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# Examining the long-term effectiveness of a culinary nutrition education intervention on children's dietary practices and variety

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ABSTRACT

The study aimed to evaluate the effectiveness of a culinary nutrition education program at a 3-month follow-up, in terms of children's dietary practices and variety. The randomized-controlled trial was conducted among Malaysian children aged 10–11 years, in a school-based setting. The main intervention components include a parent-child session on the home food environment, followed by 5 experiential healthy meal preparation sessions, conducted fortnightly with each session lasting an hour. Dietary data were collected using an adapted guided form, in line with the Malaysian Dietary Guidelines for Children and Adolescents at baseline, post-intervention, and a 3-month follow-up (intervention: n = 41, control: n = 42, drop-out rate: 15.3 %). Overall, the children recruited were mainly from low-to middle-income households (76 %) whose families attained at least secondary or tertiary education (95 %). At the 3-month follow-up, significant group and time interaction effect ($p < 0.001$) revealed that the intervention group consumed whole grains (F-stat = 24.04), fruits (F-stat = 30.45), and vegetables (F-stat = 77.69) more frequently, while the frequency consumption of the control group remained relatively stable over time. Similarly, desirable change was seen favoring the intervention group ($p < 0.001$) for refined grains (F-stat = 30.96), processed foods (F-stat = 49.74), and sweetened beverages consumption (F-stat = 40.78). Further, the intervention group had good diet variety during dinnertime, compared to the controls ($\chi^2 = 5.655$, $p = 0.017$). Findings highlighted the prospect of experiential culinary nutrition programs in advocating healthy eating behavior among children.

## 1. Introduction

A healthy eating pattern is a foundation for optimal health and the prevention of chronic disease. Longstanding data has established that a diet rich in whole grains, vegetables, and fruits, along with an adequate amount of fish, legumes, nuts, seeds, and dairy confers health benefits and provides essential nutrients [1,2]. Hence, numerous dietary guidelines worldwide recommend the consumption of a balanced and varied diet, consisting of wide-ranging nutritionally distinct food groups [3]. In contrast, the excessive intake of energy-dense, nutrient-poor foods such as ultra-processed foods and sugar-sweetened beverages contributed to obesity and poor health outcomes [4]. As such, this unhealthy eating pattern is discouraged, in line with the rising global childhood obesity trend and the prevalent micronutrient malnutrition/hidden hunger among children who consume a calorically-sufficient diet [5,6].

There is good evidence that a healthy eating pattern should be formed in childhood, which could track into adulthood and further affect the various health risks associated [7,8]. However, at an individual level, challenges often arise in the promotion of healthful food groups and the reduction of less healthful foods among children. For instance, it was reported that children did not meet the dietary guideline recommendations for cereals/grains, legumes, fruits, vegetables, fish, and milk/dairy products, irrespective of sociodemographic backgrounds [9,10]. It was elucidated that the challenges in healthy eating could be partly related to children's food pickiness and a taste preference for less healthful foods [11,12]. It seemed logical that building a healthy relationship with foods in childhood by creating a preference for healthy foods in a fun atmosphere would drive healthy dietary practices.

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With regard to this, culinary nutrition education has received attention recently as a promising avenue to improve the nutritional status of children. The potential of culinary nutrition education could be attributed to the experiential approach involving healthful foods. For instance, a systematic review and meta-analysis highlighted that experiential learning strategies were most effective for reducing excessive energy intake, and improving fruit and vegetable preference/consumption and nutrition knowledge [13]. Furthermore, the experiential features and potential drivers of behavior change in culinary nutrition education programs have been described. These involved challenging participants to explore foods through various sensory means, creating an enjoyable experience, accomplishing goals, generating a sense of fulfillment, building positive feelings with peers, improving the home food environment, and enhancing hands-on skills [14].

Encouragingly, various reviews have documented the effectiveness of culinary nutrition education in improving children's attitudes and preferences toward healthy foods, food skills, dietary practices, and weight status [15,16]. Of note, the impact of these culinary nutrition interventions reported was largely focused on developed nations in the United States, and to a lesser extent in Europe, Australia, and Asia (Japan, Korea). In Asia, 1 study conducted in Korea reported desirable outcomes in vegetable consumption, intention, attitude, preference, and self-efficacy [17] while another study in Japan showed improvement in cooking attitude and self-efficacy [18]. Overall, research is needed to determine the applicability of culinary nutrition programs in underexplored regions, particularly the developing nations, as highlighted earlier [19,20]. Moreover, the long-term outcome effectiveness must be assessed given the limited data available as studies often conduct baseline and post-intervention assessments, without longer follow-up periods [21–23]. A culinary nutrition intervention study conducted in Australia demonstrated favorable outcomes in children's knowledge, self-efficacy, and self-control at a 3-month follow-up [24]. However, the results did not correspond to positive changes in most of the dietary behaviors assessed during the follow-up period, except for a higher serving of fruits consumed. The study also reported a trend of increasing fruit and vegetable variety, although these were insignificant, possibly due to the low sample size.

In sum, programs that impart nutrition knowledge through food preparation are now recognized as one of the policy actions that could be integrated to instill healthy eating [25,26], yet much work is required to ascertain the long-term impact, ideally among populations in the developing nations. With regards to this, schools could provide practical and sustainable platforms to reach children [27], yet the implementation should be assessed and contextualized given the varied school systems. Hence, this study aimed to determine the long-term effectiveness of a culinary nutrition education program conducted in Malaysia at 3-month follow-up, particularly in terms of children's dietary practices and variety.

## 2. Material and methods

### 2.1. Study design and participants

The current study was a single-blinded, prospectively registered cluster randomized-controlled trial (RCT) in Kuala Lumpur, Malaysia (IRCT20190626044024N1; https://www.irct.ir/trial/40804). Schools were the allocation unit with a 1:1 ratio and children were the analysis unit. The study included generally healthy Malaysian children aged 10–11 years old who can converse in English or Malay language. Exclusion criteria were those with physical/intellectual disabilities, medical conditions that require clinical care (e.g. cardiovascular diseases), or those with food allergies (e.g. gluten, dairy, or peanut). The exclusions were considered in relation to the different sets of challenges involved, including differing learning abilities, food safety, and health reasons.

The current study has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki). The study protocol was approved by the Medical Research and Ethics Committee [NMRR-18-725-41268, KKM/NIHSEC/P18-815(11)]. In addition, the Ministry of Education Malaysia and Kuala Lumpur Federal Territory Education Department [KPM.600-3/2/3 Jld 45 (91)] granted permission for the study to be carried out in schools. Approval was obtained from the respective principals of the selected schools. Prior to the study commencement, parents were provided with an information sheet and a consent form, while children received an assent form. Only those with parental consent and individual assent were enrolled.

### 2.2. Randomization and recruitment

Initially, one zone was randomly selected out of the 3 major zones in the capital of Malaysia, Kuala Lumpur. Simple random sampling was utilized to select two schools from a list of all public schools in the selected zone. Subsequently, the selected two schools were randomly assigned to the intervention or control groups. Finally, convenience sampling was used to select children for participation. The sample size of the present study was calculated based on the sample size formula for cluster RCT [28] with 80 % power, 5 % level of significance, a minimum difference detectable in children's cooking scores, and standard deviation based on previous culinary nutrition education RCT [29]. To meet the minimum requirement of 60 children, and account for a potential 50 % non-compliance/dropout rate [30], the sample size was increased to 96. Altogether, 98 children agreed to participate with parental consent. At the 3-month follow-up, 83 children completed the assessment, resulting in a 15.3 % drop-out. The drop-out rate was due to involvement in extracurricular activities/competitions, and relocation (Fig. 1).

### 2.3. Intervention

The protocol employed has been described previously [31]. In summary, the culinary nutrition education program was developed and tailored according to the need assessment findings from a cross-sectional study [32,33], focus group discussions among schoolchildren (n = 16), evidence-informed nutritional guidelines, and in line with the social cognitive theory (SCT). Accordingly, an expert panel in children's nutrition (n = 3; 2 nutrition academicians, 1 nutritionist in practice) and children's behavior/psychology (n = 3; 1 psychologist, 1 primary school teacher, 1 parent) made additional revisions to the program modules.

The intervention consisted of 6 sessions, conducted for a 12-week period from August to October 2019. Firstly, the intervention group received 1 introductory session with their parents and subsequent 5 hands-on culinary nutrition education sessions. The 1-h introductory parent-child session centered on the topic of home food environment; comprised of nutrition talk on home food availability, food/kitchen safety, interactive parent-child activity on food labels, healthy meal tasting, and apron fitting. Next, the 5 hands-on practical sessions with children were carried out fortnightly, which lasted 1 h per session. A nutrition lead with food handler certification and several nutrition facilitators conducted the sessions, resulting in a ratio of 1 facilitator for every 5 children. All facilitators were equipped with the module content and trained beforehand to ensure standardized program delivery. The training sessions lasted 1 h for every module, consisting of a briefing on specific objectives, learning outcomes, program flow, explanation of healthy meal preparation tasks, and nutrition education content. Each session focused on one core food group needed for a healthy diet and good health which comprised (a) whole grains, (b) protein foods, (c) vegetables, (d) fruits, and (e) dairy. Every session began with nutrition education delivered in a storytelling format, followed by hands-on healthy meal preparation tasks and lastly, meal tasting.

At the end of every session, children were provided with a healthy meal preparation booklet, a healthy food ingredient, measuring cups, and spoons to encourage their involvement in meal preparation at home. On the other hand, the control group received one 1-h delayed nutrition

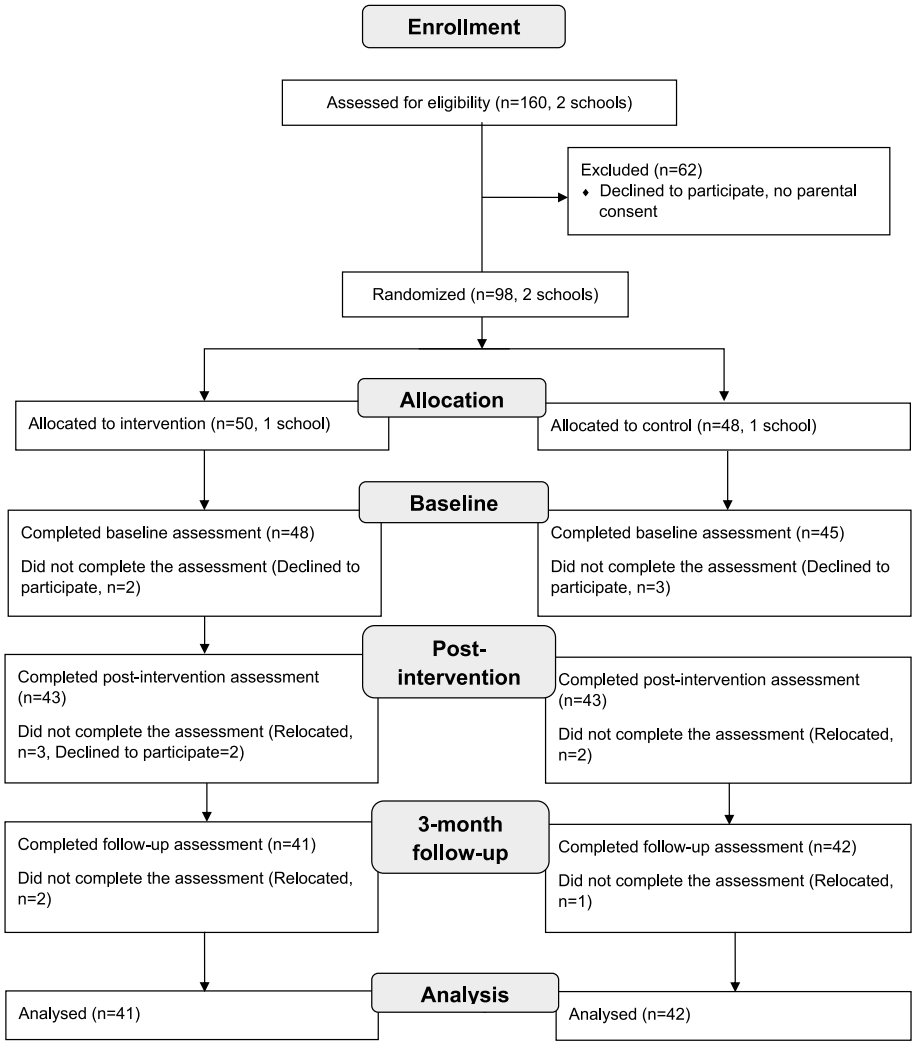


**Fig. 1.** Participants' flow diagram.

education session on healthy meal preparation, and all intervention materials after study completion.

### 2.4. Baseline, post-intervention assessment and 3-month follow-up

The baseline assessment was conducted 2 weeks prior to intervention, followed by a post-intervention assessment conducted after the end of the intervention. Further, a follow-up assessment was conducted 3 months after the intervention. At baseline, children's details (age, sex) were self-reported. Other sociodemographic characteristics such as parental education and monthly household income were assessed via a parents' questionnaire. Children's weight status was determined as per the standard protocol [34]. Height was measured to the nearest 0.1 cm via a portable stadiometer (Seca 213, Germany). Weight was measured to the nearest 0.1 kg using the Tanita Body Composition Analyzer (SC-330, Japan). Children's body mass index (BMI)-for-age z-score was computed using the World Health Organization (WHO)'s AnthroPlus software version 1.0.4 and according to WHO growth reference chart [35]. The main outcome of interest was children's dietary practices, while the secondary outcome included children's dietary variety.

### 2.5. Dietary practices

Children's dietary practices were determined using an adapted guided form [36,37], in view of the Malaysian Dietary Guidelines for Children and Adolescents [38]. Children's dietary practices included two main variables: (a) the frequency of main meal consumption in a week and (b) the frequency of food group consumption in a day. Firstly, children were queried about how often they take breakfast, morning snack, lunch, afternoon snack, dinner, and evening snack/supper, over the course of a typical week. The available response options were "never", "once", "2–3 times a week", "4–6 times a week", and "every day." In addition, the children were asked to specify the food groups they typically include in each meal, such as whole grains, vegetables, fruits, meat/poultry, legumes, fish, dairy, refined grains, processed foods, and sweetened beverages. Visual aids such as pictures and food models were used to assist the children in accurately depicting their meals. To determine the respective food group consumption (measured in the number of times daily), the total number from each food group consumed during children's meals was totaled and averaged.

### 2.6. Diet variety

One of the key messages in the Malaysian Dietary Guidelines for Children and Adolescents is to eat a variety of food groups based on the Malaysian Food Pyramid during main meals [38]. This is crucial to attain sufficient nutrients for good health and to support optimal growth. In the current study, a good dietary variety at main meals (breakfast, lunch, dinner) was defined as the consumption of at least 3 food groups as follows: (a) fruits and vegetables; (b) grains food which

may include rice, noodles, bread, cereal, and cereal products; and (c) protein food which may include meat, poultry, legumes, fish, and dairy (Appendix 1). These 3 food groups were selected on the basis of their importance for children's health in providing essential nutrients [1,2], in accordance with the Malaysian Food Pyramid. Children who met the diet variety recommendation were categorized as having a 'good diet variety', while those who did not were grouped as 'needs improvement'.

### 2.7. Statistical analysis

The data were keyed, cleaned, and checked before further statistical analyses were conducted in the SPSS software (version 20.0, SPSS Inc., Chicago, IL, 2011). Continuous variables were presented as mean [standard deviation (SD)], whereas categorical variables were reported as frequency (percentage). To assess normality, both graphical methods and statistical measures such as skewness and kurtosis (z-scores< 1.96 to indicate normality) were employed. Independent samples t-tests identified the differences between groups for continuous variables. For non-normal continuous data, results were presented as median [interquartile range (IQR)] and analyzed with Mann-Whitney U tests. Chi-square determined the independence of categorical variables. Results were analyzed between the intervention and control groups in terms of the trend in individual study variables across three time points from baseline to post-intervention and a 3-month follow-up. Analysis was conducted using mixed method repeated measure analysis of variance (ANOVA) and controlled for respective baseline values to determine the interaction of group x time across baseline, post-intervention, and 3-month follow-up [reported in mean (standard error) and partial eta squared, $\eta^2$). The assumption of mixed method repeated measure ANOVA (homogeneity of covariance matrices, homogeneity of variance, and sphericity) was tested. Results were presented using Huynh-Feldt Epilson if the assumption of sphericity was not met. The p-value of <0.05 was set as statistically significant.

## 3. Results

Table 1 displays children's characteristics at baseline. Children in the study were fairly distributed in terms of sociodemographic characteristics; with a slightly greater portion in those aged 11 years [intervention: n = 24 (58.5 %), control: n = 28 (66.7 %)], females [intervention: n = 27 (65.9 %), control: n = 24 (57.1 %)], from low-to middle-income households [intervention: n = 32 (78.1 %), control: n = 31 (73.8 %)], and those whose families attained at least secondary education or higher [intervention: n = 39 (95.1 %), control: n = 40 (95.2 %)]. The majority of the children had normal BMI z-score [intervention: n = 29 (70.7 %), control: n = 24 (57.1 %)]. As for children's dietary practices, there was no significant difference in meal frequency and food group consumption between groups at baseline, with the exception of processed foods (p = 0.006) and sweetened beverages consumption (p = 0.010).

The effects of group across the three time points-baseline, post-intervention, and follow-up, controlled for respective baseline data were displayed in Fig. 2. Significant group × time interaction effect (p < 0.001) revealed that the intervention group consumed whole grains, fruits, and vegetables more frequently, while the frequency consumption of the control group remained relatively stable over time. In addition, the intervention significantly (p < 0.001) reduced the frequency consumption of refined grains, processed foods, and sweetened beverages while the control group did not show favorable improvements throughout the three time points. On the other hand, food groups such as meat/poultry (p < 0.001), fish (p = 0.023), and dairy (p = 0.431) demonstrated generally small effect size with minimal change in the frequency consumption.

In terms of diet variety, we found no significant difference in breakfast and lunch between both groups at baseline and follow-up (Fig. 3). Likewise, at dinnertime, chi-square showed no significant difference between groups at baseline (p = 0.099). However, at follow-up, more participants in the intervention group had good diet variety than expected, as compared to the control (p = 0.017)

**Table 1**
Children's characteristics at baseline (n = 83).

| Variables | Intervention (n = 41) | Control (n = 42) | p-value |
|---|---|---|---|
| Age (years) | | | 0.444 |
| **10** | 17 (41.5) | 14 (33.3) | |
| **11** | 24 (58.5) | 28 (66.7) | |
| Sex | | | 0.415 |
| **Male** | 14 (34.1) | 18 (42.9) | |
| **Female** | 27 (65.9) | 24 (57.1) | |
| Monthly household income[a] | | | 0.050 |
| **Low (≤ MYR 2500)** | 20 (48.8) | 10 (23.8) | |
| **Middle (MYR 2500-RM5500)** | 12 (29.3) | 21 (50.0) | |
| **High (> MYR 5501)** | 9 (22.0) | 11 (26.2) | |
| Education level[b] | | | 0.145 |
| **Primary education** | 2 (4.9) | 2 (4.8) | |
| **Secondary education** | 18 (43.9) | 10 (23.8) | |
| **Tertiary education** | 21 (51.2) | 30 (71.4) | |
| BMI z-score[c] | | | 0.434 |
| **Underweight** | 3 (7.3) | 4 (9.5) | |
| **Normal** | 29 (70.7) | 24 (57.1) | |
| **Overweight/Obese** | 9 (22.0) | 14 (33.3) | |
| Meal frequency (times/week)[d] | | | |
| **Breakfast** | 2.50 (4.50) | 5.00 (4.50) | 0.764 |
| **Lunch** | 7.00 (2.00) | 7.00 (2.00) | 0.671 |
| **Dinner** | 7.00 (0.00) | 7.00 (2.00) | 0.234 |
| Food group consumption (times/day)[d] | | | |
| **Whole grains** | 0.72 (1.86) | 0.14 (1.25) | 0.175 |
| **Refined grains**[e] | 3.02 ± 0.92 | 3.10 ± 0.80 | 0.680 |
| **Vegetables** | 1.00 (1.75) | 1.39 (1.29) | 0.553 |
| **Fruits** | 1.43 (1.50) | 1.60 (2.55) | 0.880 |
| **Meat/poultry**[e] | 2.02 ± 1.11 | 2.18 ± 1.29 | 0.533 |
| **Legumes** | 0.00 (0.00) | 0.00 (0.09) | 0.536 |
| **Fish** | 0.71 (1.47) | 1.00 (1.73) | 0.800 |
| **Dairy** | 1.00 (2.25) | 0.71 (1.85) | 0.305 |
| **Processed foods**[e] | 2.64 ± 1.18) | 3.32 ± 1.02 | 0.006[f] |
| **Sweetened beverages**[e] | 1.42 ± 1.23) | 2.21 ± 1.50 | 0.010[f] |

Data reported as n (%) and analyzed using the chi-square test of independence unless stated.
[a] According to the Department of Statistics Malaysia 2014, 1 USD = MYR4.68 (accessed on September 25, 2023).
[b] Highest education level attained by an adult in the household.
[c] Based on the Freeman-Halton test.
[d] Data reported in median (IQR) and analyzed with Mann-Whitney *U* test.
[e] Data reported in mean ± SD and analyzed with independent samples *t*-test.
[f] p significant at <0.05.

## 4. Discussion

The present study aimed to identify the long-term effectiveness of a culinary nutrition education program in terms of children's dietary practices and diet variety 3 months after the end of the intervention. To the best of our knowledge, there remained inadequate studies that evaluate the long-term outcomes of a hands-on healthy meal preparation program among children. Other outcomes of interest at post-intervention and 3-month follow-up, including children's weight status, home food availability, psychosocial factors (knowledge, attitude, practice, self-efficacy) toward healthy meal preparation and food groups consumption (post-intervention data) have been described elsewhere [39,40].

In the current study, we found that there were beneficial outcomes in children's increased frequency consumption of healthful foods, along with a reduction in less healthful foods, even 3 months after the intervention. Similar to culinary interventions conducted in other countries and populations [20,41–43], it is likely that the intervention features involving experiential and active learning led to positive outcomes in behavioral determinants, particularly cognitive-related factors, and

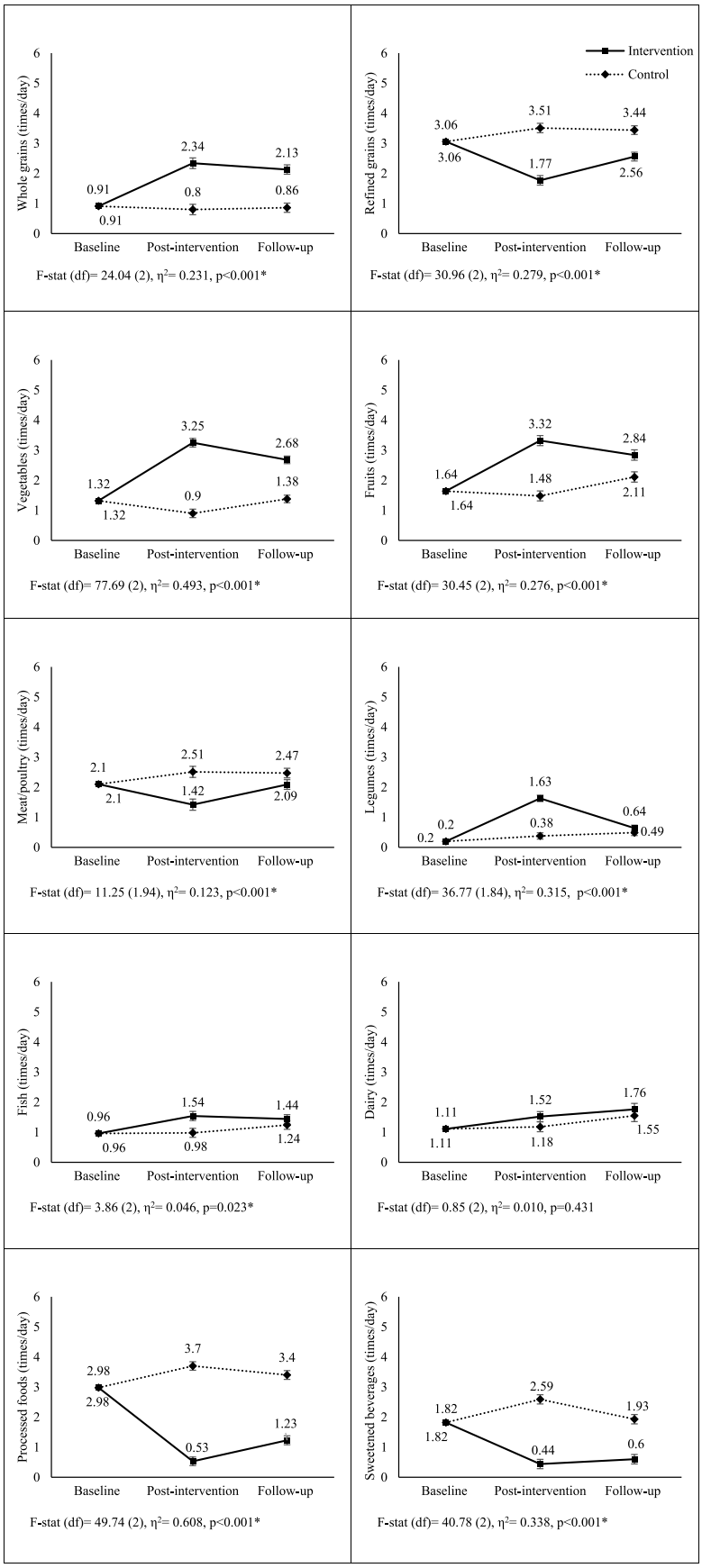


**Fig. 2.** Interaction effect (time x group) on children's food group consumption (n = 83).

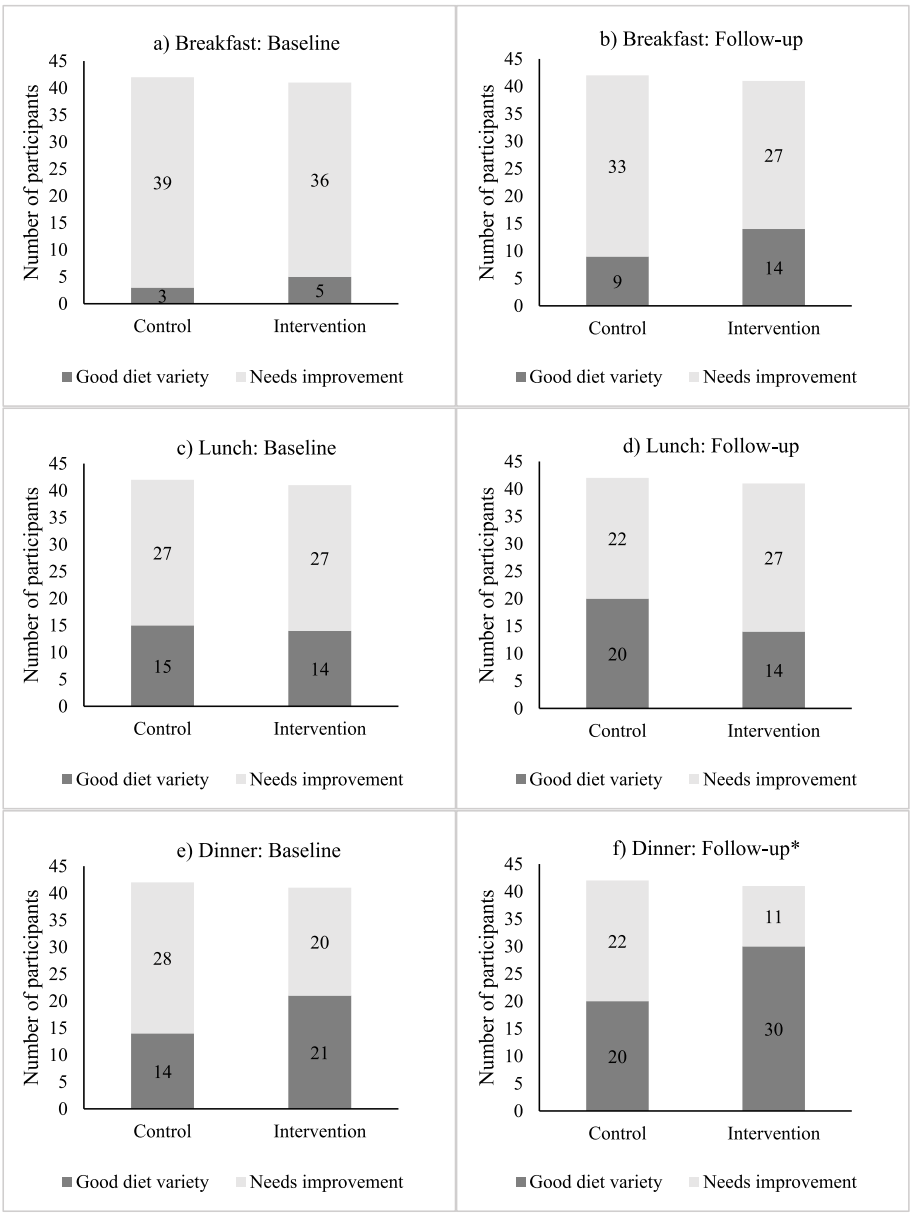


**Fig. 3.** Diet variety at main meals among intervention and control groups at baseline and follow-up. a: $p = 0.436$, $\chi^2 = 0.608$; b: $p = 0.196$, $\chi^2 = 1.675$; c: $p = 0.881$, $\chi^2 = 0.022$; d: $p = 0.094$, $\chi^2 = 2.809$; e: $p = 0.099$, $\chi^2 = 2.722$; f: $p = 0.017$*, $\chi^2 = 5.655$. *p significant at <0.05.

these resulted in behavioral change related to dietary choices. For instance, a recent culinary nutrition program in Spain reported beneficial changes in children's food phobias, knowledge, and beliefs, as well as diet quality measured by adherence to the Mediterranean diet at post-intervention [44]. Another meal preparation program conducted in Canada demonstrated increased familiarity and preference for foods that are often regarded as unpopular among children, at a 2-week follow-up period [45]. Additionally, the previous study also demonstrated a significant increase in the number of children who learned to prepare balanced meals on their own, along with parental-reported data of a greater healthy meal consumption among the children. It seems that the concept of hands-on learning involving food drives the process of behavior change among children [14]; from the initial introduction of various healthy foods, exploration, skill building, excitement, liking, and acceptance/success which are reinforced with support from peers as well as parental/family engagement.

Of note, we found limited changes in children's frequency consumption of foods such as meat, poultry, legumes, fish, and dairy during the follow-up period. The findings could be attributed to the study intervention focus, whereby most of these foods were merely included in the nutrition education sessions, but not in the hands-on meal preparation sessions. While fruits, vegetables, whole grains, and ultra-processed foods are often the emphasis in nutrition intervention programs [46], the importance of other food groups such as protein-rich foods cannot be overlooked, as the combination of these foods forms a balanced and healthy diet [47]. Nevertheless, we note the limitation of assessing the frequency consumption of foods rather than actual intake in the present study, thereby precluding the identification of any change in serving sizes, or whether children have already met the recommended serving size for some of these food groups even at baseline. For instance, national data has demonstrated that Malaysian children have achieved the dietary recommendation for the meat/poultry group, though improvements are needed for other food groups such as legumes, fish, and dairy [9]. Therefore, future research should address this by firstly, targeting these food groups in the hands-on learning session and exploring whether experiential learning can improve cognitive-related factors and

actual behaviors associated with the specific food groups, ideally through the assessment of dietary intake in terms of serving size or weight in grams.

Furthermore, the present study findings showed the potential of a culinary nutrition education program in improving diet variety at mealtimes. As highlighted earlier, it would be advantageous to include parental involvement since they had the autonomy to nurture positive dietary practices and were considered the gatekeepers to the home food environment [41,48]. Furthermore, observational studies in Malaysia have consistently highlighted that components of feeding practices and parenting styles could influence children's upbringing and health-related factors in terms of weight status. For instance, parents with overweight/obese children tend to perform an indulgent parenting style, apply less pressure to eat, perceive less feeding responsibility, and reduce monitoring of their children [49–51]. Such findings concur with the crucial role parents can hold in affecting children's outcomes. In the current study, the improvement in diet variety at dinnertime could be attributed to the positive change in both children's motivations coupled with parents' encouragement. Interestingly, we observed that among all main meals, only dinner showed a significantly greater number of children who had a good diet variety. One possible explanation could be related to the nature of meals, of which families were more likely to have additional time and flexibility over meal decisions for dinner. Correspondingly, among all meals, dinner is often targeted in interventional studies as an avenue to increase family meals and overall diet [52–54]. On the other hand, breakfast and lunch could be limited by time and location/food environment related to work, school, and after-school activities.

While we did not assess the type and nature of meals consumed, whether meals were home-cooked, takeout, and/or eaten with family, past studies have shown that culinary nutrition education has the potential to reduce the consumption of meals prepared away from home [53]. On the other hand, another culinary nutrition intervention study reported insignificant change in the frequency of family meals, though the findings could be limited by the high portion of families who already had frequent dinners together at baseline [55]. Overall, our findings suggest that culinary nutrition intervention can be feasible to promote a balanced diet consisting of vegetables/fruits, grains, and protein foods. The results hold importance because eating a varied diet containing all the essential food groups at main meals will likely contribute to a better overall eating pattern.

### *4.1. Strength, limitations, and future research*

In sum, we have shown that experiential culinary nutrition education has the potential to promote healthy eating among children through improvement in drivers of behavior change including knowledge, attitude, practice, and self-efficacy towards healthy meal preparation, their environment (home food availability) as reported elsewhere; and in current work, actual behavior in terms of dietary practice and variety. To the best of the authors' knowledge, the current study was one of the first few to explore the long-term effectiveness of a hands-on culinary nutrition education up to a 3-month follow-up period and among children in a developing nation, particularly in an Asian context. Study findings are important given the limited data in such population, thereby extending the potential approach of culinary nutrition education in promoting healthy eating pattern to children of different backgrounds. However, the current study has limitations to note. First, dietary practices and variety were self-reported and thus, may introduce recall and social desirability bias to the results. However, we used appropriate prompts and ensured confidentiality to children during data collection, minimizing possible bias. In addition, the frequency of various food group consumption and diet variety provided information on the overall eating pattern. Yet, the method was inadequate to determine portions/serving sizes, specific cooking methods, and nutrient intake. Hence, future studies may consider assessment methods that can allow the estimation of dietary intake. Besides that, we recommend a longer follow-up period and preferably, with short refresher courses in order to fully evaluate the effect of similar interventions. Lastly, the results should be interpreted with caution, as the study was conducted only among Malaysians aged 10–11 years old.

## 5. Conclusion

In conclusion, the current study presented the effectiveness of a culinary nutrition education program in increasing the frequency consumption of healthful foods, reducing the consumption of less healthful foods, and improving diet variety at dinnertime, up to 3 months post-intervention. We extended the current literature by highlighting the prospect of an experiential culinary nutrition program in advocating healthy eating behaviors among children from a developing nation, which can be effective in the long run. With the promising outcomes of culinary nutrition interventions as reported in various populations, similar programs deserve implementation in schools ideally with the support of the government and other related stakeholders.

## Data availability statement

Study data are available from the corresponding author upon reasonable request.

## Conflict of interest disclosure

None.

## CRediT authorship contribution statement

**Choon Ming Ng:** Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. **Satvinder Kaur:** Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Supervision, Writing – review & editing. **Hui Chin Koo:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Firdaus Mukhtar:** Conceptualization, Methodology, Supervision, Writing – review & editing.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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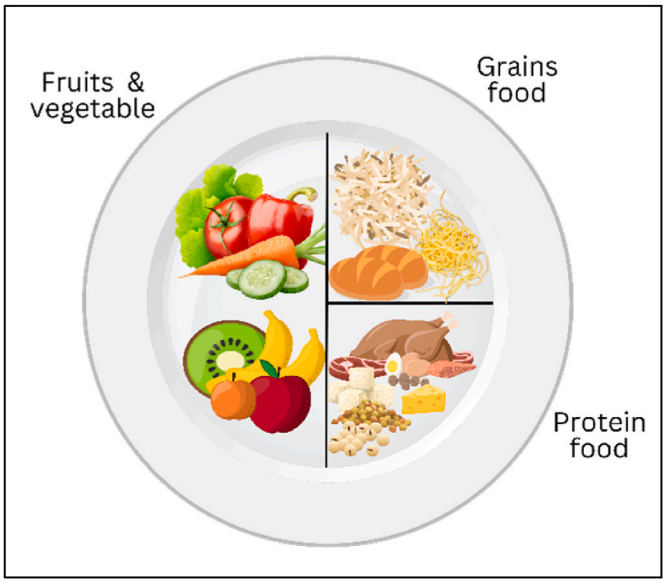
## Appendix 1

Diet variety at main meals.

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