CHANGES IN SUGAR, SALT, AND FAT CONSUMPTION PATTERNS THROUGH ONLINE NUTRITION EDUCATION

Dina Rahayuning Pangestuti[1], Trias Mahmudiono[2], Rahayu Indriasari[3], Naintina Lisnawati[1] and Alfi Fairuz Asna[1]

[1]Department of Public Health Nutrition, Faculty of Public Health, Universitas Diponegoro, Semarang, Indonesia; [2]Department of Nutrition, Faculty of Public Health, Universitas Airlangga, Surabaya, Indonesia; [3]Department of Nutrition, Faculty of Health Hasanudin University, Makassar, Indonesia

Abstract. Online media are potentially useful teaching resources, especially for students studying from home during the coronavirus disease (COVID-19) pandemic. Previous research found that this method can improve understanding of the material other than the face-to-face method. This study evaluated whether online nutrition education could influence the sugar, salt, and fat diet of elementary school students. Semarang City served as the site of this experimental study. Participants in this study were given a weekly online nutrition education intervention for eight weeks. Based on the inclusion and exclusion criteria, 100 students were randomly selected and divided into two groups, so that 45 students remained until the end of the study in the control group, while the intervention group had 39 students. Data on general characteristics, self-reported anthropometry, sugar, salt, and fat eating patterns, and variables influencing social media use, were gathered. The data were analyzed through descriptive, bivariate, and multivariate analyses. In this study, students used YouTube more often (83.7%) than other social media platforms. The intervention caused a shift in the students' dietary patterns. The scores of fried food consumption in both groups and sugary food consumption in the control group varied before and after the interventions. There was no difference in the delta scores between the intervention and control groups; however, it was 4.1 times harder for female students than for male students to change their eating habits. Even though there was no significant difference between the two groups, online nutrition education could alter high-sugar and high-fat diets.

Keywords: sugar-salt-fat intake, eating pattern, online, nutrition education, students

Correspondence: Dina Rahayuning Pangestuti, Faculty of Public Health, Universitas Diponegoro University, Jl. Prof. Sudarto, SH, Tembalang, Semarang, Indonesia
Tel: +62 81328308026 E-mail: dinapangestuti@lecturer.undip.ac.id

INTRODUCTION

The World Health Organization (WHO) argues energy imbalance between calories taken and calories expended mainly causes obesity and overweight. Globally, people consume more calories from fats and sugary foods while exercising less. Trends in sedentary work, changes in transportation, and urbanization may trigger changes in dietary patterns. However, policies related to health, agriculture, transportation, urban planning, the environment, food processing, distribution, marketing, and education are not lacking and lead to unstable changes in diet and physical activity (WHO, 2022).

The number of overweight or obese individuals in the world increased (Mazidi *et al*, 2018; WHO, 2022). Obesity was prevalent in 15-year-old Indonesian adolescents (MOH RI, 2019). High pre-pregnancy body mass index (BMI) of mothers, cigarette exposure in the prenatal stage, excessive gestational weight gain in mothers, as well as high and fast infant birth weight gain are risk factors for obesity in childhood (Woo Baidal *et al*, 2016). Some studies found other risk factors such as gestational diabetes, child receiving care in day care, weak emotional bond between mothers and infants, low socioeconomic status, reduced infant sleep, inappropriate bottle use, consumption of solid food before four months of age, and antibiotic exposure among infants (Woo Baidal *et al*, 2016).

There is no evidence for a hypothesis that child obesity was a standalone risk factor for adult blood lipid status, insulin levels, metabolic syndrome, or type-2 diabetes. The lower end of the BMI range in infancy is also associated with obesity in adulthood, and child BMI and metabolic factors show weak negative associations (Lloyd *et al*, 2012). The transition from childhood to adulthood is influenced by various factors, such as the

consumption of healthy food, lifestyle, and BMI control (Kansra *et al*, 2021). Considering this issue, WHO advises individuals to reduce salt, sugar, and fat consumption to avoid obesity. The WHO's program of obesity prevention is aimed at planning dietary health services and evaluating the initiatives taken (WHO, 2012; WHO EURO, 2013).

In the last couple of years, students have faced learning challenges due to the COVID-19 pandemic. They utilized social media and the internet frequently. In Thailand, the proportion of students who drank tea or coffee with milk and sugar during online learning increased during the pandemic. Skipping breakfast and drinking sugary beverages more frequently were substantially connected with increased online learning duration (Chusak *et al*, 2022). On the other hand, social media may also be a great tool for controlling dietary habits despite many concerns about the negative aspects (Brug *et al*, 2005). According to the findings of a study conducted on Hong Kong students, online learning satisfaction and preferences in students are determined by the techniques and appreciation of teachers during learning, which creates excitement during online learning. Students in grades 3 to 6 are more satisfied with online learning than students in grades 1 and 2 (Zheng *et al*, 2022). A review of the efficacy of online education in the United States discovered no difference in efficacy between online and face-to-face education, even in studies with large samples and random assignment experimental designs. An online learning environment with adequate facilities, easy two-way communication, and instruction suited to students' needs improved effectiveness (Means *et al*, 2009). This study, therefore, analyzed how online nutrition education could be valuable for controlling sugar, salt, and fat intake to prevent obesity in childhood, especially among Indonesian students.

MATERIALS AND METHODS

The design of this study was a quasi-experimental. This study was carried out in Semarang City between October and November 2021 when public activities were restricted due to the COVID-19 pandemic. Four primary

schools willing to participate were enlisted for this study. The recruited students were aged 10 and 12 years and they had to obtain consent from their parents before participating in this study. Only students who met the criteria were included as the research participants. The criteria were having the ability to access the internet and social media, read questionnaire questions and provide answers. A total of 100 students were selected randomly, and 49 students were in the control group while 51 students in the intervention group. At the end of the study, there were 32 students in the control group and 45 students in the intervention group. The sampling protocols of the study have been described in previous publications (Mahmudiono *et al*, 2021) and the ethical feasibility of this study was approved by the Health Research Ethics Committee Universitas Airlangga School of Medicine (No. 98/EC/KEPK/FKUA/2021).

The interventions consisted of eight weeks of regularly scheduled nutrition education on an online platform with a module and report cards on sugar, salt, and fat intakes, and facilitators who had received training in nutrition education taught the class. In this study, the control group received two education sessions about food safety that were different from the topics presented to the intervention group. Documentations were taken from students' literacy competency in Indonesian, self-reported nutritional status (BMI/age), social media preferences, frequency of social media use, and dietary habits related to sources of sugar, salt, and fat. Data reporting on student weight and height comes from self-measurement at home assisted by parents and ensures that they have valid weight and height measurement equipment at home. Nutritional status was categorized based on the WHO's classification of z-score for children aged 5-19 years, greater than +1 standard deviation (SD) for overweight, greater than +2SD for obesity and lesser than -2SD for thinness (de Onis and Lobstein, 2010).

We assessed them by assigning a score of 0 to 4 in contrast to their eating frequency to see a clearer distinction in food consumption patterns. The score of eating pattern is captured through their consumption in a week, where the maximum value is 4 if students never consume and zero if they eat every day. The total score ranged from 0 to 12 from fried, savory, and sweet

food consumption. Fried foods are all foods cooked by frying in vegetable oil, while foods that are dominated by salty or savory flavors are tasted by students and packaged food products with high salt content labels that have been informed during education are defined as salty or savory foods. Foods with a sweet taste and based on labels on food packaging containing sugar are referred to as sweet foods. So that students who get high scores are those who less frequently eat fried foods, salty and sweet foods. The general characteristics and consumption patterns of the students were described. Afterward, the Wilcoxon test was performed to evaluate the intervention effect, and logistic regression analysis was used to determine the variables with the greatest impact on changes in the consumption pattern scores. The significance level of the applied tests was determined using a *p*-value of 0.05.

RESULTS

The general characteristics and nutritional quality of the two groups did not significantly differ before the intervention. Almost 40% of the total students were initially overweight and obese (Table 1), and some students were malnourished. During the pandemic, students faced online schooling and a few days a week for limited face-to-face learning. Their daily physical activity, diet, and lifestyles before and during the pandemic were different.

Most students consumed sugary and savory food 1-2 times a day and fried foods around 3-4 times a day. There was no difference in the consumption of sugary, savory, and fatty food between the intervention and control groups before the intervention. After the intervention, their eating habits changed. About half of total students reduced consuming fried food from 3-4 times a day to 1-2 times a day (50.6%), and more than half of them less consumed sugary and savory food and beverages to once or twice daily. Before and after the intervention, the two groups showed different scores in the consumption of fried food, and the control group also showed a decrease in sweet food consumption (Table 2). However, there was no difference in the delta scores of the intervention and control groups.

Table 1

Baseline characteristics of students

Variables	Control (N = 49)			Intervention (N = 51)			Total (N = 100)		
	n (%)	Mean ±SD	Median (min, max)	*n* (%)	Mean ±SD	Median (min, max)	*n* (%)	Mean ±SD	Median (min, max)
Male	22 (44.0)			21 (42.0)			43 (43.0)		
Female	28 (56.0)			29 (58.0)			57 (57.0)		
Weight (kg)		38.5±9.1	38.0 (25.0, 63.0)		36.7±9.9	35.5 (21.0, 70.0)		38.4±10.7	37.0 (21.0, 78.0)
Height (cm)		141.4±7.8	140.0 (128.0, 161.0)		142±10.5	140.0 (120.0, 178.0)		141.5±8.3	140.0 (125.0, 164.0)
Z score-BMI/age		0.52±1.52	0.24 (-2.99, 3.89)		0.58±1.42	0.48 (-2.99, 2.94)		0.55±1.46	0.38 (-2.99, 3.89)
Nutritional status:									
Normal	28 (57.1)			27 (52.9)			55 (55.0)		
Overweight	10 (20.4)			12 (23.5)			22 (22.0)		
Obese	9 (18.4)			8 (15.7)			17 (17.0)		
Thin	2 (4.1)			4 (7.8)			6 (6.0)		
Literacy competency		93.3±5.5	94.0 (80.0, 100)		90.3±6.8	91.0 (70.0, 100)		91.8±6.4	92.5 (70.0, 100)

BMI: body mass index; max: maximum; min: minimum; SD: standard deviation

Table 2

Score comparison of fried, savory, and sweet food consumption before and after intervention

Types of food	Intervention (n = 45)		Control (n = 32)	
	Before	After	Before	After
Fried food				
Mean ±SD	2.2±1.1	2.7±0.8	1.9±0.9	2.5 0.8
Median (min, max)	2 (0, 4)	3 (0, 4)*	2 (0, 3)	3 (0, 4)*
Salt and savory food				
Mean ±SD	2.6±0.9	2.7±0.9	2.5±1	2.7±0.9
Median (min, max)	3 (0, 4)	3 (0, 4)	3 (0, 4)	3 (0, 4)
Sweet food				
Mean ±SD	2.4±1.2	2.7±1	2.5±1.1	2.9±0.8
Median (min, max)	3 (0, 4)	3 (0, 4)	3 (0, 4)	3 (1, 4)*
Total score				
Mean ±SD	7.2±2.2	8.1±2	6.8±2.2	8.1±1.6
Median (min, max)	8 (2, 10)	8 (0, 11)*	7 (2, 10)	8 (3, 11)*
Delta score (total score post-pre)				
Mean ±SD		0.8±2.5		1.3±2.3
Median (min, max)		1 (-9, 6)		1 (-4, 6)

*Significantly different when p<0.05, Wilcoxon test

max: maximum; min: minimum; SD: standard deviation

Table 3
Factors associated with changes in salt, sugar, and fat consumption patterns among students

Variable	B	SE	p-value	Exp (B)	95% confident interval for Exp
Intervention	0.411	0.565	0.447	1.509	0.329-2.370
Sex*	1.408	0.603	0.020	4.087	0.753-5.455
Nutritional status	-0.423	0.610	0.489	0.655	0.404-3.061
Constant	-22.170	13,661.381	0.999	0.000	

*Significantly different when $p<0.05$
B: coefficient; Exp (B): exponential coefficient; SE: standard error

Gender was identified as the primary factor in a multivariate analysis that influenced the variations in consumption scores. It was typically 4.1 times harder for female students than for male students to alter their food consumption habits according to the logistic regression equation model which had a 76% accuracy rate.

DISCUSSION

Prior research was conducted to study improvement in knowledge about healthy diet through education. In China, a regular diet curriculum for elementary school students was an effective way to lower salt intake for both the children and their families (He *et al*, 2015). A review study revealed that worldwide consumption of sweetened beverages rises, and this is a significant factor in both child and adult obesity (Ponzo *et al*, 2021). Given the need for energy and the micronutrients that are soluble in fat for growth, reasonable fat intake is still needed. When saturated fatty acids are replaced with polyunsaturated fatty acids, this leads to a significant decrease in total cholesterol, Low-density Lipoprotein (LDL) cholesterol, or both. On the other side, increasing fat intake might also raise trans-fatty acid intake. If not controlled properly, it encourages the accumulation of abdominal fat, which leads to weight gain (Jawaldeh and Al-Jawaldeh, 2018).

In addition to providing sustainable health education through a regular curriculum, educational facilities, and a conducive-school environment, it is necessary to increase student knowledge about food sources, particularly the roles and dangers of sugar, salt, and fat contents in metabolism, as well as dietary control. The online education may be a great way for improving dietary status, but it requires more active participation from educators and students (Brug *et al*, 2005). The interaction and involvement of students in this study was shown by students following all assignments that were inserted during education and self-reporting of the food consumption they ate every week.

Improving health-related attitudes toward food choice and nutrient

intake needs good communication, and well-thought information delivery relevant, meaningful, and practical to the recipients' knowledge, culture, and behavior (Ponzo *et al*, 2021). Even though nutrition education was conducted regularly for two months with enough support, it had not demonstrated a significant effect on students' food preferences. Referring to a study in China, primary school students decreased salt consumption after participating in a 3.5-month program (He *et al*, 2015). Reducing salt and sugar intake is more challenging than fat intake among children. A feasible technique to further lower intakes of salt, sugar, and fat is a gradual and steady reduction in flavor. Reduction of sodium is a challenge because salt is not only used for sensory purposes but also for preservation. Sugar, like salt, is used for sensory purposes as well as food preservatives. The labels of packaged foods should be monitored for hidden sugars and salts. The salty and sweet flavours that children are attracted to may have something to do with the introduction of these flavours during their first food introduction (Ponzo *et al*, 2021).

This current study argued that gender had an impact on food preferences. In America, female elementary school students were more likely to prefer sweets, fruits, and vegetables than male students. When transitioning from elementary to middle school levels, vegetable choices among female students declined, but vegetable preferences of male students exceeded those of female ones (Caine-Bish and Scheule, 2009).

This current study discovered that male students had a worse nutritional status than female ones, making it easier for them to change sugar, salt, and fat intakes. A study in Mexico supports the finding by stating that someone who is aware of their abnormal nutritional status was more likely to adjust their diet immediately (López-Gamiño *et al*, 2012).

In summary, the eating patterns in both intervention and control groups positively changed after the interventions, but there was no significant difference in the improvement between the groups. The most important determinant in reducing sugar, salt, and fat intake was gender. Food preferences and attempts to enhance nutrition were also influenced by nutritional status.

ACKNOWLEDGEMENTS

We would like to thank the Universitas Diponegoro, Universitas Airlangga, and Hasanudin University, the elementary schools, students, and nutrition educators for participating in this study.

This study was funded by the Universitas Diponegoro, Universitas Airlangga, and Hasanudin University through the Indonesian Collaborative Research Program.

CONFLICT OF INTEREST DISCLOSURE

There is no conflict of interest in this study.

REFERENCES

Brug J, Oenema A, Kroeze W, and Raat. H. The internet and nutrition education: challenges and opportunities. *Eur J Clin Nutr* 2005; 59 (Suppl 1): S130-7.

Caine-Bish NL, Scheule B. Gender differences in food preferences of school-aged children and adolescents. *J Sch Health* 2009; 79: 532-40.

Chusak C, Tangmongkhonsuk M, Sudjapokinon J, Adisakwattana S. The association between online learning and food consumption and lifestyle behaviors and quality of life in terms of mental health of undergraduate students during COVID-19 restrictions. *Nutrients* 2022; 14: 890.

de Onis M, Lobstein T. Defining obesity risk status in the general childhood population: which cut-offs should we use? *Int J Pediatr Obes* 2010; 5: 458-60.

He FJ, Wu Y, Feng XX, *et al*. School based education programme to reduce salt intake in children and their families (School-Edusalt): cluster randomised controlled trial. *BMJ* 2015; 350: h770.

Jawaldeh AA, Al-Jawaldeh H. Fat intake reduction strategies among children and adults to eliminate obesity and non-communicable diseases in the Eastern Mediterranean Region. *Children* 2018; 5: 89.

Kansra AR, Lakkunarajah S, Jay MS. Childhood and adolescent obesity: a review. *Front Pediatr* 2021; 8: 581461.

Lloyd LJ, Langley-Evans SC, McMullen S. Childhood obesity and risk of the adult metabolic syndrome: a systematic review. *Int J Obes* 2012; 36(1): 1-11.

López-Gamiño MR, Alarcón-Armendáriz ME, Torres-Beltrán XK. Nutritional status, food consumption at home, and preference-selection in the school. *Food Nutr Sci* 2012; 3: 281-5.

Mahmudiono T, Indriasari R, Pangestuti DR, *et al*. Online-based nutrition education to reduce sugar, salt, and fat intake in school children: a research protocol. *Open Access Maced J Med Sci* 2021; 9(E): 873-8.

Mazidi M, Banach M, Kengne AP, Lipid and Blood Pressure Meta-analysis Collaboration Group. Prevalence of childhood and adolescent overweight and obesity in Asian countries: a systematic review and meta-analysis. *Arch Med Sci* 2018; 14: 1185-203.

Means B, Toyama Y, Murphy R, Bakia M, Jones K. Evaluation of evidence-based practices in online learning: a meta-analysis and review of online learning studies, 2009 [cited 2022 Oct 07]. Available from: URL: https://repository.alt.ac.uk/629/1/US_DepEdu_Final_report_2009.pdf

Ministry of Health of Republic Indonesia (MOH RI). 2018 Basic Health Research Report, 2019 [cited 2021 Aug 07]. Available from: URL: https://dinkes.kalbarprov.go.id/wp-content/uploads/2019/03/Laporan-Riskesdas-2018-Nasional.pdf [in Bahasa]

Ponzo V, Pellegrini M, Costelli P, *et al*. Strategies for reducing salt and sugar intakes in individuals at increased cardiometabolic risk. *Nutrients* 2021; 13: 279.

Woo Baidal JA, Locks LM, Cheng ER, Blake-Lamb TL, Perkins ME, Taveras EM. Risk factors for childhood obesity in the first 1000 days: a systematic review. *Am J Prev Med* 2016; 50: 761-79.

World Health Organization (WHO). Population-based approaches to childhood obesity prevention, 2012 [cited 2022 Sep 11]. Available from: URL: https://apps.who.int/iris/bitstream/handle/10665/80149/9789241504782_eng.pdf

World Health Organization (WHO). World health statistics 2022: monitoring health of the SDGs, 2022 [cited 2022 Sep 11]. Available from: URL: https://apps.who.int/iris/rest/bitstreams/1435584/retrieve

World Health Organization Regional Office for Europe (WHO EURO). Marketing of foods high in fat, salt and sugar to children: update 2012–2013, 2013 [cited 2022 Sep 11]. Available from: URL: https://www.euro.who.int/__data/assets/pdf_file/0019/191125/e96859.pdf

Zheng X, Zhang D, Lau ENS, *et al*. Primary school students' online learning during coronavirus disease 2019: factors associated with satisfaction, perceived effectiveness, and preference. *Front Psychol* 2022; 13: 784826.