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INVESTIGATING FACTORS OF CHILDREN'S SHIFT TOWARDS SUSTAINABLE FOOD CONSUMPTION

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The consumption of food and related processes, including production, transport, storage, and disposal, significantly contribute to environmental issues. Sustainable eating habits and nutrition can mitigate the negative impact of animal-based foods, resource-intensive products, highly processed items, and those transported over long distances. The EU Fruit, Vegetable, and Milk School Scheme aims to shift children's eating habits towards more sustainable choices. Based on data from EU Member States spanning the school years 2017/2018 to 2020/2021, we assessed the effects of various Accompanying Educational Measures, their themes, communication activities, and the Covid-19 pandemic on children's average fruit and vegetable consumption at primary schools. The results of our panel data models indicated that educational activities focusing on Healthy eating habits and Dedicated websites as communication channels had a significantly positive effect on children's average consumption of fruits and vegetables within the EU School scheme. Interestingly, the Covid-19 pandemic had an insignificant impact on children's average fruit and vegetable consumption at primary schools. Furthermore, we found no significant difference in fruit and vegetable consumption between children in western and eastern EU Member States. Identifying the School Scheme educational activities, themes and communication channels with a significant effect, policymakers can better tailor and support future initiatives aimed at encouraging children to make healthy and sustainable food choices.

Keywords: *EU School Scheme; consumption; fruit and vegetables; children; factors; panel data model*

INTRODUCTION

Shifting consumer behaviour toward sustainable and healthy food choices is essential for environmental sustainability and public health. These challenges are driven by accelerating climate change and the escalating prevalence of overweight and obesity across various age groups. In dietary recommendations over the past decade, the primary objective has been shifting towards plant-based diets, as they have been considered advantageous in terms of both climate and health. (Hallström et al., 2015). Transitioning consumer eating habits towards sustainability, however, is a long-term objective that requires a comprehensive commitment.

The consumption of food and its associated production, distribution, and disposal processes have become major contributors to environmental issues, including greenhouse gas emissions, resource depletion, and waste generation (Munesue et al., 2015). These challenges have prompted a growing interest in promoting sustainable eating habits and nutrition practices, particularly in the context of reducing the negative impacts on the environment (Truder, 2019).

Agriculture's ecological footprint is intricately linked to dietary choices, contributing significantly to climate change, greenhouse gas emissions, deforestation, and biodiversity depletion (Bonnet et al., 2018; Jansson & Säll, 2018). Therefore, altering consumer behaviour is important to mitigate these environmental consequences and bolster the resilience of food systems.

Population in the European Union Member States (EU MS) faces a pressing issue with obesity, affecting nearly 60% of adults and a third of school-aged children (WHO, 2022). Among the related health problems, childhood obesity stands out and has gained prominence on the European public health agenda due to its substantial surge in prevalence, over the past few decades (Alemán-Díaz et al., 2018).

Fostering healthful dietary habits, particularly during childhood, is complex but crucial for public health improvement and the prevention of non-communicable diseases, including obesity (Story et al., 2008). Empirical research demonstrates the effectiveness of information dissemination and policy instruments in shaping dietary preferences, especially when instilled from a young age. There has been a remarkable increase in the number of policies aimed at addressing the underlying determinants of health behaviours, such as physical inactivity (Lakerveld et al. 2020). De

Schutter et al. (2020) propose a comprehensive policy approach to promote healthier diets, and innovative view on governance, suitable for the transition to sustainable food systems.

Empirical evidence concerning the efficacy of educating consumers about the implications of dietary choices for personal health and the environment, often leads to only marginal changes in dietary behaviour (Matthews, 2023).

Several food environmental factors linked to dietary habits and obesity have been identified and assessed (Mattes & Foster, 2014; Mei et al., 2022). According to findings of Pineda et al. (2021), changes in the school food environment can enhance children's dietary behaviours and BMI. Increasing attention has been paid to the role of the school environment and policies aimed at creating healthier food environments by promoting dietary and physical activity behaviours (Hawkins et al., 2023; Micha et al., 2018).

The European Union's (EU) Fruit, Vegetable and Milk School Scheme was designed to encourage children to adopt more sustainable eating habits by focusing on increased consumption of selected healthy and sustainable foods. In 2017, the EU School Scheme underwent revisions, aimed to improve effectiveness, provide more targeted support, and introduce a strengthened educational dimension, to improve children's access to healthy products and increase their understanding of the benefits of healthy and sustainable food. It complements the EU Farm to Fork (F2F) strategy, which is designed to transition the EU's food system toward more sustainable, healthier, and environmentally friendly, aligning with broader goals of improving public health and reducing the environmental impact of food production and consumption. These policy measures could have a significant direct impact on children's dietary intake and, if introduced and communicated effectively, hold substantial potential for shaping the nutrition habits of the entire family. Therefore, policy actions are crucial for improving the school food environment, facilitating healthy and sustainable dietary habits, and subsequently enabling the modification of individual dietary behaviours, as a key step in preventing childhood obesity and reducing the environmental impact.

This study aims to investigate the effect of interventions and other factors influencing children's consumption of fruits and vegetables in primary schools under the EU School Scheme within the EU MS. We seek to identify Accompanying Educational Activities (AEM), their themes and information activities of the EU School scheme that contributed to enhancement of children's fruit and vegetable consumption in schools over school years 2017/2018 – 2020/2021 and that could change children's food consumption toward a healthier and more sustainable diet.

RESEARCH METHODS

We estimated the effect of selected factors on average fruit consumption across 21 EU MS and vegetable consumption across 19 EU MS over a four school years period 2017/2018 – 2020/2021. We used EU MS School Scheme country data from the European Commission (2022). Our datasets included variables related to average fruit and vegetable consumption per child aged 6 to 15 years in primary schools, Accompanying Educational Measures (AEM) per 100 children, dummy variables: AEM themes, information and communication activities, the COVID-19 pandemic, and the inclusion of EU MS to the eastern (ceec) or western European group.

We employed the panel data model to analyse data with both cross-sectional and time-series dimensions. The general equation of the panel data model can be expressed as Equation 1 and Arellano-Bond dynamic panel model (arbond) with both time-varying and time-invariant explanatory variables as Equation 2 (Wooldridge, 2010):

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \ldots + \beta_k X_{kit} + \lambda_i + \varepsilon_{it} \quad (1)$$

$$Y_{it} = \beta_0 + \alpha Y_{it-1} + X'_{it}\beta + \lambda_i + \varepsilon_{it} \quad (2)$$

Where:
Y_{it} represents dependent variable - average fruit or average vegetable consumption for country *i* at time *t*;
Y_{it-1} represents the lagged average dependent variable for country *i* at time *t-1*;
β_0 the intercept term;
$\beta_1, \beta_2, \ldots \beta_k$ the coefficients for explanatory variables;
$X_1, X_2, \ldots X_k$ represent the explanatory variables: educational measures, AEM themes, and COVID-19 impact for country *i* at time *t*;
X'_{it} a row vector of explanatory variables;
λ_i represents country-specific fixed effects, capturing unobserved heterogeneity across countries;
ε_{it} the error term.

We conducted post-estimation tests to ensure the validity of our results. These tests encompassed checking for multicollinearity using the Variance Inflation Factor (VIF), identifying heteroskedasticity through the modified Wald test, and assessing autocorrelation in panel data using the Wooldridge test. To select the most appropriate model, we performed diagnostic tests, including the Breusch and Pagan LM test, Mundlak test, and Hausman test.

RESEARCH RESULTS AND DISCUSSION

Implementation of EU School Scheme in Member States

There are differences in the School scheme implementation by individual EU MS. Children in primary schools however, are the most targeted by MS. Childrens from primary schools represented 71% of the children involved in the scheme at EU-27 level (2017/18-2020/21 average). According to the EU MS strategies, the age classes indicated under

the primary school level in the EU School scheme accounts mostly children aged from 6 to 15 years, although the age range is rather differentiated (Agrosynergie, 2022).

Fourteen western EU MS (Figure 1a) and eleven eastern EU MS (Figure 1b) supplied fruits and vegetables to children in primary schools. Denmark, Ireland, Italy, Malta, Portugal, and the Netherlands distributed school fruits and vegetables solely to children in primary schools. Similarly, in the Czech Republic, Hungary, Poland, and Slovenia, fruits and vegetables were distributed only to children in primary schools.

Not all these countries supplied fruits and vegetables to all children in primary schools (Figure 1a, 1b). The lowest but increasing share of participating children in the fruit and vegetable School Scheme subprogram of the crucial group of 6 - 15 aged children were in Estonia, Bulgaria, stable in Lithuania and was declining in Romania (Figure 1b).

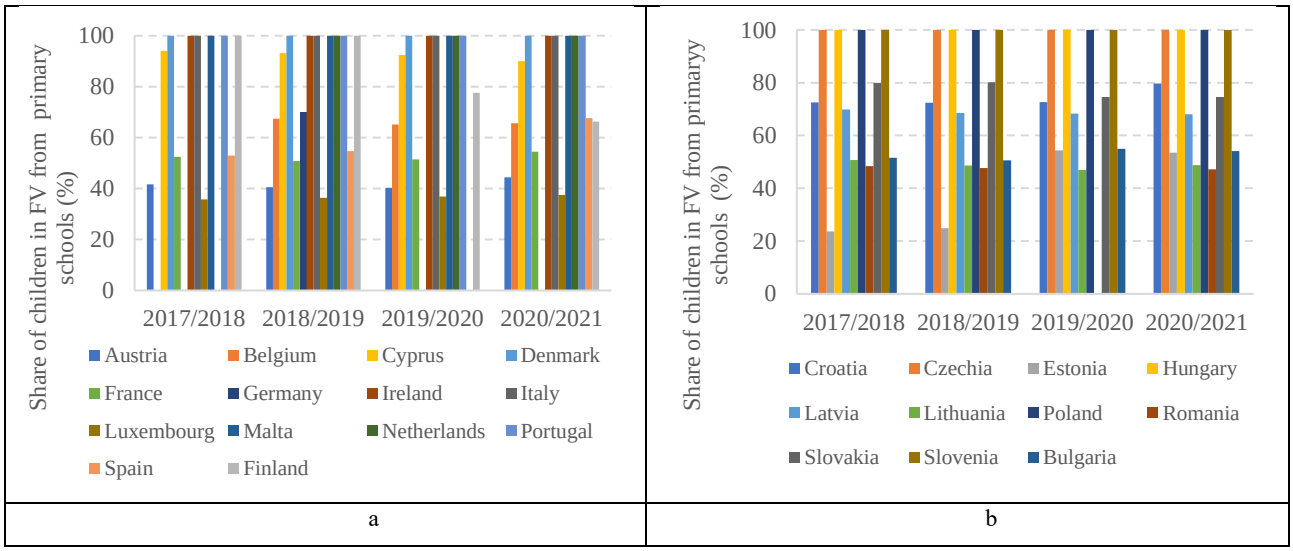

Figure 1. Children from primary schools participation rate in the fruit and vegetable subprogram (FV) of the EU School Scheme in EU MS over 2017/2018 – 2021/2022. a.) Western EU MS, b.) Eastern EU MS

The approved assortment of the EU School Scheme consisted of 21 types of fresh fruits and 33 types of fresh vegetables. Although the scheme emphasizes the supply of fresh produce, six types of processed fruits and vegetables were also possible to distribute to children in schools.

The range of supplied fruit and vegetable assortments varied. In Ireland and Finland, 4-5 types of fruits were supplied. In Cyprus, Spain, France, Belgium, and Germany, the range extended from 15 to 21 types of fruits for children in schools (Figure 2a). A wide range of assortment was offered to schools in the Czech Republic (18-20), Slovenia (15), and Romania (13) before the Covid-19 pandemic (Figure 2b). The narrowest assortment was supplied by Lithuania, Latvia, and Poland (Figure 2b).

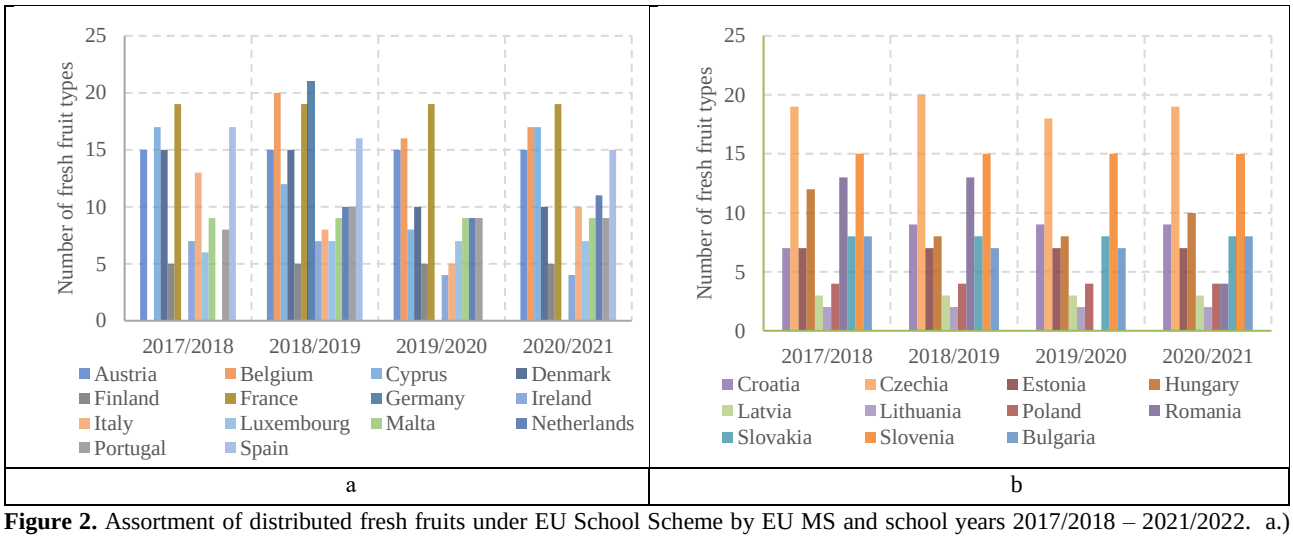

Figure 2. Assortment of distributed fresh fruits under EU School Scheme by EU MS and school years 2017/2018 – 2021/2022. a.) Western EU MS, b.) Eastern EU MS

Children's average consumption of vegetables in schools was lower in all EU MS compared to fresh fruits. The assortment of supplied vegetables was however wider. In Estonia (24 types), Slovenia (23). The narrow offer of vegetable types was distributed in Lithuania (1), Croatia (2), during Covid-19 pandemic in Romania (1). 7 EU MS also supported distribution of processed fruit and vegetable products to children in schools. Four western EU MS distributed these

products over Covid-19 pandemic 2019/2020 - 2020/2021. 8 eastern Member States supplied a wider range of processed products to schools. In 2019/2020, the Czech Republic and Slovakia have reduced the offer from 4 to 3 processed products.

Based on data from participating EU MS over 4 school years period, the results of estimation effects of selected Accompanying Educational Measures, their themes and information measures on children's average fruit consumption at schools under the EU School Scheme (Table 1) we found that the Accompanying Education Measures (AEM) have positive but insignificant effect on fruit consumption.

The AEM activities do not significantly affect children's average fruit consumption. Among AEM themes we found positive significant effect of theme 'Healthy eating habits' (thm_hhab) at $p<0.05$ and 'Other themes' (thm_oth) at $p<0.05$ on average fruit consumption. Positive, although insignificant effect had theme of 'Sustainable food production' (thm_suspr). Negative insignificant effect had themes 'Reconnection to agriculture' (thm_recag), 'Local food chains' (thm_locfch), and 'Organic production' (thm_org).

Among communication activities 'Poster at school' (comm_postsk) at $p<0.05$ and 'Dedicated website' (comm_dweb) at $p<0.01$ had positive significant effect on average children's fruit consumption at schools. Also, 'Other communication activities' showed positive, although insignificant effect:

We found that AEM activity – 'Visits to farms' (dsvo_farm) had a positive significant effect on children's average vegetable consumption under the EU School Scheme. 'Tasting, cooking' (dsvo_cook) however, had a negative significant effect, both at $p<0.01$.

Positive significant effect on children's vegetable consumption had themes of AEM – 'Healthy eating habits' (thm_hhab) at $p<0.01$, 'Sustainable food production' (thm_suspr) at $p<0.05$, and 'Organic production' (thm_org) at $p<0.05$. Positive, although insignificant effect had AEM activities in 'School gardens' (dsvo_gard), 'Lectures' (dsvo_lect), 'Competitions, games' (dsvo_game), and 'Local food chains' (thm_locfch). 'Tasting, cooking' (dsvo_cook) at $p<0.05$ and 'Reconnection to agriculture' (thm_recag) at $p<0.01$ had however negative significant effect on children's vegetable consumption at schools.

Positive significant effect on children's average vegetable consumption among communication activities had 'Dedicated website' (comm_dweb) at $p<0.001$. Remaining communication activities had positive insignificant effect, similarly 'Poster at other places' (comm_posto), 'Informative graphics' (comm_infgr), 'Information and awareness campaign' (comm_infaw), and 'Other communication activities' (comm_oth). Results showed that Poster at school (comm_postsk) at $p<0.05$ had negative significant effect on children's average vegetable consumption.

Our findings align with the conclusions drawn by other studies. According to Collado-Soler, et al. (2023), nutrition intervention programs prove to be effective in enhancing children's knowledge and in promoting their healthy behaviour. These programs subsequently led to a reduction in children's body mass index values. Verdonschot et al., (2020) found a significant increase in nutrition knowledge for children attending schools in Netherlands that had participated in both programs EU School fruit scheme and Taste Lessons, compared to control schools. The study revealed, however, insignificant increase in children's fruit and vegetable intake. In schools without food policies, fruit and vegetable provision alone contributed to an increase in child fruit and vegetable intake (Verdonschot et al., 2020). Vitale & Coccia, (2023) showed the positive impact of the nutritional program on increasing knowledge, taste, and intake of vegetables among young children of a Southeastern US Montessori school. On the contrary, Outzen et al. (2023) found no effect of school-based educational intervention on the children's intake of vegetables and fruits in Denmark. Based on meta-analysis, Pineda et al. (2021) assess the effectiveness of interventions targeting the school food environment and its vicinity. Their findings indicate that these interventions had a notable and statistically significant effect on children's BMI scores and fruit consumption, but not on vegetable intake. Wolnicka, Taraszewska & Jaczewska-Schuetz (2021) used survey data from 2012 to 2016 on children's fruit and vegetable consumption under the School Scheme implemented in Poland. They found that providing fruits and vegetables in schools free of charge can be an effective strategy for enhancing their consumption among children. In particular, study shows importance of raising the awareness of fruit and vegetable consumption importance for health.

Further, we found that Covid-19 pandemic in 2020 (covid) had an insignificant negative effect on children's average fruit consumption and an insignificant positive effect on vegetable consumption at schools under the EU School Scheme. This suggests that the pandemic did not significantly alter children's fruit and vegetable consumption in schools participating in the scheme.

Similarly, we observed an insignificant difference in children's average fruit and vegetable consumption between eastern and western EU Member States. The lagged dependent variable for both average fruit as well as vegetable consumption had a negative effect ($p<0.01$). Based on the estimated coefficients for the lagged dependent variables for both average fruit and vegetable consumption, there appears to be a decline in consumption over the period studied. However, the decline in vegetable consumption was more pronounced, as indicated by the larger magnitude of the coefficient.

Hebestreit, et al. (2015) have already found that the eating patterns of children in 8 EU MS do not conform to established dietary guidelines. Despite extensive policy initiatives, the diets of many children and adolescents in the EU continue to be inadequate, carrying substantial present and future implications for overweight, obesity, and nutrition-related illnesses (Rippin et al., 2018). Embracing healthy eating habits during childhood supports growth and development and has the potential to shape dietary behaviours and practices in adulthood (Lake et al., 2009). To change children's dietary habits, policies need to comprehensively address the entire food environment, encompassing daycare, schools, homes, retailers, and out-of-home eating settings, in a more unified and coordinated manner.

Table 1. Estimate parameters of panel data models for children average fruit consumption and average vegetable consumption 2017/2018 – 2020/2021

Average fruit consumption							**Average vegetable consumption**					
Variable	**ols**	**fixed**	**reth**	**areg**	**arbond**	**dpsys**	**ols**	**fixed**	**randomr**	**reth**	**arbond**	**dpsys**
dsvo_gard	0.059	0.027	0.029	0.027	0.016	0.016	0.017	0.018	0.017	0.018	-0.01	-0.01
dsvo_farm	-0.004	0.017	-0.002	0.014	0.026	0.026	0.007	0.008	0.007	0.005	0.046***	0.046***
dsvo_cook	0.009	0.002	0.004	0.004	0.009	0.009	-0.007	0.003	-0.007	-0.008	-0.038*	-0.038*
dsvo_lect	0.012	0.007	0.017*	0.005	0.005	0.005	-0.005	-0.002	-0.005	-0.005	0	0
dsvo_game	0.007	0.007	0.008	0.009	0.004	0.004	0.003	0.006	0.003	0.003	0.009	0.009
thm_recag	-2.386	0.902	-1.132	0	0	0	-3.241**	(omitted)	-3.241***	-3.206***	0	0
thm_hhab	2.336	2.301*	0.806	2.959**	4.443*	4.443*	3.102***	3.665***	3.102**	2.880**	-18.317*	-18.317*
thm_locfch	-2.031	-0.354	-1.999	-0.518	0	2.336	0.75	0.138	0.75	0.77	0	-1.853
thm_org	-1.722	0.04	-1.507	0.074	-0.529	-0.529	-0.09	-0.005	-0.09	0.013	4.888*	4.888*
thm_suspr	0.437	-0.46	1.147	-0.556	-0.134	-0.134	1.137*	0.446	1.137**	1.258**	1.092	1.092
thm_fw	1.521	-0.104	1.3	0.151	0.356	0.356	-0.335	0.07	-0.335	-0.28	-0.121	-0.121
thm_oth	1.396	0.597	0.124	1.105	1.700*	1.700*	-0.211	0.122	-0.211	-0.375	0.939*	0.939*
comm_postsk	-1.713	-2.037	-0.723	-3.153*	-4.639**	-4.639**	-3.602*	-3.961**	-3.602*	-3.412*	18.030*	18.030*
comm_posto	-2.403	-0.475	-2.076	-1.049	0.776	0.776	0.263	0.972	0.263	0.384	0.78	0.78
comm_dweb	-1.084	2.539**	-0.854	1.880*	5.565***	5.565***	-0.06	3.694***	-0.06	-0.055	8.102***	8.102***
comm_infgr	-0.035	-0.145	-0.398	0.044	1.291	1.291	-0.511	0.559	-0.511	-0.612	1.326	1.326
comm_infaw	0.060	-0.921	-0.639	-0.382	1.072	1.072	0.206	0.982	0.206	0.155	0.589	0.589
comm_oth	0.850	0.601	1.097	0.436	0.012	0.012	-0.059	0.017	-0.059	-0.025	-0.973	-0.973
lag1	.421**	-0.182*					0.138	-0.235	0.138*			
covid	-0.001	-0.453	-0.071	-0.356	-0.256	-0.256	0.511	-0.012	0.11	0.097	-0.148	-0.148
ceec		(omitted)	0.473	(omitted)	0	0.157	0.11	(omitted)	0.511	0.45	0	-6.666
dqfresh_f L1.					-0.428	-0.428					-3.729**	-3.729**
_cons	4.996	2.137	5.506**	2.878	-0.032	-1.704	3.946*	-2.413	3.946***	4.055***	-5.297**	-0.55
N	74	74	75	75	32	53	67	67	67	68	31	49
r2	0.485	0.597		0.922			0.533	0.655				

Note: dsvo_gard – activities in school gardens; dsvo_farm – visits to farms; dsvo_cook – tasting, cooking; dsvo_lect – lectures; dsvo_game – competitions, games; thm_recag – reconnection to agriculture; thm_hhab – healthy eating habits; thm_locfch – local food chains; thm_org – organic; thm_suspr – sustainable food production; thm_fw – food waste; thm_oth – other themes; comm_postsk – poster at school; comm_posto – poster at other places; comm_dweb – dedicated website; comm_infgr – informative graphics; comm_infaw – information and awareness campaign; comm_oth – other communication activities; covid – Covid-19 pandemic in 2020; ceec – country belongs to group of eastern European EU MS;

ols – pooled OLS estimation; fixed – fixed effect model robust estimation; reth, randomr – random effect estimation; areg – linear regression with a large dummy-variable; arbond - Arellano-Bond linear dynamic panel-data estimation; dpsys - Arellano-Bover/Blundell-Bond linear dynamic panel-data estimation.

* p<0.05; ** p<0.01; *** p<0.001

Our findings provide valuable insights into the EU School Scheme educational activities, themes, and communication activities affecting children's fruit and vegetable consumption in schools participating in the School Scheme over the school years 2017/2018 – 2020/2021. However, these results should be taken with caution as they are based on statistical associations. Further research is needed to understand the underlying mechanisms driving a change in children's eating habits.

CONCLUSIONS

Based on data from participating EU Member States in the EU School Scheme over four school years, we can draw the following conclusions and recommendations to enhance the effectiveness of interventions – including Accompanying Educational Measures (AEM), their themes, as well as communication and information activities aimed at promoting healthier eating habits among children. The AEM themes 'Healthy eating habits' and 'Other themes' have shown a positive significant effect on children's average fruit consumption in primary schools under the EU School Scheme. For vegetable consumption, the themes of 'Healthy eating habits,' 'Sustainable food production,' and 'Organic production' also demonstrated a positive significant effect. These themes should be emphasized in future interventions.

The educational activity 'Visits to farms' has shown a positive significant effect on children's vegetable consumption, while 'Tasting and cooking' activities have had a significant opposite effect. This suggests that different strategies may be needed to promote fruit and vegetable consumption. For example, organizing more farm visits could potentially increase vegetable consumption.

In terms of communication activities, 'Posters at school' and a 'Dedicated website' have shown a positive significant effect on average children's fruit consumption at schools. For vegetable consumption, a 'Dedicated website' has shown a positive significant effect. These communication channels could be effectively utilized to disseminate information and promote healthier eating habits. However, several AEM measures, themes, and communication activities have shown insignificant effects on children's average fruit and vegetable consumption. Further research is necessary to understand why these measures were not as effective and how they might be improved. Our results also indicate that past levels of fruit consumption significantly affect current consumption levels, suggesting that children's eating habits are somewhat consistent over time. This temporal dependency should be considered when designing policy interventions.

The scientific problem investigated in this article involves identifying policy measures (interventions) and other factors that influence children's fruit and vegetable consumption in primary schools. This issue was explored using data from primary schools in the EU Member States participating in the EU School Scheme. The objective of this study was to understand how various educational activities, their themes, communication channels about healthy and sustainable eating, and the impact of the Covid-19 pandemic affect children's dietary habits, especially their consumption of fresh fruits and vegetables. The study aimed to identify effective strategies for shifting children's eating patterns towards healthier and more sustainable choices. These insights could assist policymakers in enhancing interventions that promote sustainable and healthy eating habits among children. Contributing to empirical research on the factors affecting children's healthy eating habits, the study highlights specific educational activities and communication strategies that significantly increase children's fruit and vegetable consumption. These findings contribute to the broader goal of improving public health and addressing environmental concerns through the promotion of sustainable food consumption.

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