IZVORNI ZNANSTVENI RAD / ORIGINAL SCIENTIFIC PAPER

How the number and type of primary school meals affect food variety and dietary diversity?

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Abstract

School meals should encourage a varied and diverse diet, since children may eat up to three meals at school per day. The aim of this study was to assess food variety and dietary diversity among primary school children regarding the number and type of school meals. Dietary records for three non-consecutive days were used to estimate the food variety score (FVS) and dietary diversity score (DDS) of 195 children (52.3% boys) aged 8-9 years from schools in the city of Zagreb. For analysis, children were divided into 5 groups according to the number and type of school meals consumed: non-consumers (23.1%), breakfast consumers (30.3%), lunch consumers (5.6%), breakfast and lunch consumers (13.3%), and breakfast, lunch and snack consumers (27.7%). The children had an average FVS of 14.3 (12.6 - 16.7) and DDS of 5.7 (5.0 - 6.0). The food group with the highest frequency of consumption was starchy staple (99.9% of children), while legumes, seeds, and nuts were consumed least frequently (15.4%). The number and type of school meals were moderately correlated ($r = 0.313$, $p < 0.001$) with FVS and weakly ($r = 0.230$, $p = 0.02$) with DDS. In addition, children who ate breakfast and lunch or breakfast, lunch, and snack from school meals had significantly higher FVS ($p < 0.001$) and DDS ($p = 0.027$) compared to children who ate fewer school meals or ate no school meal. Children (50%) who ate breakfast, lunch, and snacks from school meals were more likely ($p = 0.022$) to consume dark green leafy vegetables. The number of school meals may affect the food variety and dietary diversity, with children who eat more school meals having better quality. However, the values obtained by the index suggest that both parents and school food services should provide more varied meals in terms of different foods and food groups.

Keywords: children, dietary diversity, food variety, school meals

Introduction

School-aged children have a special form of nutrition, considering that some meals are eaten at home under the supervision of parents/caregivers and others are eaten at school from school food service, which can account for up to 60% of energy intake, depending on the length of the class. Therefore, to promote the growth and development of children and the development of proper eating habits, school meals must be nutritionally adequate and varied (World Health Organization, 2006; Capak et al., 2013).

Regarding the impact of school meal consumption on overall nutritional adequacy and diet quality, it is suggested that the consumption of school meals could contribute to a better overall diet quality, however, it is indicated that the quality of school meals could be improved (Cullen and Chen, 2017; Au et al., 2016, Au et al., 2018; Asakura and Sasaki, 2017; Sabinsky et al., 2019; Evans et al., 2016; Tugault-Lafleur and Black, 2020; Colombo et al., 2020). According to the available literature, only one study was conducted in Croatia, in which the consumption of school meals was not associated with overall nutritional quality due to the low quality of school meals (Ilić et al., 2021). Similarly, in UK, no association was found between school meal consumption and overall diet quality. It was suggested that children did not eat the entire served meal at school and compensated the rest of the energy by eating outside (Gatenby L., 2011).

Regarding variety, a distinction can be made between dietary diversity, which represents the number of food groups consumed, and food variety, which represents the number of food items consumed by a person in a reference period, namely 24 hours (Hatløy et al., 1998; Kennedy et al., 2011). Both, dietary diversity and food variety can be measured with the indices dietary diversity score (DDS) and food variety score (FVS), respectively (Hatløy et al., 1998; Kennedy et al., 2011; Kant et al., 1991; Kant et al., 1995; Krebs-Smith et al., 1987; Drewnowski et al., 1997). Food variety and dietary diversity are an important indicators of nutritional status, whereas they are related to nutrient intake weight status in children (Hatløy et al., 1998; Steyn et al. 2006; Zhao et al. 2017; Meng et al., 2018; Evans et al., 2018; Ayogu, 2019; Singh and Sharma, 2020; Olumakaiye, 2013, Aboussaleh et al., 2013; Golpour-Hamedani et al., 2020; Zhao et al., 2017). The available literature lacks information on how school nutrition affects children's overall DDS (Zhang et al., 2020), while no study was found linking school meal consumption to FVS.

Therefore, there is insufficient information on how school meals affect children's dietary diversity and food variety. To address this knowledge gap, the aim of this study was to assess the overall food variety and dietary diversity of primary school children in relation to the number and type of school meals.

Subjects and methods

Study population and design

The study was conducted in the school year 2019/2020 on a total of 681 children from 14 primary schools in the city of Zagreb. The schools were selected according to the protocol of the project "Strengthening European Food Chain Sustainability by Quality and Procurement" (Colić Barić et al., 2021). Of the 681 primary school children who gave written consent to participate, 195 children (52.3% boys) with an average age of 8.8 (8.6 - 9.1) years were included in the study. Inclusion criteria were measured anthropometric characteristics and completed 3-day dietary records.

This study was designed and conducted as a cross-sectional observational study in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the School of Medicine, University of Zagreb (380-59-10106-19-11/307). The study was conducted as part of the "Pilot Project: School Meals and Fruit and Vegetable Intake in Schools With and Without a Garden", which is part of the Horizon 2020 project "Strengthening European Food Chain Sustainability by Quality and Procurement" (Strength2Food, H2020-SFS-2015-2, contract number 678024). Approvals for the implementation of the pilot project in primary schools were obtained from the relevant institutions (the Ethics Committee of the Institute for Medical Research and Occupational Health: 100-21/16-8; the Croatian Ministry of Science and Education and the Education and Teacher Training Agency: 602-01/16-01/00388).

Anthropometric measurements

Height and weight were measured according to the standard protocols using a combined medical digital scale and stadiometer (Seca, Type 877-217, Vogel & Halke Gmbh & Co., Germany), with the children in light clothing and without shoes. Height was measured to the nearest 0.1 cm and weight to the nearest 0.1 kg. Body mass index (kgm^{-2}) was calculated as body weight in kilograms divided by height in meters squared. Sex- and age-standardized z-scores for height, weight, and body mass index were determined using AnthroPlus software (Blössner et al., 2009).

Dietary assessments

Dietary records from 3 non-consecutive days were used to estimate children's FVS and DDS. All participants and their parents/caregivers were given detailed instructions on keeping dietary records and measuring food intake. All food consumed had to be weighed or reported in household measurements if there were no conditions for weighing the food. In addition, the place and time of food intake were noted. Children's dietary records were analysed using the "Prehrana" software (Infosistem d.d., Zagreb, Croatia) based on the National Food Composition Database (Kaić Rak and Antonić, 1990) and supplemented with food nutrition labelling, which was used to estimate daily energy intake. In addition, excel spreadsheets were extracted from the software, from which the amounts of food items were filtered for further analysis of the DDS and FVS.

The FVS was calculated as the mean number of different foods eaten by each child during the recording of the 3-day dietary record. The maximum number of foods included in the FVS was 169 and was equal to the mean number of all foods eaten by the children in the present study during the recording of the 3-day dietary record (Hatløy et al., 1998).

The DDS was calculated as mean number of different food groups consumed each child consumed during the recording of the 3-day dietary record. All consumed food and beverages were divided in nine food groups according to the Food and Agricultural Organization guidelines for measuring individual dietary diversity: (1) starchy staples (including cereals, roots and tubers); (2) dark green leafy vegetables; (3) vitamin A rich fruits and vegetables; (4) other fruits and vegetables; (5) organ meat; (6) meat and fish; (7) eggs; (8) legumes, nuts and seeds; (9) milk and dairy products. One point was given for each food group consumed, with 9 being the maximum score (Hatløy et al., 1998; Kennedy et al., 2011).

Statistical analysis

For data analysis, the children in the study sample were divided into five groups according to the number and type of school meals consumed: non-consumers, breakfast consumers, lunch consumers, breakfast and lunch consumers, and breakfast, lunch and snack consumers. Descriptive analysis results were reported as frequencies for categorical variables and as median and interquartile range for continuous variables due to their skewness according to the Shapiro-Wilk normality test. Differences in FVS and DDS between child groups were tested with a one-way analysis of variance for non-normal distribution with Dunnett's post hoc test. Kendall's τb correlation coefficient was performed to test the relationship between child groups FVS and DDS. Differences in the distribution of children by food group consumption from the dietary diversity assessment between child groups were tested using Fisher's exact test. For all analyses, the significance level was set at $p < 0.05$. All analyses were performed using IBM SPSS Statistics v. 23.0, released in 2015 (IBM SPSS Statistics for Windows, Armonk, NY, USA: IBM Corp.).

Results and discussion

The aim of this study was to investigate the relationship between overall dietary diversity and food variety in school-aged children in relation to the type and number of school meals. Results indicate that children who eat two or more school meals have greater dietary diversity and food variety. This study adds to the existing literature on how different types of school meals and their combination may affect overall dietary diversity and food diversity, about which there are a limited number of studies, particularly in high-income countries. Also, to author's knowledge, this is the first study in Croatia to examine dietary diversity and food variety among primary school-aged children.

A total of 195 school-aged children (52.3% boys) were included in the study. The anthropometric characteristics of the study sample are shown in Table 1. According to the mean z-scores, the children had adequate height and weight. In addition, 64.9% of the children had adequate weight status to the body mass index z-score. On average, children had a daily energy intake of 1762 kcal, which is close to the national guidelines for primary school children's diet, which recommend an intake of 1855 kcal (Capak et al., 2013).

In Croatia, primary schools are required to organize meals for children while they are at school, especially for children in the lower grades who participate in afterschool activities. Schools can provide up to 3 meals: breakfast, lunch and snacks. Students from socially disadvantaged families, families without income, and children of war veterans receive free school meals. School meals for other children are financed by state, local and regional self-government units, while parents pay the necessary difference each month (Zakon, 2008; Državni pedagoški standard, 2008; Capak et al., 2013). At the time of the study (Table 1), 23.1% of children did not eat school meals, while 30.3% of children ate breakfast only, 5.6% of children ate lunch only, 13.3% of children ate breakfast and lunch, and 27.7% of children ate breakfast, lunch and snack from the school food service. The varying distribution of the type and number of school meals consumed among the children in the present study reflects the fact that not all children participated in afterschool programs and that parents/caregivers could decide whether their child ate school meals.

In the present total study sample, the children had an average FVS of 14.3 (12.6 - 16.7). This result is lower compared with the results of previous studies conducted in other high-income countries (Meng et al., 2018; Evans et al., 2018), but higher than in middle-income country (Steyn et al. 2006). Children aged 6 to 12 years from China had an average FVS of 16.53 ± 6.35 estimated from three 24-hour recalls. In addition, the study results showed that less than 23.77% of children met the FVS recommendation. However, the cut-off value was not reported in the study, nor was the maximum number of foods included in the FVS (Meng et al., 2018). Children aged 7-10 years from London had an average FVS of 17.1 (16.8 - 17.5), with a maximum number of foods included in the study of 115 from the Children and Diet Assessment Tool. Of the total sample, 13.5% of children consumed 13-14 foods, while the majority of them (60%) consumed more than 15 food items (Evans et al., 2018). The authors observed that children with lower FVS (4-10 food items) consumed more food items from snacks, pasta, pizza, sugar-sweetened beverages, and breakfast cereals food groups, while children with higher FVS (≥ 19 food items) consumed more food items from fruits and vegetables groups (Evens et al., 2018). In 7-8-year-old children from South Africa, an average FSV of 5.67 ± 3.24 was observed for a total of 45 food items, estimated from three 24-hour recalls (Steyn et al. 2006).

Children from the present study reached on average 5.7 (5.0 - 6.0) on DDS from total 9 food groups, where 51.8% of children had high dietary diversity (≥ 6 food groups) and 45.1% of children medium dietary diversity (4 – 5 food groups) according to guidelines for measuring individually dietary diversity (Kennedy et al. 2011). DDS in school-aged children varies widely in recent studies. In two studies conducted in low-income countries, children had average DDS of 3.64 ± 1.74 (7-8 years) and 5.03 ± 0.78 (6-9 years) (Styen et al., 2006; Ayogu et al., 2019) which is lower compared with the present study. Only 10% of children were found to have high dietary diversity and 31% had medium dietary diversity (Ayogu et al., 2019). DDS was estimated using individual dietary diversity (Kennedy et al., 2011), however, Styen et al. (2006) estimated DDS using three 24-hour recalls, whereas Ayogu et al. (2019) estimated DDS using weighted 3-day dietary records. Children in Ghana (average 8.1 years old) had higher DDS (6.44-6.95) compared with the present study and with studies in other low-income countries (Abizari et al., 2017; Styen et al., 2006; Ayogu et al., 2019), with DDS estimated by measuring dietary diversity in the household with a maximum of 13 food groups (Kennedy et al., 2011). Somewhat higher than in the present studies, average DDS were estimated in two studies conducted in China (Zhao et al. 2017; Meng et al., 2018). In the first study, children aged 6 to 12 years had an average of 5.6 ± 1.5 DDS (Zhao et al. 2017), and in the second study, it was 6.10 ± 1.67 in children aged 3-12 years (Meng et al., 2018). Meng et al. also found that 77.51% of children had a DDS level below the recommendation, with the cut-off value set at 8. In both studies, DDS food groups were defined according to the Chinese Dietary Guidelines (Chinese National Society, 2016), but with different numbers of food groups examined (10 and 9, respectively).

Food variety and dietary diversity are important indicators of adequate nutrition as they relate to nutrient intake. A higher FVS and DDS may indicate a more adequate diet for children (Hatløy et al., 1998; Steyn et al. 2006; Zhao et al. 2017; Meng et al., 2018; Evans et al., 2018; Ayogu, 2019; Singh and Sharma, 2020). Besides that, DDS and FVS have been suspected to be related to the anthropometric characteristic of school-aged children, but study results have been inconsistent (Olumakaiye, 2013, Aboussaleh et al., 2013; Golpour-Hamedani et al., 2020; Zhao et al., 2017). It was suggested that stunted children had lower DDS and FVS (Olumakaiye, 2013, Aboussaleh et al., 2013). In contrast, Iranian children with higher DDS had higher odds of overweight and obesity (Golpour-Hamedani et al., 2020). However, among Chinese children, dietary diversity was not related to weight status (Zhao et al., 2017). In the present study, the relationship between nutritional status and FVS and DDS was not investigated. However, it can be assumed that, on average, the children have adequate body weight, height, and weight status according to the z-score for body mass index. In other studies, in which children had, on average, adequate weight status according to the z-score for body mass index, DDS and FVS were higher (Abizari et al., 2017; Zhao et al., 2018; Meng et al., 2018). The large differences between the results of the different studies may be due to the methodology used

Table 1. Characteristics of study sample[1]

Characteristics	Total of 195 children
Age (yr.)	8.8 (8.6 – 9.1)
Sex (% children)	
Boys	52.3
Girls	47.7
Body height (cm)	134.9 (131.5 – 140.5)
Body height-for-age z-score	0.75 (0.15 – 1.35)
Body weight (kg)	29.7 (27.0 – 33.5)
Body weight-for-age z-score	0.42 (-0.12 – 1.16)
Body mass index (kgm^{-2})	16.0 (15.1 – 17.6)
Body mass index-for-age z-score	0.04 (-0.67 – 0.66)
Body mass index categories according to z-score body mass index-for-age (% children)	
< - 1	13.1
-1 – 1	64.9
> 1	22.0
Daily energy intake (kcal)	1762 (1455 – 1984)
Type of school meals (% children)	
Non-consumers	23.1
Breakfast	30.3
Lunch	5.6
Breakfast and lunch	13.3
Breakfast, lunch and snack	27.7

[1] Continuous data are reported as median (and interquartile range) and categorical data as percentage.

to collect the food consumption data, the calculation method for FVS and DDS, and the setting of the cut-off values. The study sample could be the reason for these differences, namely age, gender, socioeconomic status, area of residence, parental education level, and also agricultural conditions (Singh and Sharma, 2020; Zhao et al., 2017, Abizari et al., 2017; Steyn et al. 2006).

The number and type of school meals were moderately ($r = 0.313$, $p < 0.001$) correlated with FVS and weakly ($r = 0.230$, $p = 0.02$) correlated with DDS, with children with numerous and more complex meals having higher FVS and DDS in the present study. As shown in Figures 1 and 2, children who ate breakfast and lunch (FVS: 15.8; 13.3 - 17.0 and DDS: 5.7; 5.3 - 6.0) or breakfast, lunch, and snack (FVS: 16.2; 15.0 - 17.3 and DDS: 5.7; 5.3 - 6.0) from school meals had significantly higher FVS ($p < 0.001$) and DDS ($p = 0.027$) compared to children who ate only breakfast (FVS: 13.6; 11.7 - 15.2 and DDS: 5.3; 4.7 - 5.7) or lunch from school meals (FVS: 13.3; 12.0 - 14.2 and DDS: 5.3; 5.3 - 5.7) or ate no school meal (FVS: 13.3; 11.3 - 15.3 and DDS: 5.3; 5.0 - 6.0). In the available literature, there was no study that observed the impact of school food service on overall FVS. Only one study examined how the school food service affects the overall DDS of children aged 10-14 years in Ethiopia (Zenebe et al., 2018). Data for DDS were collected using a questionnaire adapted from the Food and Nutrition Technical Assistant Guideline, and estimation was based on 8 food groups. The children who ate a school lunch (150 g of hot prepared meal) had significantly higher DDS than those who did not eat a school lunch (5.8 ± 1.1 and 3.5 ± 0.7, respectively). Although it can be hypothesized that children who do not eat school lunch eat a brought meal with less food variety and dietary diversity, however, the children in the present study ate their meals at home before or after school and did not bring them to school as packed meals. Consistent with this hypothesis, Zhang et al. (2020) found no differences in DDS and FVS of school lunch prepared for 6-11-year-old children compared with lunch taken outside of school in China.

In the total sample of the present study, more than 95% of children consumed starchy staples, meat and fish, milk and dairy products, and other fruits and vegetables food groups (Figure 3). Only 15.4% of children consumed the legumes, seeds, and nuts food group, while no children consumed the organ meat food group. Consistent with the present study, starchy staples were most commonly consumed among school-aged children in recent studies, although the proportion of children consuming other food groups varied by cultural and agricultural factors (Abizari et al., 2017; Ayogu et al., 2019, Zhao et al., 2017). For example, in Ghana, during in both the dry and rainy seasons, most children consumed whole small fish (99.1 - 99.7%), vitamin C-rich vegetables (96.5 - 100%), other fruits and vegetables (90.8 - 93.4%), and legumes and nuts (89.9 - 98.3%), while 10% or fewer children consumed dairy products, organ meats, eggs, other flesh food, and vitamin C-rich fruits (Abizari et al., 2017). In Nigeria, all children consumed vitamin A-rich foods, while 95.6% of children consumed fats and oils. The lowest proportion of children (11.3%) consumed eggs (Ayogu et al., 2019). In addition, Zhao et al. (2017) found that most children consumed oils and fats, other vegetables, meat, poultry, and fish.

No difference was found in the consumption of food groups between groups of children (Figure 4), except for the consumption of dark green leafy vegetables, with children (50%) who ate breakfast, lunch, and snacks from school meals being more likely ($p = 0.022$) to consume dark green leafy vegetables than children who ate fewer school meals or did not eat school meals (< 35%). In Ethiopia, children who ate school meals were overall more likely to consume legumes, non-vitamin A-rich vegetables, starchy staples, and fats and oils than children who did not eat school meals (Zenebe et al., 2018). Although the impact of school meals on overall consumption of food groups from the DDS has not been observed, studies in high-income countries have examined the consumption of food groups in relation to school meal consumption, however, the results are inconclusive (Au et al. 2016; Evans et al., 2016; Tugault-Lafleur and Black, 2020; Evans et al., 2016). In the United States and the United Kingdom, it was observed that children who consumed school meals had higher daily consumption of total fruit, whole fruit, vegetables, and dairy products (Au et al. 2016; Evans et al., 2016), whereas in Canada, children who consumed school meals had lower intake of dark green and orange vegetables, whole fruit, fruit juices, whole grains, milk, and milk alternatives (Tugault-Lafleur and Black, 2020). In addition, children who ate a school meal consumed fewer sugar-sweetened beverages in the United Kingdom and Canada (Evans et al., 2016; Tugault-Lafleur and Black, 2020), while in the United States, children who ate a school meal consumed more empty calories from solid fats and added sugars (Au et al., 2016), which is associated with consumption of fast foods, salty and sweetened snacks, and beverages. Food choices are subject to a multilevel sociological framework in which not only the biological determinants of behavioural predisposition and food experience are crucial, but also personal drivers (e.g., beliefs, cultural norms, and religion) and environmental drivers (e.g., food availability, public policy, school food policy, economics, etc.) (Bonfenbrenner and Morris, 2006; Contento I., 2011). Therefore, it is not surprising that children's eating habits differ in studies related

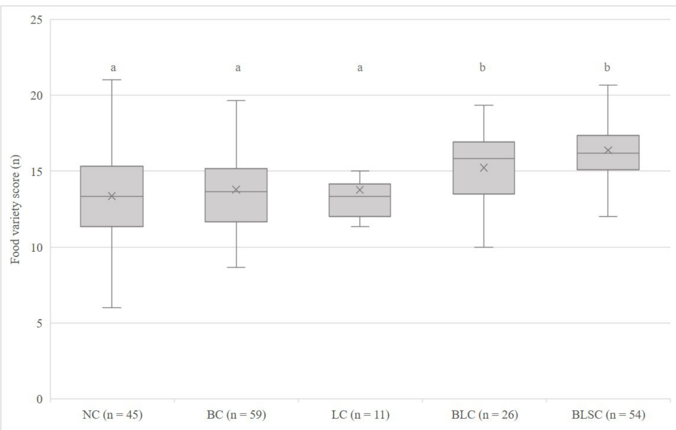

Figure 1. Difference in food variety scores between groups of children by number and type of school meals.

NC – non-consumers; BC – breakfast consumers; LC – lunch consumers; BLC – breakfast and lunch consumers; BLSC – breakfast, lunch and snack consumers

a,b Different letters indicate significant difference among groups ($p < 0.05$ by Kruskall-Wallis test followed by Dunnett's test)

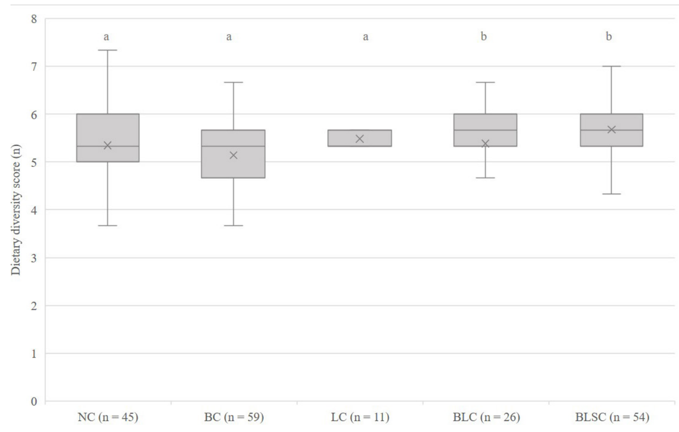

Figure 2. Difference in dietary diversity scores between groups of children by number and type of school meals.

NC – non-consumers; BC – breakfast consumers; LC – lunch consumers; BLC – breakfast and lunch consumers; BLSC – breakfast, lunch and snack consumers

a,b Different letters indicate significant difference among groups ($p < 0.05$ by Kruskall-Wallis test followed by Dunnett's test)

to demographic, socioeconomic, cultural, and agricultural factors. The small difference in the consumption of different food groups among Croatian children may be the result of the fact that traditional dietary patterns still prevail in Croatia, where most meals at home and in the school canteen are prepared mainly from unprocessed or minimally processed foods (Čačić Kenjerić and Sokolić, 2021; Ilić et al., 2022).
The present study highlights the positive impact of school nutrition

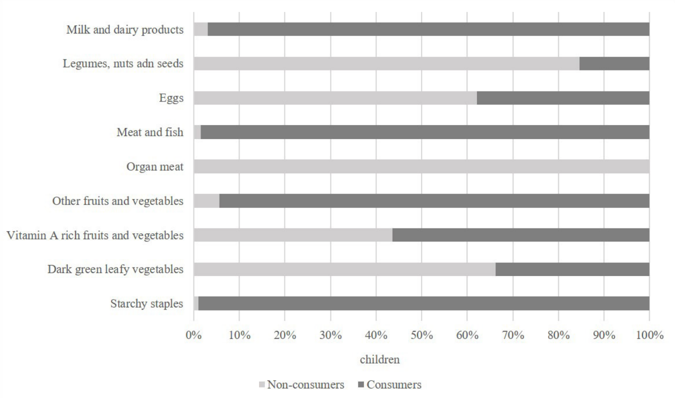

Figure 3. Distribution of children (n = 195) who consumed and not consumed food groups from dietary diversity score.

Figure 4. Differences in the distribution of children who consumed food groups from the dietary diversity score between groups of children by number and type of school meals.

NC – non-consumers; BC – breakfast consumers; LC – lunch consumers; BLC – breakfast and lunch consumers; BLSC – breakfast, lunch and snack consumers
* Differences between groups were test using Fisher's Exact test ($p < 0.05$)

and the importance of community-based nutrition on the overall dietary habits of school-aged children. However, the present study has some limitations that need to be emphasised. The small study sample reflects the small number of children in each group of children divided by number and type of school meals consumed. Given this and the skewness of the data, nonparametric analyses were conducted, limiting the ability to adjust the analysis for factors such as school neighbourhood poverty index, socioeconomic status, gender, weight status, physical activity, and parental education. Although the study by Sila et al. (2018) suggests that there are no differences in children's eating habits between rural and urban areas in Croatia, the generalizability of the results is limited by the fact that the data were collected only in the urban area of Zagreb. Overall, FVS and DDS may be subject to errors arising from the dietary assessment methodology. Namely, a common problem is that children are unable to report on their consumption and parents have limited ability to report on food consumption outside the home, which can lead to underreporting and exaggeration of food consumption (Livingstone et al., 2004). However, these potential biases are limited by the use of a 3-day dietary record. Accordingly, further studies should be performed on larger samples from different regions. In the future, it would be interesting to observe the FVS and DDS of individual school meals and see how the introduction of meals with higher FVS and DDS would affect the overall quality and diversity of school children's diets. In addition, the introduction of such meals needs to be accompanied by nutrition education, because while the variety of school meals may be improved, children do not need to consume them, and there arise the additional problem of food waste.

Conclusions

This study suggests how school nutrition can have a positive impact on children's dietary diversity. The number and type of school meals can affect the food variety and dietary diversity of school-aged children, with children who eat numerous and more complex school meals having better quality. However, the values obtained by the food variety score and dietary diversity score suggest that both parents and school food service should provide more varied meals in terms of different foods and food groups.

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