week 1–week 12) group in comparison to the children in COI and COC (without intervention) groups. Active participation from both children and parents could be the reason for the improvement in anthropometric parameters for all groups except COI and COC.

Additionally, waist circumference, which is a highly predictive cardiovascular risk factor [14] reduced significantly (1.69 cm) among participants in POI group during the intervention period (week 1 to week 12). The effect of IMNEP intervention on BMI was rather smaller for COI group than the CPI group, showing the parents' participation was
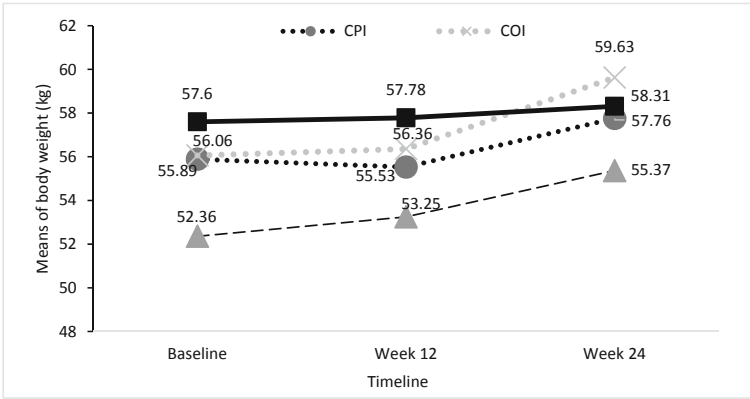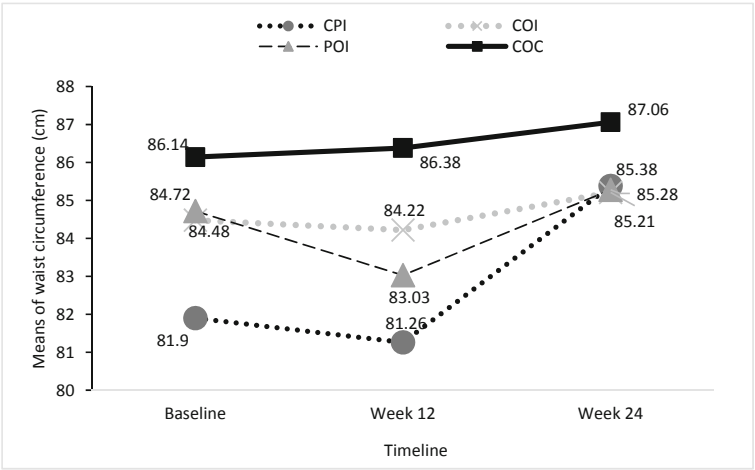
(a)   Changes in body weight (kg)
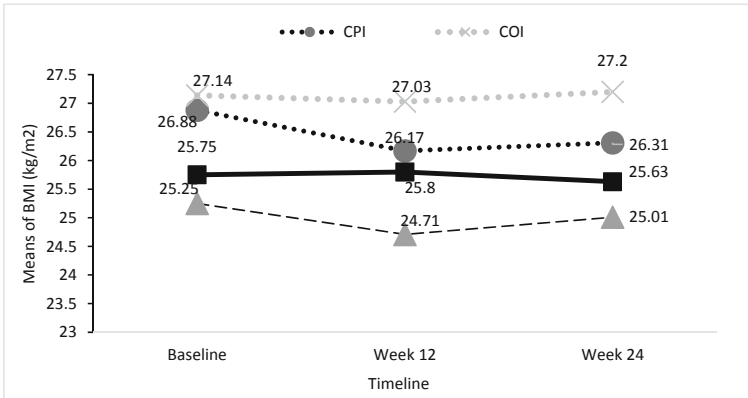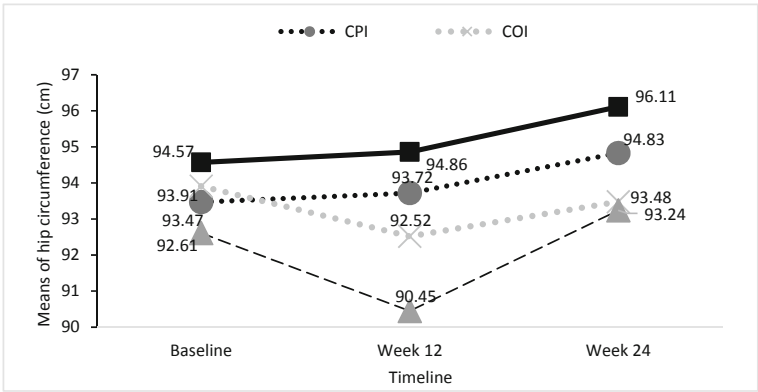

(b)   Changes in BMI (kg/m²)
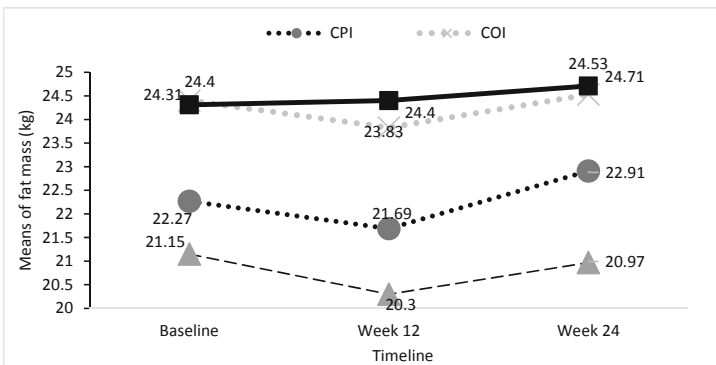
(c)   Changes in fat mass (g)

Fig. 2. Estimated marginal means plot

(d) Changes in Waist Circumference (cm)

(e) Changes in Hip Circumference (cm)

Fig. 2. continued

notably effective in slowing the rate of undesirable weight gain to promote the growth of healthy children [15]. As regards to the time-interaction effect, the profile plot showed that participants in the CPI group experienced a significant decrement of body weight, BMI, fat mass and waist circumference within 12 weeks of the intervention period. Participants in the COI and POI groups portrayed similar reduction pattern except for body weight outcome. A previous study also showed that intervention targeting both parents and children as represented by the CPI group in this study is more effective than intervention focusing only children or without target specified in the treatment of intervention program [16].

Other than that, establishing a well-designed nutrition education program with consistent positive effects on anthropometric measurements is of great public health importance [17]. A multicomponent intervention study which involved modification in dietary intake, increase in physical activity, classroom curriculum focused on healthy eating and lifestyle and family-involvement program was carried out among American Indian school children over three consecutive years [18]. However, this study found no significant reduction in BMI and body fat of the children. This was due to no target was specified for excess body weight participants and the study included all the children at the school. Thus, it is evident that setting up a target population is crucial for significant study outcomes besides designing a well-planned intervention.

In contrast, the body weight increased significantly among participants in the POI within-group analysis from week 1 to week 12 and continuous increment of body weight was observed for all groups including control group from week 12 to week 24. However, participants in the CPI group showed an insignificant decrement in body weight during the intervention period (week 1 to week 12). Another study stated that children grow according to the third percentile with an average height of 5.1–6 cm per year and body weight of 2.5 kg per year until the onset of puberty [19]. Other possible reason could be the limited time available for the intervention (12 weeks). Thus, it was difficult to observe the changes as a reasonable timeline for 5% to 10% weight loss of overweight individuals is between three to six months, with a safe weight loss of 0.5 to 1 kg per week [20].

The findings from this study suggest that parents are highly concern about their children's health. Many previous studies reported a significant reduction in body weight among obese children as affected by healthy eating behavior, increased physical activity, and improved parent-youth relationship [21–24]. Parents play a vital role in nourishing their children with healthy and good quality foods [25]. Parents who are concerned about their children's weight and the associated negative health consequences due to overweight should adopt child-feeding practices [26]. A high BMI during childhood has been associated with coronary heart disease in adulthood [27]. Therefore, parent participation in any interventions could pose positive effects on both parents and their children and results from intervention studies should be considered by relevant authorities for larger-scale nutrition-related educational program implementation for a specific community.

Other positive change noted include the decrease in the number of obese children towards the end of this study. The number of obese children in POI group reduced from 26 to 20 at week 12, whereas the number of overweight children reduced from 10 to

7 at week 24 for intervention groups as compared to control group. The reduction in the number of obese and overweight children was consistent with the reduction in fat mass (total mean change = 0.79 kg) after 12 weeks of intervention which was coherent with findings by Gortmaker et al. [28]. The intervention by the authors over two school years focused on decreasing television viewing time, decreasing consumption of high-fat foods, increasing fruits and vegetables intake, and increasing moderate and vigorous physical activity. Previous research also showed an insignificant reduction in the number of overweight and obese participants below the 1-year duration of the intervention [29, 30]. It is difficult to expect a behavioral change in a short time and in an environment which promotes a sedentary lifestyle [31].

5 Conclusion

The findings from the present intervention study propose the use of Interactive Multimedia Nutrition Education package which include explainer video and game-based strategy to improve the anthropometric status, nutrition knowledge, and enhance children's physical activity. Implementation of such intervention that targets both children and their parents should be encouraged to reduce the alarming rate of obesity cases among children.

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